

# Midwest Vegetable Production Guide for Commercial Growers 2009

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# What's New in 2009?

## Highlights of Changes in this Edition

### *New and Revised Sections*

- A number of chapters have been combined so that the information presented in this guide is presented in a format similar to pesticide labels.
  - The new Fruiting Vegetables chapter contains information for eggplant, pepper, and tomato.
  - The new Legumes chapter contains information for peas and cowpeas; and snap bean, dry bean, and lima bean.

### *Cultural Practices*

- Spacing recommendations have been added for mini- or “personal” watermelon.

### *Disease Management*

- The fungicide Nova 40W<sup>®</sup> (myclobutanil) has been renamed Rally 40WSP<sup>®</sup>. Like Nova 40W<sup>®</sup>, Rally 40WSP<sup>®</sup> is labeled for use on asparagus, cucurbits, mints, snap beans, and tomato for control of powdery mildew, rust, and Rhizoctonia diseases.
- The fungicide Presidio 4SC<sup>®</sup> (fluopicolide), manufactured by Valent, has been labeled for use on cucurbits, fruiting vegetables, leafy vegetables, and sweet potato for control of downy mildew, white rust, and phytophthora diseases.
- The fungicide Revus 2.09SC<sup>®</sup> (mandipropamid), manufactured by Syngenta, has been labeled for use on crucifers, cucurbits, leafy vegetables, onions, and peppers for control of downy mildew and phytophthora diseases.
- The fungicide Folicur 3.6F<sup>®</sup> (tebuconazole), manufactured by Bayer CropScience, has been labeled for use on asparagus, cucurbits, onions, leafy vegetables, and root crops for a variety of diseases.
- The fungicide Quintec 2.08SC<sup>®</sup> (quinoxifen), manufactured by Dow AgroSciences, has been labeled for use on lettuce, muskmelon, and watermelon for powdery mildew control.

### *Weed Management*

- Callisto<sup>®</sup> (mesotrione), manufactured by Syngenta, and Chateau<sup>®</sup> (flumioxazin), manufactured by Valent, have been labeled for asparagus.
- Callisto<sup>®</sup> (mesotrione), manufactured by Syngenta, and Casoron<sup>®</sup> (dichlobenil), manufactured by Chemtura, have been labeled for rhubarb.
- Cadet<sup>®</sup> (fluthiacet-methyl), manufactured by FMC, Option<sup>®</sup> (foramsulfuron), manufactured by Bayer CropScience, and Laudis<sup>®</sup> (tembotrione), manufactured by Bayer CropScience, have been labeled for sweet corn.
- Poast<sup>®</sup> (sethoxydim), manufactured by BASF, has been labeled for okra, dill, root vegetables and turnip tops.
- Chateau<sup>®</sup> (flumioxazin), manufactured by Valent, has been labeled for garlic and, in Indiana and Illinois, dry bulb onions.
- Valor<sup>®</sup> (flumioxazin), manufactured by Valent, has been labeled for sweet potato.

### *Insect Management*

- Belt SC<sup>®</sup>, manufactured by Bayer CropScience, has been labeled for control of caterpillars on sweet corn.
- Coragen<sup>®</sup>, manufactured by DuPont, has been labeled for control of caterpillars and other insect pests of cole crops, cucurbits, fruiting vegetables, and leafy vegetables.
- Radiant SC<sup>®</sup>, manufactured by Dow Agroscience, has been labeled for control of caterpillars, thrips, and other insects on asparagus, onions, cole crops, sweet corn, fruiting vegetables, leafy vegetables, root and tuber vegetables, legume vegetables, and potatoes.
- Movento<sup>®</sup>, manufactured by Bayer CropScience, has been labeled for control of aphids and whiteflies on fruiting vegetables, leafy vegetables, cole crops, and tuber and corn vegetables.

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**Purdue Extension Vegetable Crops Hotline**

Purdue Extension issues a bi-weekly vegetable newsletter to growers throughout the vegetable growing season at a nominal cost. This newsletter provides timely information on disease and insect activity and management, as well as cultural and post harvest information. To subscribe, send your name, address, and phone number, along with a check for \$15, payable to Purdue University to:

Dan Egel  
Southwest Purdue Ag Program  
4369 N. Purdue Rd.  
Vincennes, IN 47591

Subscribers to the hotline also will receive the *Vegetable Crops Hotline Bulletin*, and faxed or e-mailed updates,

at no extra cost. Please indicate e-mail address or fax number. The hotline also is available free at [www.entm.purdue.edu/Entomology/ext/ext\\_newsletters.html](http://www.entm.purdue.edu/Entomology/ext/ext_newsletters.html).

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# Fertilizing, Liming, and Soil Sampling

## Fertilizer Recommendations

The phosphorus ( $P_2O_5$ ) and potassium ( $K_2O$ ) fertilization recommendations in this publication are based on soil test levels. Recommendations based on a soil test may be obtained from your state soil testing lab or the Cooperative Extension Service.

Nitrogen (N) recommendations given in this publication should be adjusted to account for soil type, cropping history, additions of organic matter, and crop culture system used. For example, for soils with more than 3 percent organic matter and following soybeans, alfalfa, or a grass-legume hay crop, no sidedressed N may be needed. For soils with less than 3 percent organic matter and the above rotation, half of the total N can be applied preplant and the other half sidedressed early in the crop growth cycle. Where the vegetable crop is following corn, rye, oats, wheat, or a previous vegetable crop, there may be no residual soil N available and the crop may benefit from additional sidedressed N.

Transplanted crops, such as cabbage, broccoli, tomatoes, peppers, and melons, often respond to a small amount of water soluble fertilizer in the transplanting water. Special fertilizer grades are used at a rate of 3 pounds per 50 gallons of water. Examples are 14-28-14, 10-52-10, and 23-21-17. The high phosphorus liquid 10-34-0 can also be used at the rate of 2 quarts per 50 gallons of water. Apply the starter solution at 0.5 pint (8 ounces) per plant. If dry weather is prevalent, irrigate after setting the plants.

## pH and Lime

Maintaining mineral soil at a soil pH of 6.0 to 6.8, and organic soil at a soil pH of 5.5 to 5.8, is recommended for most vegetable crops. Soil pH should be adjusted only on the basis of a soil test, which should be conducted routinely. If your soil has little natural buffering capacity, low clay content, and low cation exchange capacity (CEC), then annual soil tests are recommended. Such sandy soils include those found along the Wabash, Illinois, Kankakee, Cedar, Iowa, Mississippi, and Missouri rivers.

Low pH (or acid) soils can be a significant problem in most vegetable-producing regions. Vegetables grown under acid soil conditions lack vigor and yield poorly. Under severe conditions, visible foliage injury can result from magnesium deficiency and/or manganese toxicity. The problem can be easily prevented and corrected for the next crop by a proper lime application based on soil

analysis. Magnesium deficiency in low pH soils can best be corrected by applying dolomitic limestone. Be sure to inquire about the magnesium content in the limestone.

Sources of magnesium, other than dolomitic lime, are the soluble salts, potassium-magnesium sulfate (11 percent magnesium) and Epsom salts (10 percent magnesium). Apply one of these products according to the soil test level in Table 1.

**Table 1. Magnesium Application Rates Based on Soil Test Levels**

Magnesium		Relative Level	Magnesium to Apply	
Magnesium Soil Test (ppm)	Minnesota Only		Broadcast lbs./A	Row
0-39	0-50	low	100	20
40-69	51-100	medium	50	10
70+	100+	high	0	0

## Soil Sampling and Analysis

Over any given field, there can be large variations in soil pH, so soil samples for testing should be representative of the entire field. Instructions for taking soil samples are available at your county Extension office.

Soil samples should be taken at the same time each year, preferably in the fall or early spring. Soil pH varies seasonally, making comparisons between winter and summer samples difficult. Samples can be analyzed for pH, lime index, available Bray P1 phosphorus, exchangeable potassium, calcium, magnesium, sulfur, micronutrients, CEC, color, and texture.

The lime index determines the tons of lime per acre a field requires. The lime recommendation should be broadcast and worked into the entire plow layer. In addition to the routine water pH test, soils that are susceptible to large variations in soil pH should be tested for salt pH. The pH (salt) provides a more accurate estimate of the true acidity in these soil types by simulating the effects of fertilizer salts on soil pH.

# Transplant Production

## Greenhouse

Transplant production has replaced direct seeding for many vegetable crops. One of transplanting's primary advantages is earlier fruit production, allowing growers to capture better market conditions. In addition, the high cost of hybrid seed makes it desirable to use each seed as efficiently as possible. Transplanting also gives the crops a competitive advantage against weeds. This section addresses the special skills and knowledge required for successful transplant production.

Most growers use polyethylene-covered greenhouse structures to provide warmth and protection from the environment. Although cole crops do not need the more moderating conditions a greenhouse provides, they can be grown in coldframes, lean-tos, or covered wagon beds.

The heater is one of the most critical features of a transplant greenhouse. Vegetable transplants must be kept at the appropriate temperatures. However, if heaters are improperly exhausted, the transplants can be stunted or deformed. To prevent heater fumes from returning into the greenhouse, chimneys should extend two feet above the ridge of the greenhouse.

There should be some provision for bringing fresh air into the greenhouse. Some heaters vent fresh air into the greenhouse every time the furnace operates. For others, a hole or holes should be cut in the greenhouse wall and fitted with tubes to feed outside air to the heater. Avoid space heaters that may "spit" diesel or gasoline onto nearby plants. Heated air should be circulated using a perforated "sock" or tube that runs the length of the greenhouse, or fans placed on opposite sides of the greenhouse and blowing in opposite directions. Place thermometers in several locations to measure the temperature at plant level. At least one high-low thermometer is a good investment.

For detailed information on greenhouse structures, write to the address below and ask for the publication, *Greenhouse Engineering* (NRAES-33):

Northeast Regional Agricultural Engineering Service  
PO Box 4557  
152 Riley-Robb Hall  
Cooperative Extension  
Ithaca, NY 14853-4557.

## Transplant Containers

A wide variety of transplant containers are available, each with advantages and disadvantages. The most common ones are:

1. Todd planter trays made of Styrofoam (Speedling type)
2. Polystyrene or PVC flats or trays
3. Peat strips, pots or pellets (e.g., Jiffy)

Peat pot containers have the advantage that the root system need not be disturbed upon planting. This is important in crops such as cucurbits that are sensitive to root disturbance. Peat pots also are more forgiving of over watering than other containers. However, peat pots have to be reordered every year. If peat pots are planted partially above ground, moisture is "wicked" away from the plant, often resulting in plant death — peat pellets do not have this disadvantage.

An advantage of the polystyrene and Todd planter flats is that they may be used for several years. Polystyrene and Todd planter flats are both designed so that transplants must be "popped" out of the trays, thus disturbing the root system. This is particularly true if the roots are allowed to grow into the ground beneath the tray. Avoid this problem by raising the flats off the ground. Both the polystyrene and Todd planter flats must be watered with care. Todd planter flats have a pyramidal design that forces roots downward to an open bottom where the roots are air pruned. Some polystyrene containers have open bottoms — tube types have open bottoms, groove types have small drainage holes.

In general, peat type containers are the most expensive, followed by the Todd planter type, then the polystyrene type.

The number of plants in a tray depends on the cell size for each plant. Vegetables are commonly grown in trays with 30 to 300 cells. In general, larger cells lead to greater early yield in fruiting crops. Larger cells are also easier to manage because the greater soil volume holds more water and nutrients. Due to the expense of building and maintaining greenhouse space, many growers have moved to smaller cell volumes so more transplants can be grown in the limited space available. Some growers use two different cell sizes: a larger size for crops they expect to harvest earlier, and a smaller size for crops they expect to harvest later.

## Seeding and Growing

Most vegetable transplants are sown one seed per cell. As a general rule, plant vegetable seeds at a depth two times their diameter. Vegetable seeds temperature requirements vary; most vegetable seeds germinate in the 70°F to 90°F range. The time from seeding to transplanting varies from three to four weeks (e.g., muskmelon) to 10 to 12 weeks (e.g., celery).



Vegetable seed may be ordered with special features, including seed priming and pelletizing. Primed seeds have been partially hydrated, then dried down, resulting in earlier germination and better uniformity. Priming may be useful for hard-to-germinate seed such as triploid watermelon. Seed may be pelletized to make it easier to handle. In this process, varieties with small seeds, or irregular seeds (such as lettuce) are coated to make the seed larger and uniform in size and shape. This process makes mechanized planting easier.

The growing mix should be well-drained and free of disease-causing organisms (pathogens). Most commercial mixes fit this description and perform well. These mixes are often referred to as “soilless mixes” since they are composed primarily of peat or coconut coir, perlite or vermiculite, and sometimes bark or ash. These mixes usually come in bales or bags and have been pasteurized (sufficiently heated to kill soil microorganisms capable of causing disease problems). It is advisable to test the mix before using it to make sure the pH is within an acceptable range (between 5.5 and 6.5) and to determine the initial nutrient content of the mix.

Most mixes include a small amount of fertilizer, but transplants usually benefit from additional regular nitrogen (N), phosphorus (P), and potassium (K) fertilization once true leaves appear. Depending on the initial nutrient level in the mix, including calcium (Ca) and magnesium (Mg) in the fertilizer solution may also be advised. Soluble synthetic fertilizers (21-5-20, 20-10-20) and liquid organic fertilizers (fish emulsion) are commonly used. The best rate, frequency, and method of fertilization will depend on your potting mix and watering practices. Common alternatives include a 50 to 200 ppm N solution applied at every watering, or a 300 to 500 ppm N solution applied weekly.

To make a 100 ppm N solution, use 0.42 pounds (6.6 ounces) of a 20 percent nitrogen fertilizer for every 100 gallons of water. Over-application of ammoniacal N can be detrimental to transplants. This problem can be minimized by not over-applying N, and by using fertilizer in which most N is in the nitrate form. Check the bag label.

Transplants that are too tall and tend to fall over are often referred to as “spindly,” “shanky,” or “leggy.” Such transplants may have low survival rates in the field. Spindly transplants are produced under low light conditions, high fertilizer rates, and/or over watering. Cloudy weather or greenhouse structures that don’t let in adequate light could be the culprits. Artificial lights could be helpful during inclement weather, but may be cost prohibitive.

Under such conditions, use a fertilizer containing a lower percentage of P. For instance, try 21-5-20 rather than 20-20-20. It is important to provide adequate P, but not too much. Under fertilization with P will produce short plants, but yields also will suffer. Hot days and cold nights favor leggy transplants. If night temperatures are equal to or higher than day temperatures, stem elongation will be reduced. It may be sufficient to lower the temperatures for a two-hour period starting at dawn.

To prepare transplants for the harsher environment of the field, it is necessary to harden them off. Transplants may be hardened off by withholding water and lowering temperatures moderately during the last week or so of growth. Some growers place transplants in wagons and wheel the transplants outside on appropriate days to get the plants used to field conditions. The transplants are wheeled back inside at night and during especially harsh weather.

After transplanting, plants should be irrigated as soon as possible. Some transplanters are equipped to irrigate plants at the time of transplanting. Otherwise, arrange to irrigate soon. Applying a small amount of starter fertilizer in the transplant water is often beneficial. See Fertilizer Recommendations on page 7, for starter fertilizer recommendations. If transplants are held in the greenhouse to replace those that don’t survive, remember to avoid using transplants that have begun to vine or flower.

## **Diseases**

Diseases that are likely to affect vegetable transplant production in the Midwest fall into two types: damping off diseases (caused by soilborne fungi) and transplant diseases (usually associated with fungi or bacteria which survive with seed or plant residue). Both disease types can cause extensive transplant loss.

Damping off may occur before or after seedlings emerge from the soil. Preemergence damping off occurs when fungi infect seeds as they germinate. As infections progress, seeds rot and eventually disintegrate. Poor stands become apparent after several days or weeks.

Postemergence damping off is usually observed in seed flats or among transplants. Fungi infect stems at or near the soil surface. The affected area of the stem takes on a water-soaked appearance and sometimes becomes constricted. Eventually, the stems are unable to maintain the structural support of seedlings, which usually collapse and die within 24 to 48 hours.

Several soilborne fungi cause damping off on vegetables. *Fusarium*, *Phytophthora*, *Pythium*, and *Rhizoctonia* species are well known causal agents of pre- and post-

**Transplant Production** (continued)

emergence damping off. Control measures to prevent damping off diseases include:

- Using uncontaminated soil mix. Use a commercially prepared soilless growing mix sold in 3 to 4 cubic foot bales or bags. A common mistake is to open a bag of “clean” soil mix and place it on a dirty floor or some other unclean surface prior to planting. Remember that your soil is only as clean as the dirtiest surface it has contacted.
- Planting seeds shallow and in warm soil.
- Using soil mixes that drain well.

Seedborne and residueborne diseases affect most vegetable crops. The pathogens (disease-causing microorganisms) survive in or on seeds or plant residues, not in soil mixes. Outbreaks of these diseases often show up as clusters of diseased plants, and symptoms often include brown lesions with yellow halos on leaves. By contrast, environmentally induced problems often occur uniformly throughout the seedlings or only in one location (for example, close to an outside wall).

Several different fungal or bacterial pathogens may be introduced into a transplant facility via contaminated seed or transplants (Table 2). Once introduced, these pathogens may continue to cause problems year after year if proper precautions are not taken.

**Table 2. Vegetable crops frequently grown as transplants and the diseases that are most often observed on the seedlings.**

Vegetable Crop	Disease
cabbage	black rot
	Alternaria leaf spot
cucumber	angular leaf spot
muskmelon	anthracnose
	gummy stem blight
pepper	bacterial spot
tomato	bacterial canker
	bacterial speck
	bacterial spot
watermelon	anthracnose
	gummy stem blight
	bacterial fruit blotch

The pathogens that cause these diseases may be seedborne.

Several measures should be taken to minimize or prevent introducing seedborne or residueborne pathogens into a transplant facility:

- Avoid saving seed unless you are specifically trained and equipped for seed production.
- Inspect seedlings frequently while they are growing.
- Separate seedlots from one another. Save all information regarding seed purchases.
- Irrigate in the morning to ensure soil and leaf surfaces dry.
- Check fungicide and bactericide labels for specific mentions of greenhouse use when treating transplants (see Table 3 for liquid pesticide conversion table).
- Practice good sanitation. Plant pathogens often survive in soil and plant residues. Therefore, sanitation is as important for a greenhouse as it is for a kitchen. Greenhouse floors should be as free of soil and residue as possible; plastic or cloth floor coverings provide a barrier between dirt floors and transplants. Transplant trays and flats should be new or cleaned and disinfected before each transplant generation.

More detailed information on disease prevention and control in the greenhouse is available in the Purdue Extension publication *Preventing Seedling Diseases in the Greenhouse*, [www.ces.purdue.edu/extmedia/BP/BP-61/BP-61.html](http://www.ces.purdue.edu/extmedia/BP/BP-61/BP-61.html).

**Table 3. Conversion table for use of liquid pesticides on small areas.**

Rate per acre	Rate per 1,000 square feet	Rate per 100 square feet
1 pint	0.75 tablespoon	0.25 teaspoon
1 quart	1.5 tablespoons	0.5 teaspoon
2 quarts	3 tablespoons	1 teaspoons
1 gallon	6 tablespoons	2 teaspoons
25 gallons	4.5 pints	1 cup
50 gallons	4.5 quarts	1 pint
75 gallons	7 quarts	1.5 pints
100 gallons	9 quarts	1 quart

Remember to check the fungicide label for the particular crop, pest, and site of your planned use.

## Using a Plant Diagnostic Lab

The best way to identify insects, plants and plant diseases, or diagnose plant and pest problems, is to send a sample to a diagnostic laboratory. The National Plant Diagnostic Network Web site ([www.npdn.org](http://www.npdn.org)) lists diagnostic laboratories by state and region. Contact individual laboratories for specific submission and fee information (see page 12).

To ensure an accurate diagnosis, it's important to collect and ship your specimens properly. Here are a few guidelines for collecting and shipping specimens to a diagnostic lab.

1. Collect fresh specimens. Send a generous amount of material, if available.
2. Ship specimens in a crush-proof container immediately after collecting. If holdover periods are encountered, keep specimen cool. Mail packages to arrive on weekdays.
3. Incomplete information or poorly selected specimens may result in an inaccurate diagnosis or inappropriate control recommendations. Badly damaged specimens are often unidentifiable and additional sample requests can cause delays.

## Submitting Plant Specimens for Disease/Injury Diagnosis

**Herbaceous Plants.** For generally declining, wilting, or dying plants, send several whole plants showing a range of symptoms (early through more advanced) with roots and adjacent soil intact. Dig up the plants carefully. Place roots and surrounding soil in a plastic bag and fasten it to the base of stem with a twist tie or string. Wrap the plants in dry newspaper and place in a crush-proof container for shipment. Do not add water.

**Leaves/fruit/tubers.** When localized infections (such as leaf spots or fruit rots) are suspected, send specimens representing early and moderate stages of disease. Press leaves flat between heavy paper or cardboard and wrap fruits or tubers in dry paper. Place in a crush-proof container for shipment.

## Submitting Insect Specimens

Package insects carefully so they aren't damaged when they arrive at the lab. Separate and label the specimens if you send more than one type in the same package. Provide the appropriate information for each specimen.

**Tiny or Soft-bodied Specimens.** Submit such specimens (aphids, mites, thrips, caterpillars, grubs, spiders) in a small, leak-proof bottle or vial of 70 percent alcohol. Rubbing alcohol (isopropyl) is suitable and readily available. Do not submit insects in water,

formaldehyde, or without alcohol or they will ferment and decompose.

**Hard-bodied Specimens.** Submit such specimens (flies, grasshoppers, cockroaches, wasps, butterflies, beetles) dry in a crush-proof container. Do not tape insects to paper or place them loose in envelopes.

## Submitting Samples for Nematode Analysis

If you suspect a nematode problem, contact clinics for state-specific submission information (see page 12).

In general nematode identification requires collection of at least one quart of soil from the root zone of affected plants. Include roots if the plants are actively growing.

Place the entire sample in a plastic bag. Do not add water or allow it to dry out. Protect the sample from extreme heat (for example, don't leave samples inside a parked vehicle in direct sunlight). It is often helpful to collect a second, similar sample from a nearby area where plant growth appears normal.

Attach a label, note, or tag identifying the sample to the outside of each bag or package.



*The root system of this plant has been bagged so diagnosticians can examine the roots as well as its foliage upon arrival at the diagnostic laboratory. When submitting samples to a lab, remember to attach a label, note, or tag identifying the sample to the outside of each bag or package.*

## Selected University Diagnostic Labs

### Illinois

May 1-September 15  
Plant Clinic  
1401 W. St. Mary's Road  
University of Illinois  
Urbana, IL 61802

October-April  
N-427 Turner Hall  
1102 S. Goodwin Avenue  
University of Illinois  
Urbana, Illinois 61801

Phone: (217) 333-2478  
Contact: Nancy Pataky  
E-mail: npataky@uiuc.edu  
Web: <http://plantclinic.cropsci.uiuc.edu>

### Indiana

Plant and Pest Diagnostic Laboratory  
Purdue University  
LSPS 101  
915 W. State Street  
West Lafayette, IN 47907-2054

Phone: (765) 494-7071  
Fax: (765) 494-3958  
Contact: Tom Creswell and Gail Ruhl  
E-mail: ppdl@purdue.edu  
Web: [www.ppdl.purdue.edu](http://www.ppdl.purdue.edu)

### Iowa

Iowa State University Plant and Insect Diagnostic Clinic  
327 Bessey Hall  
Iowa State University  
Ames, IA 50011

Phone: (515) 294-0581  
Fax: (515) 294-9420  
Contact: Laura Jesse  
E-mail: sickplant@iastate.edu  
Web: [www.plantpath.iastate.edu/pdc](http://www.plantpath.iastate.edu/pdc)

### Kansas

Plant Disease Diagnostic Lab  
Extension Plant Pathology  
4032 Throckmorton Hall  
Kansas State University  
Manhattan, KS 66506-5504

Phone: (785) 532-5810  
Fax: (785) 532-5692  
Contact: Judith O'Mara  
E-mail: jomara@ksu.edu  
Web: [www.plantpath.ksu.edu/DesktopDefault.aspx?tabid=49](http://www.plantpath.ksu.edu/DesktopDefault.aspx?tabid=49)

### Minnesota

Plant Disease Clinic  
Department of Plant Pathology  
495 Borlaug Hall  
1991 Upper Buford Circle  
University of Minnesota  
St. Paul, MN 55108

Phone: (612) 625-1275  
Fax: (612) 625-9728  
Contact: Dimitre Mollov  
E-mail: dmollov@umn.edu  
Web: <http://pdc.umn.edu>

### Missouri

Extension Plant Diagnostic Clinic  
23 Mumford Hall  
University of Missouri  
Columbia, MO 65211

Phone: (573) 882-3019  
Fax: (573) 884-4288  
Contact: Simeon Wright  
E-mail: plantclinic@missouri.edu  
Web: <http://soilplantlab.missouri.edu>

## Use of Plastic Mulch

Black plastic mulch laid before planting helps control weeds, reduce root pruning, and give profitable increases in early yields of warm-season crops. Wavelength-selective and clear mulches typically lead to greater early yields than black plastic, but weed growth under these mulches may be a problem. This is particularly true for clear mulch. Because leaching is retarded, less fertilizer is lost, and nitrogen sidedressing is often unnecessary with the plastic mulch. If nitrogen needs to be added, it can be applied later through the irrigation system.

Try to lay plastic mulches as early in the season as possible. Mulches should be laid as soon as the ground can be worked after a heavy rain. Plastic mulches should be laid over moist soil. If the plastic is laid over dry soil, it will actually delay subsequent transplant growth. It is

better to lay out plastic at midday so it can be stretched tight. However, do not overstretch the plastic because cool nights may actually cause it to tear.

The seedbed should be as fine as possible in order to get a good covering. The plastic is laid by burying about 6 inches of each edge. Black plastic mulch is most effective in warming the soil when it is in direct contact with the soil.

A disadvantage of plastic mulch is disposal at the end of the season. Many landfills do not accept plastic mulches. Photodegradable plastic mulches, which degrade into small pieces of plastic that remain in the environment, are available. Biodegradable plastic mulches that break down completely are available.

## Irrigation and Water Management

Vegetables require an adequate supply of moisture throughout their entire growth. While the frequency and amount of water varies according to individual vegetable crop, its age, current soil moisture, soil type, and weather conditions, generally 1 to 1.5 acre inches of water are required each week.

**Table 4. Effective Rooting Depth of Selected Vegetables**

Shallow (6-12")	Moderate (18-24")	Deep (> 36")
Beet	Cabbage, Brussels Sprouts	Asparagus
Broccoli	Cucumber	Lima Bean
Carrot	Eggplant	Pumpkin
Cauliflower	Muskmelon	Sweet Potato
Celery	Pea	Watermelon
Greens & Herbs	Potato	Squash, Winter
Onion	Snap Bean	
Pepper	Squash, Summer	
Radish	Sweet Corn	
Spinach	Tomato	

**Table 5. Vegetable Crops and Growth Period Most Critical for Irrigation Requirements**

Crop <sup>1</sup>	Most Critical Period
broccoli, cabbage, cauliflower, lettuce	head development
carrot, radish, beet, turnip	root enlargement
sweet corn	silking, tasseling, and ear development
cucumber, eggplant, pepper, melon, tomato	flowering, fruit set, and maturation
bean, pea	flowering, fruit set, and development
onion	bulb development
potato	tuber set and enlargement

<sup>1</sup> For transplants, transplanting and stand establishment represent a most critical period for adequate water.

The total available water holding capacity (AWHC) for a given location depends on soil texture, organic matter, and rooting depth. AWHC estimates are best obtained from the county soil survey or the local Soil and Water Conservation District office. Table 6 shows AWHC estimates for some typical soil textures in the upper Midwest. Irrigation should be initiated for most crops before 50 percent of the available water is removed by the plants in the active root zone. In most vegetable crops, the majority of the roots are usually within the top 6 to 18 inches of soil. When using a trickle irrigation system on shallow-rooted, water sensitive crops (lettuce, peppers, etc.), the allowable depletion is generally 20 to 25 percent of AWHC and the system is run more frequently. With deeper rooted, more drought-tolerant crops (tomatoes, melons), a higher depletion allowance can be used without loss of yield or quality.

**Table 6. Available Water Holding Capacities for Several Soil Types**

Soil Texture	Available Water Holding Capacity	
	In Inches per Inch of Soil	In Inches per Foot of Soil
Loamy fine sand	0.08-0.12	0.96-1.44
Sandy loam	0.10-0.18	1.20-2.16
Loam	0.14-0.22	1.68-2.64
Silt loam	0.18-0.23	2.16-2.76
Clay loam	0.16-0.18	1.92-2.16

## Soil Water Monitoring

Two common ways of estimating soil water deficit to assist irrigation scheduling are:

1. Measuring soil water tension with soil moisture sensors
2. Measuring the feel and appearance of soil with a soil probe

Soil water tension can be monitored at a given point in the active root zone by electrical resistance moisture

blocks or tensiometers. Soil tension or suction is a measurement usually expressed in centibars that describes how tightly water is held to the soil particles.

Tensiometers directly read soil tension between 0 and 80 centibars and work best in sandy loam or lighter textured soils. Resistance blocks work in a wider range of soil textures, and some types, such as Watermark sensors, work as well in lighter textured soils, as do tensiometers. If the soil texture is known, use Table 7 to estimate the inches of soil water deficit for a given tension reading; use Table 8 to estimate the point of 20 to 25 percent depletion.

For example, let's say you have a sandy loam soil that has an AWHC of 1.5 inches per foot. A tomato crop would be irrigated when 50 percent (or about 0.7 inch) has been depleted in the upper foot of soil, or when a 6-inch tensiometer reads 45 centibars (Table 7). If we use the same soil for another example, a trickle-irrigated pepper crop would be irrigated when 20 to 25 percent (or 0.3 inch) has been depleted in the upper foot soil, or a 6-inch tensiometer reads 22 centibars (Table 8).

To obtain representative soil tension readings with any sensor, the sensors should be left installed throughout the irrigation season and preferably at two or more locations in the field. Two depths are generally desired at each location. These depths should be about one-third and two-thirds of the active root zone, or about 6 and 12 inches.

The feel and appearance method involves collecting soil samples in the root zone with a probe or a spade. The soil water depletion of each sample can be estimated by feeling the soil and comparing its appearance to the description in Table 9. Soil samples should be taken from the top 6 to 12 inches in the root zone and at several locations in the field. Sum up the estimations from various depths for one location to estimate the total soil water depletion in the root zone. The operator must use this method frequently in order to perfect the art of consistently estimating soil water.

Your local Extension office will have more information on in-field soil moisture monitoring tools.

**Table 7. Soil Water Deficit Estimates for Different Soil Textures and Selected Tensions**

Soil Texture	Soil Tension in Centibars						
	10	30	50	70	100	200	1,500 <sup>1</sup>
Soil Water Deficit — Inches per Foot of Soil							
Coarse sands	0	0.1	0.2	0.3	0.4	0.6	0.7
Fine sands	0	0.3	0.4	0.6	0.7	0.9	1.1
Loamy sands	0	0.4	0.5	0.8	0.9	1.1	1.4
Sandy loam	0	0.5	0.7	0.9	1.0	1.3	1.7
Loam	0	0.2	0.5	0.8	1.0	1.6	2.4

<sup>1</sup> 1,500 cbs refers to the permanent wilting point and the soil deficit value is equal to the soil's total available water capacity.

**Table 8. Soil Tension Values for Different Soil Textures For Use in Scheduling Trickle Irrigation**

Soil Texture	0% Depletion of Available Water Holding Capacity (Field Capacity) <sup>1</sup>	20-25% Depletion of Available Water Holding Capacity <sup>2</sup>
	Soil Tension Values (in centibars)	
Sand, loamy sand	510	17-22
Sandy loam	10-20	22-27
Loam, silt loam	15-25	25-30
Clay loam, clay	20-40	35-45

<sup>1</sup> At field capacity the soil contains 100 percent of AWHC; any excess water in the rootzone has drained away.

<sup>2</sup> Start trickle irrigation for shallow-rooted crops at this point.

Information adapted from *New Jersey Commercial Vegetable Production Guide*, New Jersey Ag Expt. Station, Rutgers; and *Water Management in Drip-irrigated Vegetable Production* by T.K. Hartz, UC-Davis, Calif., Vegetable Research and Information Center.

**Table 9. Guide for Judging Soil Water Deficit Based on Soil Feel and Appearance for Several Soil Textures**

Moisture deficiency in./ft.	Soil Texture Classification			
	Coarse (loamy sand)	Sandy (sandy loam)	Medium (loam)	Fine (clay loam)
	<b>(field capacity)</b>	<b>(field capacity)</b>	<b>(field capacity)</b>	<b>(field capacity)</b>
0.0	Leaves wet outline on hand when squeezed	Appears very dark, leaves wet outline on hand, makes a short ribbon	Appears very dark, leaves wet outline on hand, will ribbon out about one inch	Appears very dark, leaves slight moisture on hand when squeezed, will ribbon out about two inches
0.2	Appears moist, makes a weak ball			
0.4		Quite dark color, makes a hard ball	Dark color, forms a plastic ball, slicks when rubbed	Dark color will feel slick and ribbons easily
0.6	Appears slightly moist, sticks together slightly	Fairly dark color, makes a good ball	Quite dark, forms a hard ball	Quite dark, will make thick ribbon, may slick when rubbed
0.8	Dry, loose, flows through fingers (wilting point)	Slightly dark color makes a weak ball		
1.0		Lightly colored by moisture, will not ball	Fairly dark, forms a good ball	Fairly dark, makes a good ball
1.2			Slightly dark, forms weak ball	Will ball, small clods will flatten out rather than crumble
1.4		Very slight color due to moisture (wilting point)	Lightly colored, small clods crumble fairly easily	Slightly dark, clods crumble
1.6				
1.8			Slight color due to moisture, small clods are hard (wilting point)	Some darkness due to unavailable moisture, clods are hard, cracked (wilting point)
2.0				

# Chemigation Management

Chemigation is the process of applying an agricultural chemical (pesticide or fertilizer) to the soil or plant surface with an irrigation system in which the chemical has been injected into the irrigation water. Depending on the type of agricultural chemical being applied, chemigation may be referred to as herbigation, insectigation, fungigation, fertigation, etc.

Only pesticides displaying product EPA label approval for application through an irrigation system can be applied by chemigation. Also, each chemigation and irrigation system must use the required safety equipment specified on the EPA label as well as any listed in the user's respective state codes. Some states also may require a system or operator permit before chemigation can be used to apply any product.

Chemigation can be an effective application option for some labeled pesticides if the irrigation system can apply the chemical/water solution uniformly over the target area with the correct water depth. Some pesticides work best with less than 0.25 inches of water per application. Most late model center pivot and linear move systems provide adequate distribution but some may not be able to apply a small enough water depth. Solid set sprinkler systems may be effective for some pesticides but require close timing of chemical movements to get complete and uniform coverage of the field. Traveling gun and hand move systems do not provide water distribution that has high uniformity and are not recommended. Drip systems apply water to only a limited area of the soil so are not recommended for most pesticide products. Further information on appropriate water application amounts and which irrigation systems are recommended can be found on the product label.

If proper check valves and interlocks are not in place or maintained, injected chemicals could potentially backflow into the water source. EPA and many state regulations specify that each system must contain a reduced pressure zone (RPZ) backflow prevention valve or one or two independent check valves with low-pressure drains and vacuum relief valves between the irrigation water source and the point of chemical injection. Also, most regulations require a power interlock between the irrigation pump and the chemical injector unit, a low pressure shut down switch and a check valve on the chemical injection hose. For specific requirements, check with the appropriate local or state agency.

Accurate calibration of the irrigation system and the pesticide application rate is most important. The



*Chemigation offers the advantage of applying pesticides or fertilizers to vegetable crops when and where they are most needed.*

chemigation operator must be aware of the irrigation system's application speed (acres per hour) for the chosen water application amount and the concentration of chemical solution to determine the rate of chemical injection. A step-by-step procedure on how to determine the system's speed application and chemical injection rate is described in the MidWest Planning Service (MWPS) handbook #30 *Sprinkler Irrigation Systems*, available at [www.bae.umn.edu/extens/mwps/index.html](http://www.bae.umn.edu/extens/mwps/index.html).

More information about the special equipment, operations, and calibration is available in the University of Minnesota Extension Service bulletins, AG-FO-6122, *Chemigation Safety Measures*, and AG-FO-18, *Nitrogen Application with Irrigation Water*, available at [www.extension.umn.edu/](http://www.extension.umn.edu/).



**Table 10. Approximate Time from Pollination to Market Maturity Under Warm Growing Conditions**

Vegetable	Days to Market Maturity
Bean	7-18
Corn, market	18-23 <sup>1</sup>
Corn, processing	21-27 <sup>1</sup>
Cucumber, pickling (3/4-1 1/8-inch diameter)	4-5
Cucumber, slicing	15-18
Eggplant (2/3 maximum size)	25-40
Muskmelon	40-50
Okra	4-6
Pepper, green stage (about maximum size)	45-55
Pepper, red stage	60-70
Pumpkin, jack-o-lantern	60-90
Pumpkin, baking	65-75
Squash, summer, zucchini	3-4 <sup>2</sup>
Squash, winter, butternut	60-70
Squash, winter, hubbard	80-90
Squash, winter, acorn	55-60
Tomato, mature green stage	34-45
Tomato, red ripe stage	45-60
Watermelon	40-50

<sup>1</sup> From 50% silking

<sup>2</sup> For a weight of 0.25-0.5 lbs.

**Table 11. Yields of Vegetable Crops**

Crop	Expected Yields in Tons per Acre		
	Average	Good	Excellent
Asparagus	1	1-2	3
Bean, Snap	2	4	5
Cabbage	13	15	20
Corn, Sweet	3	8	10
Cucumber (slicing)	4	12	15
Cucumber (pickling, hand harvest)	7	10	12
Muskmelon	8	12	16
Onion	15	20	25
Pepper, Green	5	10	17
Potato (fall)	10	15	20
Pumpkin	10	15	40
Spinach	6	8	10
Summer Squash	10	15	20
Sweet Potato	7	12	15
Tomato (fresh market)	6	13	15
Tomato (processing)	25	30	35
Watermelon	15	20	25

## Table 12. Postharvest Handling and Storage Life of Fresh Vegetables

Give careful attention to the postharvest handling and storage of fresh market vegetables. Lack of adequate refrigeration and cooling will result in a shortened shelf-life and lower quality of the fresh vegetable. The following list of recommended storage condition information is modified from the USDA's Agricultural Handbook No. 66, and *Knott's Handbook for Vegetable Growers* (Donald N. Maynard and George J. Hochmuth, 5<sup>th</sup> ed. 2007).

Vegetable	Storage Conditions		
	Temperature (°F)	Relative Humidity (%)	Relative Storage Life
Broccoli	32	95-100	10-14 days
Cabbage, late	32	98-100	5-6 months
Cauliflower	32	95-98	3-4 weeks
Corn	32	95-98	2-5 days, up to 21 days for supersweet cultivars
Cucumber	50-55	90-95	10-14 days
Muskmelon	36-41	95	10-15 days
Watermelon	50-60	90	2-3 weeks
Pepper, green	45-55	90-95	2-3 weeks
Pepper, ripe	42-45	90-95	1 week
Potato, early	<sup>a</sup>	90-95	<sup>a</sup>
Potato, late	<sup>b</sup>	90-95	<sup>b</sup>
Pumpkin	50-55	50-70	2-3 months
Squash, winter	50-55	50-70	<sup>c</sup>
Sweet potato	55-60	85-90	5-6 months
Tomato, mature-green	55-62	90-95	1-2 weeks
Tomato, firm-ripe	45-50	90-95	4-7 days

<sup>a</sup> Most summer-harvested potatoes are not stored. However, they can be held 4-5 months at 40°F if cured 4-5 days at 60-70°F before storage. They can be stored 2-3 months at 50°F without curing. Potatoes for chips should be held at 70°F or conditioned for best chip quality.

<sup>b</sup> Fall-harvested potatoes should be cured at 50-60°F and high relative humidity for 10-14 days. Storage temperatures for seed or table stock should be lowered gradually to 38-40°F. Potatoes intended for processing should be stored at 50-55°F. Those stored at lower temperatures or with a high reducing sugar content should be conditioned at 70°F for 1-4 weeks or until trial cooking tests are satisfactory.

<sup>c</sup> Winter-squash varieties differ in storage life. Acorn squash can be stored for 35-55 days, butternut squash for 60-90 days, and Hubbard squash for 180 days.

Be sure the temperature is not too low. Cucumber, eggplant, lettuce, sweet pepper, potato, snap bean, squash, and tomato are among the most susceptible vegetables to chilling or freezing injury. Some of the typical cold injury symptoms that can make vegetables unmarketable include pitting, water-soaked spots, browning, surface decay, and, in pepper and tomato, failure to ripen.

Follow good agricultural practices and sanitation procedures throughout harvest, grading, and packaging operations. More information is available in *Food Safety Begins on the Farm: A Grower's Guide* from Cornell University. Visit the Cornell Good Agricultural Practices Program at [www.gaps.cornell.edu](http://www.gaps.cornell.edu).

# Farm Labor Law Information

For information about the Immigration and Reform Act and current related farm and labor laws that specify employer responsibilities and seasonal agricultural worker status, contact the resources below:

## Federal

Office of Special Counsel, Washington, D.C.  
Employer Information: (800) 255-8155.  
U.S. Citizenship and Immigration Services  
(800) 375-5283  
(800) 767-1833 (TTY)  
[www.uscis.gov](http://www.uscis.gov)

## Illinois

Travel Control Section,  
Immigration and Naturalization Service  
10 W. Jackson  
Chicago, IL 60604

(Migrant Farm Workers and Farm Labor)  
Department of Labor  
310 S. Michigan Ave.  
Chicago, IL 60604  
(312) 793-2804

## Indiana

Immigration and Naturalization Service (INS)  
950 N. Meridian Street, Room 400  
Indianapolis, IN 46204-3915

Indiana Department of Workforce Development  
Indiana Government Center South  
10 North Senate Avenue  
Indianapolis, IN 46204  
1-888-WORKONE  
[workone@dwd.in.gov](mailto:workone@dwd.in.gov)  
[www.IN.gov/dwd/employers/employer\\_svcs.html](http://www.IN.gov/dwd/employers/employer_svcs.html)

Migrant Farmworkers Project  
Krin Flaherty  
105 E. Jefferson Blvd., Suite 600  
South Bend, IN 46601  
(800) 288-8121 (toll free)  
(574) 234-8121

## Iowa

Iowa Department of Workforce Development  
Attn: John McDonald, Monitor Advocate  
150 Des Moines St.  
Des Moines, IA 50309  
(515) 281-9336

## Kansas

Kansas Department of Commerce Workforce  
Compliance and Oversight, Legal  
Attn: Jenny Tavares, Monitor Advocate  
Kansas Department of Commerce  
1000 SW Jackson St., STE 100  
(785) 296-5014  
E-mail: [jtavares@kansascommerce.com](mailto:jtavares@kansascommerce.com)

## Minnesota

Immigration and Naturalization Service (INS)  
2910 Metro Dr.  
Bloomington MN 55425

Minnesota Labor and Industry Department  
443 Lafayette Rd.  
St. Paul, MN 55155

## Missouri

Missouri Department of Economic Development,  
Division of Workforce Development  
421 E. Dunklin St.  
Jefferson City, MO 65101  
(573) 751-3773  
(573) 751-9571

## Precautions with Pesticides

Pesticides are designed to poison or otherwise manage pests. Many pesticide products may poison people, pets, livestock, wildlife, ornamental plants, and other non-target organisms. Pesticide applicators and their families are at increased risk of pesticide exposure. It is important to keep all pesticide exposures to an absolute minimum.

You must protect your family members, field workers, and other people from pesticide injuries. Most pesticide accidents result from careless practices or lack of knowledge about safe handling. The time you spend to learn about the safe use of pesticides is an investment in the health and safety of you, your family, and others.

The Environmental Protection Agency places certain restrictions on the use of pesticide chemicals. These restrictions apply to chemicals applied to control insects, mites, plant diseases, weeds, nematodes, and other pests. Such restrictions may prohibit the use of a chemical or allow residue tolerances on harvested vegetables. Growers must know what chemical to use on each vegetable; how to apply the products; the post-treatment re-entry interval, if any; when to use the chemicals with respect to farm worker and/or picker safety; and the environment and the harvest of each vegetable crop.

Growers must follow all label instructions regarding harvest restrictions to assure consumers that the food is free of dangerous residues and to comply with the law to prevent seizure of their crops. Here are some rules for the safe use of pesticides:

- Only mix the amount of a pesticide you can use in one day
- If you do have leftover spray mix, the best way to dispose of it is by applying it to a labeled crop in a legal manner
- Never dispose of surplus pesticides in a way that will result in the contamination of ground or surface waters
- Rinse all empty containers three times before disposal.
- Pour the rinse water into the spray tank. Puncture or break triple-rinsed containers to facilitate drainage and to prevent reuse for any other purpose.
- Then dispose of the container according to label directions.

## Rules For Pesticides with "Danger" Signal Word

Formulations of Monitor<sup>®</sup>, Lannate<sup>®</sup>, Thimet<sup>®</sup>, DiSyston<sup>®</sup>, Furadan<sup>®</sup>, Guthion<sup>®</sup>, and Gramoxone<sup>®</sup> are highly poisonous. They should not be applied unless applicators strictly follow all precautions listed on pesticide labels. Some label precautions include:

- Wearing the proper respiratory equipment when handling or applying
- Wearing protective clothing that covers as much of the body as possible
- Always using rubber gloves, not leather or cloth gloves, and certain never bare hands to handle pesticides
- Not breathing in these pesticides when opening containers or mixing into spray tanks
- Always washing hands, arms, and face immediately after handling, and before eating or smoking
- Never smoking while handling or applying
- Reducing all possible hazards of coming into direct contact with spray drift, and avoiding spraying if conditions are too windy
- Showering or bathing thoroughly after each day's work, and changing clothes
- Washing spray clothes separately from the family wash, then running another complete hot water and detergent wash cycle before washing other clothes
- Wearing clean overalls, underwear, socks, and cap each day you spray
- Always keeping pesticides in their original labeled containers, and storing in a safe place
- Storing and disposing containers according to information on pesticide labels

## Symptoms of Pesticide Poisoning

Poisoning symptoms include headache, blurred vision, pinpoint pupils, weakness, nausea, cramps, diarrhea, and discomfort in the chest. Symptoms can begin almost immediately after exposure or may be delayed for several hours. Call a physician any time you are concerned about illness due to contact with pesticides.

If you experience any of these symptoms during exposure to pesticides, stop spraying or dusting immediately, and have someone take you (or go yourself) to a doctor. Do not resume spraying or dusting until you have consulted a doctor and the tests show it is safe to continue. When going to the doctor, take along the pesticide label or a sample label of the pesticide you have been using, the material safety data sheet, and, if possible, the manufacturer's phone number. This information is extremely critical for the doctor to make a proper diagnosis.

## Emergency Treatments

Medical antidotes should be prescribed or given only by qualified physicians. First aid treatments should be given by someone with a specific knowledge of pesticide poisoning first aid. Prepare in advance a thorough plan of action to follow in the event of a pesticide accident.

First aid can initially help a victim while medical help is on the way, or can be administered to a victim en route to qualified help.

In an emergency, call a doctor, emergency medical service, or Area Poison Information Center for immediate help. Know whether the pesticide label has an emergency telephone information number on it. Poison Information Centers have been established in Illinois, Indiana, Iowa, Minnesota, Missouri, and surrounding states to provide physicians with current information on diagnosing and treating accidental poisoning cases.

**The nationwide emergency poison center toll-free number is (800) 222-1222.**

See the inside back cover of this publication for poison control information for your state.

After calling a doctor or hospital, give the information about the poisoning, especially the name of the pesticide product. If they do not have a poison information center there, they should be able to put you in contact with the nearest one. If not, consult your local hospital, and get the name, address, phone number, and director of the center nearest you. You should get this information now just to have it available should the need arise.



Workers applying pesticides or entering an area before the restricted entry interval (REI) period expires must wear the proper personal protective equipment (PPE) described on each pesticide label. For more information, see the EPA publication, *Recognition and Management of Pesticide Poisonings*, [www.epa.gov/pesticides/safety/healthcare/handbook/handbook.htm](http://www.epa.gov/pesticides/safety/healthcare/handbook/handbook.htm).

# Using Bees with Vegetable Crops

In most vegetable plants, seed or fruit development depends on pollination and fertilization. In most cases, this involves the transfer of pollen from the male portion of the flower to the female portion. Pollen also is a source of protein for a wide spectrum of insects. It is especially important to bee species that specialize in collecting pollen. While collecting this valuable food source, these insects provide the pollen transportation link many plants need for reproduction. A single honeybee can carry up to five million pollen grains on its body, and a strong honeybee colony may bring in more than 50 pounds of pollen during a season.

There are several factors that influence the honeybee's role as the pollinating leader. First, only honeybees have developed a significant social system that allows them to overwinter as a colony. This makes it possible for humans to manage honeybees. Populations of naturally occurring bee species have been declining over the last few decades due to reduced natural habitats, parasitic mites, brood diseases, pesticides, and other factors.

At least 90 crops grown in the United States depend to some extent upon bees as pollinators, either for seed or fruit production. The exact number of hives needed to pollinate a crop depends on a number of factors, including the strength and condition of colonies, magnitude of the natural pollinator community, amount of wild flower material competing with the crop, attractiveness of the crop to bees, projected yield, and weather.

The following are guidelines for the number of hives to use when supplemental pollination is desired:

<b>cucumber</b>	(2 to 3 colonies per acre)
<b>muskmelon</b>	(2 to 3 colonies per acre)
<b>pumpkin</b>	(1 colony per acre)
<b>squash</b>	(1 colony per acre)
<b>watermelon</b>	(1 to 5 colonies per acre — the pollination requirements of seedless varieties are generally greater than seeded)

The following vegetables will set fruit without bees, but bee activity has been shown to increase yields:

<b>eggplant</b>	<b>okra</b>
<b>lima bean</b>	<b>pepper</b>

Honeybees do not assist in the pollination of the following crops, but will collect pollen and nectar from them:

<b>pea</b>	<b>sweet corn</b>
<b>snap bean</b>	<b>tomato</b>

Many growers currently purchase pollination services for their vegetable fields from beekeepers. To ensure the mutual satisfaction of growers and beekeepers, both should sign a pollination contract. The following points should be considered in the contract: rental price, number of colonies, strength of colonies, timing of placement in the fields and removal from fields, field location, responsibility for maintenance of the colonies, access for the beekeeper to the hives, liability for stings, and protection from pesticides.

Generally, a grower should require that any hive rented for pollination should have two deep supers (boxes), a good egg-laying queen, at least four to five frames of brood, produce more than 20 pounds of surplus honey, and be disease free. Hives should only be placed in fields after some of the crop's flowering has begun. If hives are placed before flowers are available, bees will forage in surrounding areas and may not return to pollinate the flowers of the intended field. Also, when planning where to place the hives, growers should remember that honeybees usually pollinate flowers most thoroughly within 100 yards of their colony, although if forced to, they will travel much farther. Thus, hives should be distributed in groups throughout the field rather than in a single location, with convenience to the beekeeper in mind as well as uniform pollination.

Certain pesticides and pesticide application practices pose serious hazards to honeybees. In general, nighttime applications pose the least hazard to bees, with early morning applications second best. Applying a single pesticide is usually less dangerous than applying combinations. Systemic insecticides are usually very safe to bees, as are granular formulations. Emulsifiable or water soluble formulations are safer than wettable powders of the same material. The list on page 23 classifies insecticides by the degree of toxicity to honeybees. A list of chemicals and methods of application that are mutually agreeable to growers and beekeepers may be added to pollination contracts.

Growers should work closely with beekeepers to develop a pesticide application scheduling and application program to protect their liability and the honeybees.

## Highly Toxic Insecticides

Severe bee losses can be expected if the following materials are used when honeybees are present at treatment time or within a day thereafter:

Ambush<sup>®</sup>, Ammo<sup>®</sup>, Asana<sup>®</sup>, Baythroid<sup>®</sup>, Diazinon<sup>®</sup>, Dibrom<sup>®</sup>, Dimethoate<sup>®</sup>, Furadan<sup>®</sup>, Fury<sup>®</sup>, Guthion<sup>®</sup>, Imidan<sup>®</sup>, Lannate<sup>®</sup>, Lorsban<sup>®</sup>, Malathion<sup>®</sup>, Monitor<sup>®</sup>, Mustang<sup>®</sup>, Orthene<sup>®</sup>, Penncap-M<sup>®</sup>, Pounce<sup>®</sup>, Scout X-Tra<sup>®</sup>, Sevin<sup>®</sup>, Warrior<sup>®</sup>.

## Moderately Toxic Insecticides

The materials below can be used in the vicinity of honeybees if the dosage, timing, and method of

application are correct; however, they should not be applied directly on honeybees in the field or at the hives:

Admire<sup>®</sup>, Di-Syston<sup>®</sup>, Metasystox R<sup>®</sup>, Provado<sup>®</sup>, Thiodan<sup>®</sup>, Thimet<sup>®</sup>, Vydate<sup>®</sup>.

## Relatively Nontoxic Insecticides and Acaricides

This group of materials can be used around honeybees with a minimum of injury:

*Bacillus thuringiensis* products (Agree<sup>®</sup>, Biobit<sup>®</sup>, Dipel<sup>®</sup>, Javelin<sup>®</sup>, Lepinox<sup>®</sup>, M-Trak<sup>®</sup>, MVP<sup>®</sup>, etc.), Adios<sup>®</sup>, Intrepid<sup>®</sup>, Kelthane<sup>®</sup>, Methoxychlor<sup>®</sup>, Omite<sup>®</sup>, Pyrethrum<sup>®</sup>.

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## Re-entry Standards/Worker Protection

The EPA's Worker Protection Standard (WPS) is "designed to reduce the risk of illness or injury resulting from workers' and pesticide handlers' occupational exposures to pesticides used in the production of agricultural plants on agricultural establishments." It covers workers who come in contact with pesticides, workers who handle pesticides, or workers who are employed in the production of agricultural plants on four types of establishments: farms, forests, nurseries, and greenhouses. The WPS covers the following elements:

**Pesticide Safety Training.** Training instructions have to be provided on a five-year cycle. The pesticide safety training employers will provide their workers includes information on routes of entry, symptoms of poisoning, and emergency first aid. Those workers handling pesticides will need additional training on label interpretation, environmental impact from drift and runoff, wildlife hazards, and pesticide handling.

**Pesticide Safety Information.** Employers will establish a central location, accessible to all workers and handlers, for displaying pesticide information, including a pesticide safety poster, emergency medical care information, and basic pesticide safety concepts.

**Application Notification.** Workers will be notified of specific locations where pesticides have been applied, as well as any re-entry restrictions that may apply. Depending on the particular pesticide product,

notification may be oral or written and may require posting.

**Entry Restrictions.** Workers not involved in application will not be permitted to enter or remain in an area being treated. Under no circumstances may early-entry workers enter a treated area until at least four hours after a pesticide application is completed. Early-entry workers must be equipped with personal protective equipment as required by the pesticide label.

**Personal Protective Equipment.** Employers must provide pesticide handlers with whatever protective gear the pesticide label requires. Employers also must ensure that the equipment fits properly, is used correctly, and is clean, intact, and in good operating condition.

**Decontamination Site.** Water for routine washing and emergency eye flushing, soap, single-use towels, and a change of clothing will have to be provided at a clean site.

**Emergency Assistance.** If a worker or handler is poisoned or injured from a work-related pesticide exposure, the employer is responsible for making prompt transportation available to an emergency medical facility. Employers must provide product-specific information from labels (product name, EPA registration number, active ingredients, antidote, first aid) to medical personnel, and will need to know the circumstances relevant to the application and exposure.

# Insect Management Strategies

Effective insect and mite management involves at least seven steps:

1. Preventive practices.
2. Properly identifying key pest insects and mites, and beneficial organisms.
3. Selecting and using preventive pest management practices.
4. Monitoring the current status of insect and mite populations.
5. Determining the pest's economic loss potential.
6. Selecting the proper pest control option.
7. Evaluating the effectiveness of previously used control options.

## Preventative Insect Management Practices

There are a number of practices that can reduce insect numbers before you actually see the insects in the field. Often, decisions about these practices must be made based on past experience with the insect rather than current knowledge of the severity of the infestation. Many of these practices are good management practices for weeds and diseases as well, so they can easily be incorporated into an overall insect management program.

**Resistant Varieties:** There are not many vegetable varieties that have been bred for insect resistance. However, there are some varieties of cabbage that are resistant to onion thrips. Selection of sweet corn varieties that have husks that completely cover the ear tip and fit tightly around the ear can reduce the amount of corn earworm damage. Short season varieties of potatoes should be grown when possible to give Colorado potato beetles less time to feed and reproduce. This is not resistance, but it is a method that growers can use to reduce insect damage by varietal selection.

**Crop Rotation:** Rotating crops can reduce the severity of a number of pest problems. Rotating potato fields can greatly increase the amount of time it takes Colorado potato beetles to colonize a field, thereby reducing the time the beetles have to increase to damaging levels. Don't plant crops that are susceptible to wireworm or white grub damage in fields that were previously in sod or heavily infested with grassy weeds. In addition, it is a good idea not to plant cabbage or onions next to small grain fields, because onion thrips build up to very high levels in small grains and may move into cabbage or onions when the small grains dry down or are harvested.

**Crop Refuse Destruction:** Destroying the plant residue after harvest can reduce the damage experienced the next year from a number of insects. Destroying squash and pumpkin vines after completion of harvest can greatly reduce the overwintering population of squash bugs and squash vine borers. Early vine killing in potatoes will reduce the potato beetle populations for the following year.

**Tillage:** Fields that receive reduced amounts of tillage or have some sort of grass windbreaks are often more susceptible to damage from insects such as cutworms and armyworms. These cultural practices may have other advantages that outweigh the potential insect problems, but growers should be aware of the potential for increased insect activity.

**Time of Planting:** Because insects tend to become active at specific times each year, varying the time of planting can sometimes help prevent serious insect problems. Corn earworms and fall armyworms are usually a much more serious problem on late-planted sweet corn. If the option is available, planting sweet corn so that it has no green silks before large numbers of earworm moths are flying can reduce earworm problems. Root maggots are usually more serious during cool, wet weather. Waiting until soil temperatures are adequate for rapid plant growth will help reduce maggot problems.

**Biological Control:** Conserving natural enemies is one aspect of biological control that can effectively reduce pest populations and damage. This can be accomplished in several ways, but the most important is reducing the number of insecticide applications. Each time a spray is applied, more predators and parasites are killed. When deciding to use an insecticide, you should consider the impact that application will have on beneficial insects. *Bacillus thuringiensis* products, for example, do not harm beneficial insects.

## Proper Identification

Properly identifying pests is the foundation on which a good insect management program is built. If the pest is not properly identified, the chances of selecting the correct control strategies are greatly diminished. Many insects and mites can be correctly identified simply because they are encountered so often. However, it never hurts to back up your knowledge base with some reference materials. Your county Extension office has a number of bulletins available that will help you properly identify insect pests. There also are a number of good books available with color photographs of many of the common insect pests. Most entomologists don't like to admit it, but we often identify unfamiliar insects by comparing them to pictures in a book.



As will be discussed in the next section, beneficial organisms can be important components of an effective insect management program. Being able to distinguish the good guys from the bad guys may help you avoid unnecessary and possibly disruptive pesticide sprays. Some common beneficial organisms all growers should be able to identify include lady beetle larvae and adults, lacewing larvae and adults, and syrphid fly larvae.

In addition to proper identification, it is helpful to know as much as possible about the insect's biology. All growers should know the difference between insects with incomplete metamorphosis and those with complete metamorphosis.

Insects with incomplete metamorphosis have juvenile stages — called nymphs — that resemble the adults, except that they are smaller and don't have wings. The feeding behavior is usually the same for nymphs and adults. For example, squash bugs are an insect with incomplete metamorphosis.

Insects with complete metamorphosis have a larval stage that is completely different in appearance from the adult. They also have an intermediate stage, known as a pupa, between the larval and adult stages. Larvae never have wings and are not capable of reproducing. Larvae go through a series of molts (shedding their skins) in order to grow. Larvae and adults frequently, although not always, feed differently. Adult insects never grow, so little beetles don't grow up to be big beetles. For example, caterpillars are larvae. In their adult stage, these larvae become moths or butterflies.

For important insect and mite pests, it also is helpful to know the overwintering stage, life cycle length, and number of generations per year that can be expected. Again, most of this information can be found in Extension bulletins.

## **Monitoring**

Vegetable growers must make insect and mite pest management decisions on an almost daily basis during the growing season. To make the best decisions, it is often useful to have information regarding the current status of a pest's population. This can be accomplished through some sort of sampling or monitoring program. There are several methods to monitor insect populations.

Pheromone traps can be used to determine when moths are flying. This information can be used in several ways. First, catching moths in the trap can alert growers to begin looking for the pest in the field. This can save time because the grower won't be looking for the pest before it is present. Second, pheromone trap catches can

be used to time insecticide applications. Third, for some pests, such as corn earworms, the need to spray can be determined from the number of moths caught in the trap. Pheromones are available for many of the caterpillar pests of vegetables.

The most common method for monitoring insects is by scouting fields. Scouting can be formal, such as counting insects on a given number of plants throughout the field, or it can be informal, with the grower walking through the field and looking for insects on the plants. Formal scouting may be more accurate, but the most important thing is for growers to regularly walk their fields looking for insects or insect damage. Some pests, such as mites, may require the use of a hand lens to see. Others may require the use of equipment such as a sweep net or a beat cloth. Most can be monitored just by close inspection of the plants. Regular (weekly) monitoring will allow growers to make informed management decisions.

## **Determining the Potential for Economic Loss**

Unfortunately, we do not have economic thresholds for many vegetable insect pests. Whenever possible, we have listed the best thresholds available along with control options in the crop-specific sections of this manual. Although some of these estimates have not been verified by research in each state, they have been derived from scientific research or extensive observations. Growers may wish to adjust these thresholds based on past experience. Extension bulletins also are useful sources of information regarding potential losses from insects. Growers should remember that some crops, such as snap beans and potatoes, can suffer a great deal of defoliation before there is any effect on yield. Sometimes, plants with considerable amounts of insect damage will yield as well as plants that have no insect feeding. If the pest is one that feeds on the marketable portion of the plant, then less damage can be tolerated.

## **Proper Selection of a Pest Control Option**

In vegetable crops, the selection of a control option during the growing season usually means doing nothing or selecting a pesticide. Although we always encourage growers to read and follow label directions, the one area where the label is not necessarily the best source of information is concerning which insects the insecticide will control. The insecticides recommended in this book for control of various pests are listed because they are legal to use and because they have been found to be

## *Insect Management Strategies (continued)*

effective by the authors. Consider insecticide costs, application costs, relative effectiveness, gain in profits that can be expected from the application, whether it will control other pests, and how it will affect predators, parasites, and pollinators. Growers should refrain from “revenge spraying,” that is, spraying after the damage is already done. At that point, spraying is a waste of money and may actually increase pest damage by killing beneficial insects.

## **Evaluation**

Growers should always evaluate the effectiveness of a pest control action. Inspecting the field a couple of days after an insecticide is applied will help the grower determine the necessity for additional control measures in that field, as well as provide information about the insecticide’s effectiveness for future reference. Growers should pay attention to whether the insecticide killed all stages of the pests or if only small larvae or nymphs were killed. They should also notice the effects on other pests in the field and on beneficial insects.



*All insect management plans should be designed to take advantage of beneficial insects such as the ones shown here:*

*a lacewing larva feeding on aphids (1),  
a lacewing adult (2),  
a lady beetle larva (3),  
an adult lady beetle (4),  
a stink bug feeding on a caterpillar (5)*

**Table 13. Preharvest Intervals (Days) and Re-Entry Intervals (Hours) for Insecticides/Acaracides Registered for Use on Midwest Vegetables 2008<sup>1</sup>**

	Acramite®	Actara®	Admire®	Agri-Mek®	Ambush®	Asana®	Assail®	Avaunt®	Bacillus thuringiensis	Baythroid®	Brigade®, Capture®	Confirm®	Cryolite/Kryocide®	Danitol®	Diazinon®	Dimethoate®	Endosulfan®	Fulfill®	Intrepid®	Kelthane®	Lannate®	Larvin®	Lorsban®	Malathion®	Mustang®	Neemix®	Orthene®	Platinum®	Pounce®	Proclaim®	Provado®	Rimon®	Sevin®	Spin Tor®/Entrust®	Vydate®	Warrior®	
Asparagus								0								180		X			1		1	1		0			1				1	60			
Beet		7	21					0	0						14						10			7	1	0					7		7	3			
Broccoli		0	21		1	3	7	3	0	0	7	7	7	7	7	7	7	7	1		3	7	21	3	1	0		30	1	7	7	7	3	1		1	
Brussels Sprouts		0	21		1		7	3	0	0	7	7	7	7	7		14	7	1		3		21	7	1	0	14	30	1	7	7	7	3	1		1	
Cabbage		0	21		1	3	7	3	0	0	7	7	14	7	21		7	7	1		1	7	21	7	1	0		30	1	7	7	7	3	1		1	
Cantaloupe	3	0	21	7	0	3		3	0	0	3		14	7	3	3	2	0		2	X			1	1	0		30	0				3	3	1		
Carrot		7	21			7			0	0					14		7				1			7		0		30			7		7	3	14		
Cauliflower		0	21		1	3	7	3	0	0	7	7	7	7	7	7	14	7	1		3	7	21	7	1	0	14	30	1	7	7	7	3	1		1	
Celery		7	45	7	1		7	3	0	0		7					4	7	1		7	14		7	1	0	21	30	1	7	7		14	1			
Chinese Cabbage		7	21		1	3	7	3	0	0	7	7		7	10			7	1		10				1	0		30	1	7		7	14	1		1	
Collard		7	21		X	7	7		0	0	7	7	14		10		21	7	1		10		21	7	1	0		30	1	14	7		14	1			
Cucumber	3	0	21	7	0	3		3	0	0	3			7			2	0		2	X			1	1	0		30	0				3	3	1		
Eggplant	3	0	21	7	3	7	7	3	0	7	7	7	14				1	0	1		5			3	1	0		30	3	7	0		3	1	X	5	
Endive		7	21	7	1		7	3	0	0		7			14	14		7	1		10	14		7	1	0		30	1	7	7		14	1			
Green Onion									0						14						7			3	7	0											
Head Lettuce		7	21	7	1		7	3	0	0	7	7	14		14		14	7	1		X	14		7	1	0	21	30	1	7	7		14	1		1	
Kale		7	21				7	3	0	0	7	7			10	14	21	7	1		10		21	7	1	0		30		14	7		14	1			
Kidney Bean						21			0	7						0	3				14			1	X	0	14			7		X	X			X	
Leaf Lettuce		7	21	7	1		7	3	0	0	14	7	14		14	14	14	7	1		X	14		14	1	0		30	1	7	7		14	1		1	
Lima Bean			21						0		3					0					X		X	1	X	0	0			7		X	X			X	
Mint	7	7		28			7	0			14										14		90	7		0	14										
Mustard		7	21			7	7	3	0	0	7	7			10	14	21	7	1		10			7	1	0		30		14	7		14	1			
Okra	3		21					3	0	7														1										1			
Onion Bulb		0			1				0						14						7		X	3	7	0			1							14	
Parsley		7	21	7	1		7	3	0	0		7						7	1		10	14		21	1	0			1	7	7		14	1			
Parsnip		7	21						0	0														7		0		30			7		7	3			
Peas			21			3			0	3					3	0						1			3	0				7		X	X			X	
Pepper	3	0	21	7	3	7	7	3	0	7	7	7	14			0	X	0	1		3			3	1	0	7	30	3	7	0		3	1	7	5	
Potato		14	X	14	14	7	7	7	0	0	21		0			0	1	14			6			0	1	0		X	14		7	14	7	7	7		
Pumpkin	2	0	21	7	0	3		3	0	0	3			7			2	0		2				3	1	0		30	0				3	3	1		
Radish		7	21			7			0	0					14									7		0		30			7		7				
Rhubarb		7	45	7	1		7	3	0	0		7						7	1			14			1	0		30	1	7					1		
Snap Bean			21			3			0	3						0	3				X			1	X	0	14			7		X	X			X	
Spinach		7	21	7	1		7	3	0	0	40	7		X	14	21	7	1		7	14		7	1	0		30	1	7	7		14	1				
Summer Squash	3	0	21	7	0	3			0	3		7	7				2	0		2	X			1	1	0		30	0				3	3	1		
Sweet Corn		14			1	1		X	0	0	1				7		1		3		0	0	35	5	3	0		1				2	1		1		
Sweet Potato		14	125				7	7	0	0	21						1	14					125	3	1	0		X			7	14	7	7	X		
Tomato	3	0	21	7	0	1	7	3	0	0	1	7	14	3	1	7	2	0	1		1			3	1	0		30	0	7	0		3	1	3	5	
Turnip		7	21		X	7			0	0		7				14		7			10			3	1	0		30	1		7			X			
Watermelon	3	0	21	7	0	3		3	0	0	3		14	7	3	3	2	0		2	X			1	1	0		30	0				3	3	1		
Winter Squash	3	0	21	7	0	3		3	0	0	3		14	7			2	0		2				1	1	0		30	0				3	3	1		
Re-Entry Intervals (hours)	12	12	12	12	12	12	12	12	4	12	12	4	12	24	24	48	24	12	4	48	48	48	24	12	12	12	24	12	12	48	12	12	12	4	48	24	

X=check label for details.

<sup>1</sup> Check label directions before applying any of these pesticides.

**Table 14. Common Names of Registered Insecticides and Acaricides**

Common Name	Trade Names	Producers	Formulations <sup>1</sup>
abamectin	Agri-Mek <sup>®</sup>	Syngenta	0.15EC
acephate	Orthene <sup>®</sup>	Valent	75S, 90S
acetamiprid	Assail <sup>®</sup>	Cerexagri	70WP, WSP
azadirachtin	Neemix <sup>®</sup>	Certis	
azinphosmethyl	Guthion <sup>®</sup>	Bayer	2L, 50WP
<i>Bacillus thuringiensis</i> var. <i>aizawai</i>	Agree <sup>®</sup> , Xentari <sup>®</sup>	Certis, Valent,	38%
<i>B. thuringiensis</i> var. <i>kurstaki</i>	Biobit <sup>®</sup> , Dipel <sup>®</sup> , Javelin <sup>®</sup> , Lepinox <sup>®</sup>	Valent, Certis, DuPont	ES, WP, 4L ES, 10G A, WG, F, WP, P, WPG
<i>B. thuringiensis</i> var. <i>tenebrionis</i>	Novodor <sup>®</sup>	Mycogen, Novo Nordisk,	10%, 3%
bifenazate	Acramite <sup>®</sup>	Crompton/Uniroyal	50WS
bifenthrin	Brigade <sup>®</sup> , Capture <sup>®</sup>	FMC	2EC, 1.15G, WSB
carbaryl	Sevin <sup>®</sup>	Bayer, Helena, Wilbur-Ellis	50WP, 80S, 5B, XLR PLUS
carbofuran	Furadan <sup>®</sup>	FMC	4F
chlorethoxyfos	Fortress <sup>®</sup>	AMVAC	5G, 2.5G
chlorpyrifos	Lorsban <sup>®</sup>	Dow Agrosciences, Gowan	4E, 15G, 50W
cyfluthrin	Aztec <sup>®</sup> , Baythroid <sup>®</sup>	Bayer	2EC, 2.1G
cyhalothrin	Warrior <sup>®</sup>	Syngenta	1CS
cypermethrin	Ammo <sup>®</sup>	FMC	2.5EC
cyromazine	Trigard <sup>®</sup>	Syngenta	75WP
diazinon	Diazinon <sup>®</sup>	Micro Flo, Gowan, Helena	50WP, AG500, 4EC, 14G
dimethoate	Dimethoate <sup>®</sup>	Gowan, Helena, Micro Flo	E267, 4EC
disulfoton	Di-Syston <sup>®</sup>	Bayer	8EC, 15G
emamectin	Proclaim <sup>®</sup>	Syngenta	5WDG
endosulfan	Endosulfan <sup>®</sup> , Phaser <sup>®</sup> , Thiodan <sup>®</sup>	Bayer, UCPA, Helena, Micro Flo, Drexel	50WP, 3EC
esfenvalerate	Asana XL <sup>®</sup>	DuPont	0.66 EC
ethoprop	Mocap <sup>®</sup>	Bayer	10G, 20G, 6EC
fenpropathrin	Danitol <sup>®</sup>	Valent	2.4EC
imidacloprid	Admire <sup>®</sup> , Provado <sup>®</sup>	Bayer	2F, 1.6F
indoxacarb	Avaunt <sup>®</sup>	DuPont	30WDG
malathion	Malathion <sup>®</sup>	many	many
methamidophos	Monitor <sup>®</sup>	Valent, Bayer	4F
methomyl	Lannate <sup>®</sup>	DuPont	90WSP, 2.4WSL
methoxyfenozide	Intrepid <sup>®</sup>	Dow AgroSciences	2F
methyl parathion	Penncap-M <sup>®</sup>	Cerexagri	2F (encapsulated)
naled	Dibrom <sup>®</sup>	Valent	8EC
novaluron	Rimon <sup>®</sup>	Chemtura	0.83EC
oxamyl	Vydate <sup>®</sup>	DuPont	2WSL
permethrin	Ambush <sup>®</sup> , Pounce <sup>®</sup>	AMVAC, FMC	25WP, 3.2EC, 1.5G, 0.5B
phorate	Thimet <sup>®</sup>	Micro Flo	20G
phosmet	Imidan <sup>®</sup>	Gowan	70WP
pymetrozine	Fulfill <sup>®</sup>	Syngenta	50WG
pyriproxyfen	Knack <sup>®</sup>	Valent	0.86EC
sodium alumino fluoride	Cryolite <sup>®</sup> , Kryocide <sup>®</sup>	Gowan, Cerexagri	96%
spinosad	SpinTor <sup>®</sup> /Entrust <sup>®</sup>	Dow Agrosciences	2SC
tebufenozide	Confirm <sup>®</sup>	Dow Agrosciences	2F
terbufos	Counter <sup>®</sup>	BASF	15G, 20G
thiamethoxam	Actara <sup>®</sup> , Platinum <sup>®</sup>	Syngenta	25WDG, 2S
thiodicarb	Larvin <sup>®</sup>	Bayer	3.2
zeta-cypermethrin	Mustang <sup>®</sup> , Mustang MAX <sup>®</sup>	FMC	0.8EC, 1.5EW

<sup>1</sup> A=aqueous, B=bait, CS=capsule suspension, D=dust, E or EC=emulsifiable concentrate, ES=emulsifiable suspension, F=Flowable, G=granules, L=Liquid, S or SP=sprayable powder, SC=soluble concentrate, W or WP=wettable powder, WDG=water-dispersible granules, WSL=water soluble liquid, WSP=water soluble powder, WG=wettable granule.



# Weed Management Strategies

Weed management requires a multifaceted approach built on an understanding of weeds and the crop. Weed management may involve nonchemical methods, chemical methods (herbicides), or a combination of the two. The aim of any weed management strategy should be to manage the weed population so it is below a level that will reduce your economic return (economic threshold). It is important to consider the impact of weeds on yield and quality of the current crop, as well as the potential for increasing weed problems in future years if weeds go to seed. Deciding which methods to use depends on environmental concerns, marketing opportunities, desired management intensity, labor availability, weed pressure, and the crop. In some instances, the cost of controlling weeds may be more than the economic return from any yield increase that season. This situation occurs when a few weeds are present or the weeds germinate late in the season. In those instances, the best strategy may be to do nothing, or to do the minimum required to prevent seed production and dispersal. In other situations, weed populations and other considerations may require combining herbicides with nonchemical approaches.

The first step in weed management is to identify the weeds and understand their life cycles. Consult identification guides, such as *Weeds of the North Central States* (University of Illinois Agricultural Experiment Station Bulletin 772), for assistance. Weeds can be categorized by life cycles, and management strategies developed accordingly.

Annual weeds complete their life cycles in one year and reproduce solely by seeds. Annuals can be divided into summer or winter annuals, depending on when they grow. Primary tillage operations often control winter annuals before a crop is planted in the spring. The most common vegetable crop weeds (e.g., barnyard grass,

giant foxtail, common purslane, redroot pigweed, and common lambsquarters) are summer annuals.

Perennial weeds live for more than two years and can reproduce by seed or vegetative structures (stolons, rhizomes, corms, bulbs, tubers, or roots). Because perennial weeds are difficult to manage in vegetable crops, it is usually better not to use a field with severe perennial weed problems.

Many nonchemical weed management methods are common sense farming practices. These practices are of increasing importance due to consumer concerns about pesticide residues, potential environmental contamination from pesticides, and unavailability of many older herbicides.

## Cultural Practices

Farm practices should aim to establish a vigorous crop that competes effectively with weeds. This starts with land selection. A general rule is not to plant vegetables on land with a history of heavy weed infestation, especially perennial weeds. Crop selection can reduce the effects of weed competition. One criterion in selecting a crop should be the weed problems of the field. Plant the most competitive crops in the most weed-infested fields, and the least competitive crops in the cleanest ones. Consider planting heavily infested fields as long-term set-aside acres or in non-row crops such as alfalfa. Permanent cover should help prevent buildup of annual weeds.

Crop rotation is another practice that can reduce weed problems. The characteristics of the crop, the methods used to grow it, and the herbicides used, inadvertently allow certain weeds to escape control. Rotation also affects the weed management tools at your disposal. Rotating between crops will improve crop growth and competitiveness. Related vegetables should not be grown in the same location in successive years (see Table 15).

**Table 15. Botanically Related Vegetables**

Alliums	Corn	Cucurbits	Crucifers	Goosefoot Family	Legumes	Nightshade Family
Garlic	Dent corn	Cucumber	Cabbage	Beet	Dry bean	Eggplant
Onion	Sweet corn	Muskmelon	Cauliflower	Chard	Lima bean	Pepper
		Pumpkin	Broccoli	Spinach	Pea	Potato
		Summer squash	Brussels sprout		Snap bean	Tomato
		Watermelon	Horseradish		Soybean	
		Winter squash	Kale			
			Radish			
			Rutabaga			

Wild proso millet is an example of a problem weed where rotation is important for management. Rotation from sweet corn to small grains, early-planted peas, or alfalfa almost completely eliminates wild proso millet because these crops are established before the soil is warm enough for wild proso millet seed germination. A rotation from sweet corn to broadleaf crops would allow the use of postemergence grass herbicides to manage wild proso millet.

Once a crop is selected, use adaptive, vigorous varieties resistant to diseases. Disease-infected plants cannot effectively compete with weeds. Varieties suited for cultivation in regions covered by this publication are listed in each crop section of this guide.

Narrower row spacings and proper plant densities assure crop canopy closure. Closed canopies shade out later emerging weeds and prevent germination of weed seeds that require light. Weeds seldom are a problem after canopy closure. Proper row spacing and plant density also allow row cultivation.

Correct planting time is another cultural method that can improve crop competitiveness. Crops can be divided into warm- or cool-season plants, depending on the optimum temperature for their growth. Planting date affects the time until emergence and the crop's early seedling vigor, both of which are important in determining crop competitiveness. Cool-season crops germinate at cooler soil temperatures, so compete better against early emerging weeds than warm-season crops. Table 16 lists crops according to their adaptation to field temperatures. Time plantings so temperatures are favorable for crop growth. Adequate fertilization and appropriate insect and disease management are important in assuring competitive crops. Adequate

fertility assures rapid, uniform stand establishment and good crop growth, which enhance the crop's competitiveness. Disease management information and insect management information are contained in this guide. While poor insect and disease control reduce a crop's competitiveness, inadequate weed control also can cause insect and disease problems.

Mulching can be useful in managing weeds. Mulches can be classified as either natural (e.g., straw, leaves, paper, and compost) or synthetic (plastics). Because natural mulches are difficult to apply over large areas, they are best for small, specialized areas. Natural mulches should be spread evenly at least 1 to 1.5 inches thick over the soil to prevent light penetration. Natural mulch materials must be free of weed seeds and other pest organisms and be heavy enough so they will not be easily displaced by wind or water. A major advantage of natural mulches is that they add organic matter to the soil and do not need to be disposed of at the end of the season.

Synthetic mulches are easy to apply, control weeds within the row, conserve moisture, and increase soil temperature. Black or clear plastic mulches are the most common and are effective in improving early-season growth of warm-season crops such as tomato, muskmelon, watermelon, or pepper. Fast early-season growth of these crops improves their competitive ability against weeds. Plastic mulches used in combination with trickle irrigation can also improve water use efficiency.

A disadvantage of plastic mulch is disposal at the end of the season. Many landfills do not accept plastic mulches. Photodegradable plastic mulches have been developed, but their season-long persistence has been a problem, and they degrade into small pieces of plastic

**Table 16. Classification of Vegetable Crops According to Their Adaptive Field Temperatures**

Cool-season		Warm-season	
Hardy <sup>1</sup>	Semi-Hardy	Tender	Very Tender
Asparagus	Carrot	Snap bean	Cucumber
Broccoli	Cauliflower	Sweet corn	Eggplant
Cabbage	Chinese cabbage	Tomato	Lima bean
Horseradish	Lettuce		Muskmelon
Onion	Potato		Okra
Pea			Pepper
Spinach			Pumpkin
			Squash
			Watermelon

<sup>1</sup> Hardy crops are most tolerant of cool temperatures and frost. Very tender crops are most susceptible to frost and cool temperatures.

that contaminate the environment. Biodegradable plastic mulches are available.

## **Mechanical Practices**

Mechanical weed management relies on primary and secondary tillage implements such as moldboard plows, disks, rotary hoes, and row cultivators. Mechanical weed management starts with seedbed preparation. Few no-till systems have been developed for vegetable crops. No-till suggestions are discussed in the sections on biological practices and reduced tillage systems.

Moldboard plowing is usually the first step in mechanically managing weeds. Moldboard plowing is particularly useful in controlling emerged annual weeds. Rotary hoeing is often an important second step in mechanically managing weeds in large-seeded vegetable crops (sweet corn, snap bean, lima bean, and pea). Rotary hoeing should be done after the weeds germinate but before they emerge. Rotary hoeing does not control large-seeded weeds such as velvetleaf and shattercane.

Once the crop has emerged or transplants are established, a row cultivator can be used to manage emerged weeds. Adjust the cultivator sweeps or teeth to dislodge or cover as many weed seedlings as possible. Seedling weeds can be killed by cultivating 1 to 2 inches deep. Best weed control is obtained with a row cultivator in relatively dry soils by throwing soil into the crop row to cover small weed seedlings. Avoid crop injury from poor cultivation, which will reduce crop yields.

In some vegetable crops, such as asparagus, mowing can be an effective weed management tool. Mowing can prevent weed seed production and kill upright weeds, reducing competition. Mowing must be carefully timed to eliminate perennial, biennial, or annual weeds that would compete strongly in vegetables because of their upright growth habits. Timely, repeated mowing also helps deplete the food reserves (root systems) of perennial weeds.

Mechanical control has many limitations that must be considered when designing weed management systems. Because mechanical management relies on relatively dry soil, a rainy period may prevent the use of mechanical weed management options and lead to severe weed competition. Relying entirely on mechanical practices to manage weeds is labor intensive, and many growers will use herbicides combined with nonchemical approaches to control especially difficult weeds. Some of these difficult-to-control weeds include wild proso millet in sweet corn, Canada thistle, hemp dogbane, field bindweed, quackgrass, and johnsongrass. Newly introduced problem weeds often show up in scattered

patches along headlands and field borders. These are best controlled or eradicated with herbicides before large areas are infested.

## **Biological Practices**

Currently, no management system tools exist in the Midwest for using insects or diseases to control weeds common in vegetable crops. Most biological weed management systems to date have been developed to control problem weeds in rangeland areas in the West. One biological system that has potential in the Midwest is the use of cover crops to suppress weed development. These systems are still experimental, but have promise for reducing herbicide use once they are fully developed.

The most promising cover crop system is winter rye. Winter rye is planted in late summer or early fall and overwinters as a cover crop. In the spring, the rye is killed two weeks prior to planting the desired crop. Rye can be killed using herbicides, or, once it has reached the reproductive stage, by mowing, or rolling and crimping. The rye is left as a mulch on the soil surface, and the crop is no-till planted. The system appears to provide early season control of many annual weeds. To obtain acceptable weed control, additional herbicides and/or mechanical control are usually required. The system should be evaluated in small areas before it is adopted.

Table 17 summarizes some nonchemical weed management practices (see page 35.) The most effective weed management system is an integrated approach that combines many different practices. This approach must be adaptive, aiming to prevent weed problems or cope with any that occur.

## **Chemical Weed Management Strategies**

Several herbicides are often labeled for a particular crop. Scouting your area to determine which weeds are present will allow you to select the herbicides that will give you the best control.

All the herbicides labeled for a crop are not necessarily listed in this guide. If you are unfamiliar with an herbicide, conduct a small test under your environmental conditions and cultural practices before using the herbicide extensively.

## **Herbicide Labels**

**Always Read and Understand the Herbicide Label Before Use.** Reading the herbicide label is a very profitable use of your time. Information on the label will direct you to the correct uses, application methods, rates, and potential environmental hazards of the product.



Follow label directions for the best possible control with minimal crop injury and environmental contamination. The label contains restrictions on use and discusses environmental and soil conditions that affect crop injury, influence the effectiveness of weed control, and can cause nontarget site effects.

**Do Not Use Any Herbicide Unless the Label States That It Is Cleared for Your Particular Use and Crop.**

Using a nonregistered pesticide can cause harmful residues in the vegetable crop, which can result in crop seizure and consumer injury. The label also states whether the herbicide is a restricted-use or general-use pesticide. Restricted-use pesticide labels contain a statement that the products are restricted and that only licensed applicators can buy them and supervise their application. The information in this production guide is current as of the date of publication. Watch for notices of changes in the U.S. Environmental Protection Agency (EPA) registration of herbicides in the *Illinois Fruit and Vegetable News* ([www.ipm.uiuc.edu/ifvn](http://www.ipm.uiuc.edu/ifvn)), the *Pest Management and Crop Development Bulletin* ([www.ipm.uiuc.edu/bulletin/index.php](http://www.ipm.uiuc.edu/bulletin/index.php)), or the *Indiana Vegetable Crops Hotline* ([www.entm.purdue.edu/entomology/ext/ext\\_newsletters.html](http://www.entm.purdue.edu/entomology/ext/ext_newsletters.html)).

## **Reduced Tillage Systems**

Reduced tillage systems combat soil erosion. These systems often include the use of glyphosate or paraquat outside the normal growing season to control emerged weeds. Weeds should be growing actively, and the application must be made before the crop has emerged. If you are applying glyphosate to control perennial weeds, apply it before the soil is disturbed. After it is applied, glyphosate must be allowed to translocate throughout the perennial weed for several days, or incomplete control may result. Follow glyphosate label directions carefully for rates and timing of applications. If perennial weeds are not a major problem, you can eliminate early weed flushes by applying glyphosate or paraquat to all weeds that emerge. Plant the crop with minimal working of the soil. Never apply glyphosate or paraquat to an emerged crop because severe crop injury or death will occur.

Glyphosate and paraquat will control most annual broadleaf and grass weeds. Neither herbicide has any soil residual activity, so other weed control measures will be necessary during the growing season. Paraquat will suppress perennials by killing their shoots, but it does not control regrowth of perennial weeds from rhizomes or other underground storage organs. Glyphosate is better for controlling perennials because it will kill shoots and translocate to destroy underground parts. Glyphosate will only suppress some particularly

hard-to-control perennials such as bindweed, hemp dogbane, and milkweed. To control these perennials, high application rates, repeat applications of glyphosate (within label guidelines), or mechanical removal may be necessary.

## **Herbicide Rates and Guidelines for Use in Vegetable Crops**

All herbicide rates given in this guide are in amount of product per broadcast acre. Adjust amounts accordingly for banded applications. Make pre-emergence applications before weeds emerge or after removing any weeds present. Make postemergence applications after weeds have emerged. Several materials may be used between crop rows if appropriate steps are taken to prevent spray from contacting the crop. Some of these materials require shielded sprayers, while others require hooded sprayers. The herbicide recommendations in this guide do not replace careful reading of current herbicide labels. Re-registration of older herbicides has affected the availability of many products. Some of the older herbicides not re-registered are not listed in this bulletin, but may be available, and old stocks can still be used.

## **Environmental and Health Hazards of Herbicides**

Herbicides can have nontargeted effects, so it is very important that you educate yourself about these effects and consider them when designing weed management systems. The following section contains discussions of some of the potential environmental and health hazards of herbicides.

### **Environmental Hazards**

Adverse environmental effects from herbicides can have long-term consequences that are difficult to correct, and must be avoided. Some environmental hazards, such as herbicide drift and carryover, will mainly affect your operation, while other hazards, such as water contamination, affect all residents in the area. The following sections discuss some of the potential hazards and methods to avoid them.

**Herbicide carryover.** Herbicide carryover from persistent herbicides has been a particular problem to vegetable crop growers. Persistence depends on herbicide characteristics (method of degradation, water solubility, and rate of application) and site characteristics (soil type, rainfall, and temperature). Avoid carryover because correcting carryover problems after they have occurred is virtually impossible. The most important method to avoid herbicide carryover is to follow label rotation restrictions. Table 18 summarizes some of the label restrictions (see page 36.) Always refer to the label

## **Weed Management Strategies** (continued)

for specific information. If there are differences between the table and herbicide label, always follow label information.

**Herbicide drift.** Another frequent hazard to vegetable growers is crop injury from herbicide drift. Certain herbicides, if not used correctly, can injure nontarget plants. Herbicides such as clomazone (Command<sup>®</sup>), dicamba, and 2,4-D can drift up to a mile and seriously damage grapes, tomatoes, peppers, other vegetables, fruit trees, and ornamental plants. Before spraying clomazone, dicamba, or 2,4-D, survey the area for desirable plants.

Spray only on calm days, and use drift inhibitors when appropriate. Minimize drift by applying herbicides with nozzles that produce large droplets. Use an amine formulation of 2,4-D to reduce vapor drift. Spray clomazone, dicamba, and 2,4-D when the temperature is expected to be lower than 80°F to 85°F for several days after treatment. Avoid applying clomazone to wet soils.

**Spray tank residuals.** Dicamba or 2,4-D residues in spray tanks also can injure susceptible vegetable crops. Carefully follow label directions for cleaning spray equipment after using dicamba or 2,4-D. If possible, do not use the same spray equipment to apply 2,4-D or dicamba that you use to apply other pesticides.

**Herbicide resistance.** More than 180 weed species have developed resistance to one or more herbicides. Herbicide-resistant populations tend to develop when herbicides with the same mode of action for killing weeds are used every year in the same field. The Herbicide Resistance Action Committee (HRAC) groups herbicides according to their modes of action. Table 21 lists the HRAC groups for vegetable herbicides.

Weeds resistant to herbicides in HRAC Group B (ALS inhibitors) make up 30 percent of the documented resistant biotypes. Sandea<sup>®</sup>, Permit<sup>®</sup>, Matrix<sup>®</sup>, Raptor<sup>®</sup>, and Pursuit<sup>®</sup> are vegetable herbicides in this group. Weeds resistant to herbicides in HRAC Group C1 (Photosystem II inhibitors) make up another 20 percent

of the documented resistant biotypes. Atrazine, Sencor<sup>®</sup>, and Sinbar<sup>®</sup> are in this group. Widespread glyphosate use in agronomic crops has led to the development of glyphosate-resistant weeds, although they still only represent 3.5 percent of resistant biotypes.

Approaches that aim to prevent herbicide resistance combine the use of herbicides, mechanical (cultivation), and cultural (crop rotation) weed management practices. It is important to avoid relying on herbicides from a single HRAC group year after year. Rotate between, or use tank mixes of, herbicides with different modes of action. For example, in asparagus rotate between Sencor<sup>®</sup> and Treflan<sup>®</sup>. Use tillage to control weeds that escape from herbicide applications. To minimize any weed resistance that does occur, it is especially important to scout your fields, paying special attention to any patches of a weed normally controlled by the herbicide. Herbicide labels may contain additional information about avoiding resistance problems.

**Water quality.** Residues of some herbicides such as atrazine, metolachlor, and metribuzin have been found in surface and ground water. Detected levels have normally been low, but contamination of water resources is a growing concern. For example, groundwater contamination from pesticides and nitrates is a particular concern in areas of the Midwest with sandy soils and shallow groundwater.

Factors determining the potential for groundwater and surface water contamination include herbicide solubility in water, rate of degradation, volatility, and tendency for the herbicide to attach to soil particles or organic matter. Herbicides that have high water solubility and long persistence are a particular concern.

Site characteristics (soil type, soil depth, water table depth, slope, and weather) also can lead to contamination of water resources from herbicides. You should be aware of the potential problem of herbicide contamination and take all possible steps to avoid contamination of surface and subsurface water resources.

**Table 17. Summary of Nonchemical Weed Management Practices**

<b>Cultural</b>	
Land selection	Avoid fields with a history of weed problems.
Crop selection	Grow the most competitive crops in fields with histories of weed problems.
Crop rotation	Rotate between vegetables and non-row crops such as alfalfa. Rotate between vegetables in different botanical categories.
Adapted crop varieties	Select crop varieties adapted for your area.
Proper row spacings and plant densities	Use row spacings and plant densities that assure rapid crop canopy closure.
Correct planting times	Plant crops when soil temperatures favor rapid germination and emergence. Do not plant warm-season crops too early in the season.
Appropriate crop management	Vigorous, healthy crops are more competitive against weeds and insects.
Mulch	Natural mulches may be appropriate on small acreages. Synthetic (plastic) mulches are useful to manage weeds within the row in warm-season crops. Consider disposal problems when using plastic mulches.
<b>Mechanical and Thermal</b>	
Moldboard plowing	This can eliminate emerged annual weeds.
Rotary hoeing	This is useful to manage small-seeded weeds in large-seeded crops such as sweet corn, snap bean, lima bean, and pea.
Row cultivator	Dislodge or cover as many weed seedlings as possible. Avoid damaging crop root systems.
Mowing	Mow weeds as soon as flowers appear so no viable weed seed is produced.
Flame weeding	Flame weeding, or using a hot flame to kill weeds, is effective for stale seedbed weed removal or weeds that emerge before the vegetable crop. Flame weeding is effective for weed control in vegetables such as onions, parsnips, and carrots. Some growers have successfully used flame weeding on transplanted onions that are 8-10 in. tall. Sweet corn that has just emerged and potatoes up to 2 in. tall can be flame weeded.
<b>Biological</b>	
Cover crops	This is still experimental. Winter rye system is the most promising and most effective against small-seeded broadleaf weeds.
Insect or disease pests or weeds	No current systems use insects or diseases to manage weeds in common vegetables.

**Table 18. Label Restrictions (in Months) on Rotating to Vegetable Crops**

Herbicide	Tomato	Pea	Snap Bean	Sweet Corn	Pumpkin	Melon	Cole Crops
<b>Soybean Herbicides</b>							
Backdraft®	18-26V	18	11	18	18	18	18-26V
Boundary®	12	8	12	12	12	12	12
Broadstrike Treflan®	26+FB	26+FB	26+FB	18	26+FB	26+FB	26+FB
Canopy XL®	12 <sup>1</sup>	30	30	18	18	18-30	30
Classic®	15 <sup>1</sup>	FB	FB	FB	FB	FB	FB
Command®	9	AT	9	9	AT	9	V
Domain®	NNY	NNY	NNY	NNY	NNY	NNY	NNY
Extreme®	18-40+FB,V	18-40+FB,V	18-40+FB,V	18-40+FB,V	18-40+FB,V	18-40+FB,V	18-40+FB,V
First Rate®	30	9	9	18	30	30	30
Flex Star®	18	10	10	18	18	18	18
Gauntlet®	NNY	NNY	NNY	18	NNY	NNY	NNY
Pursuit DG® <sup>2</sup>	40+FB	4	4	18	40+FB	40+FB	40+FB
Pursuit Plus®	40+FB	4	4	18	40+FB	40+FB	40+FB
Python®	26	4	4	10.5-18V	26	26	26
Raptor®	9	AT	AT	9	9	9	V
Reflex®	18	10	18	10	18	18	18
Sencor®	4	8	12	12	12	12	12
Scepter®	18	18	11	18	18	18	18
Spartan®	12	12	12	18	12	12	12V
Squadron®	18	18	11	18	18	18	18
Synchrony STS®	9 <sup>1</sup>	15	15	15	15	15	15
Tri-Scept®	18	18	11	18	18	18	18
Valor®	12+FB	12+FB	12+FB	4	12+FB	12+FB	12+FB
<b>Corn Herbicides</b>							
Aatrex® and others	NNY	NNY	NNY	AT	NNY	NNY	NNY
Accent®, soil pH < 6.5	10	10	10	10	10	10	10
Accent®, soil pH > 6.5	18	18	18	18	18	18	18
Aim®	AT	AT	AT	AT	V	V	12
Axiom®	NNY	NNY	NNY	NNY	NNY	NNY	NNY
Balance Pro®	18V	18V	18V	6	18V	18V	18V
Basis®	18	8	8	10	18	18	18
Beacon®	18	18	18	8	18	18	18
Bicep®, Bicep II®	18	18	18	AT	18	18	18
Callisto®	18	18	18	AT	18	18	18
Camix®	18	18	18	AT	18	18	18
Celebrity®, Celebrity Plus®	10-18V	10	10	10-15V	10-18V	18-18V	18-18V
Define®	12	12	12	AT	12	12	4-12V
Epic®	NNY	NNY	NNY	NNY	NNY	NNY	6
Exceed®	10	10	10	3	18	18	10
Hornet®	26	10.5-18V	10.5-18V	10.5-18V	26	26	26
Harness Xtra®	NNY	NNY	NNY	NY	NNY	NNY	NNY
Impact®	18	9	9-18V	AT	18	18	18
Lariat®, Bullet®	NNY	NNY	NNY	AT	NNY	NNY	NNY
Laudis®	10	10	10	AT	18	18	18
Leadoff®	NNY	NNY	NNY	AT	NNY	NNY	NNY
Lightning®	40	9.5	9.5	18	40	40	40
Lumax®, Lexar®	18	18	18	AT	18	18	18
Marksman®	18	18	18	AT	18	18	18
Northstar®	18	8	18	8	18	18	18
Permit®	8 <sup>1</sup>	9	9	3	9	18	15-18
Princep®	NNY	NNY	NNY	AT	NNY	NNY	NNY
Spirit®	10-18V	10V	10V	8V	18	18	18
Steadfast®	10-18V	10	10	10-15V	10-18V	10-18V	10-18V
Stinger®	18	18	18	AT	18	18	AT
Surpass®, TopNotch®, Ful-Time®	NNY	NNY	NNY	NY	NNY	NNY	NNY

<sup>1</sup>Transplanted tomatoes only.<sup>2</sup>In Indiana, the replant restriction for transplanted tomatoes and peppers, cabbage, melons, and cucumbers is 18 months.

AT=anytime herbicide labeled for the crop or no rotation restriction exists, FB= field bioassay required before planting the crop, NY=the crop can be planted the year after application, NNY= not next year, the crop cannot be planted the following year, V=variable, intervals vary by crop variety or other conditions specified on label.

**Table 19. Relative Effectiveness of Herbicides for Vegetable Crops<sup>1</sup>**

Ratings Key G=Good F=Fair P=Poor N=None/None Labeled																	
	Barnyardgrass	Crabgrass	Fall Panicum	Foxtails	Goosegrass	Yellow Nutsedge	Morningglory, Annual	Galinsoga	Jimsonweed	Lambsquarters	Nightshade	Pigweed	Purslane	Common Ragweed	Smartweed	Velvetleaf	
<b>Preplant Incorporated Herbicides</b>	Balan <sup>®</sup>	G	G	G	G	G	P	P	P	F	P	G	P	P	P	P	
	Devrinol <sup>®</sup>	G	G	G	G	G	N	N	P	N	F	N	G	N	P	N	
	Dual II Magnum <sup>®</sup>	G	G	G	G	G	F	N	G	P	F	G	G	P	P	N	
	Eptam <sup>®</sup>	G	G	G	G	G	F	P	P	N	F	F-P	G	G	P	P	F
	Eradicane <sup>®</sup>	G	G	G	G	G	F	P	P	N	F	P	F	F	N	N	N
	Frontier <sup>®</sup> /Outlook <sup>®</sup>	G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
	Prefar <sup>®</sup>	G	G	G	G	G	N	N	N	N	F	N	F	F	N	N	N
	Prowl <sup>®</sup> /Pendimax <sup>®</sup>	G	G	G	G	G	N	N	N	N	G	P	G	G	P	P	P
	Pursuit Plus <sup>®</sup>	N	N	N	N	N	N	N	N	N	N	G	G	N	N	N	N
	Ro-Neet <sup>®</sup>	G	G	G	G	G	F	N	F	N	F	P	G	F	P	P	P
	Sonalan <sup>®</sup>	G	G	G	G	G	N	N	N	N	F-G	F	F-G	F-G	N	P	N
	trifluralin	G	G	G	G	G	N	F	N	N	G	P	G	G	P	P	P
	<b>Preemergent Surface Applied Herbicides</b>	atrazine	G	G	P	F	G	F	F-G	G	G	G	G	G	G	G	F
		Callisto <sup>®</sup>	N	N-P	N	N	N	N	F	G	G	G	G	N	P	G	G
Camix <sup>®</sup>		G	G	G	G	G	G	F	G	G	G	G	G	F	G	G	
Chateau <sup>®</sup>		F	F	F	F	F	N	G	N	G	G	G	G	G	G	G	
Command <sup>®</sup>		G	G	G	G	G	N	F	P	F	G	P	G	G	G	G	
Curbit <sup>®</sup>		G	G	G	G	G	N	N	F	N	F	F	G	G	P	P	N
Dacthal <sup>®</sup>		G	G	G	G	G	N	N	P	P	F	N	F	F	N	N	N
Define <sup>®</sup>		G	G	G	G	G	F	N	N	N	F	F	F	G	F	N	N
Dual II Magnum <sup>®</sup>		G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
Frontier <sup>®</sup> /Outlook <sup>®</sup>		G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
FullTime <sup>®</sup> , Keystone <sup>®</sup> , Keystone LA <sup>®</sup>		G	G	G	G	G	F	G	G	G	G	G	G	G	G	G	F
Goal <sup>®</sup>		P	F	F	P	P	N	F	G	F-G	G	G	G	G	G	G	F
Karmex <sup>®</sup>		G	F	F	G	G	P	G	G	G	G	G	G	G	G	G	G
Kerb <sup>®2</sup>		F	F	P	F	F	P	P	P	P	F	P	P	G	F	F	P
Lasso <sup>®</sup>		G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
Lexar <sup>®</sup>		G	G	G	G	G	G	F	G	G	G	G	G	G	G	G	G
Lorox <sup>®</sup>		F	F	F	F	F	N	P	G	F	G	F	G	G	G	G	G
Lumax <sup>®</sup>		G	G	G	G	G	G	F	G	G	G	G	G	G	F	G	G
Matrix <sup>®</sup>		G	P-F	G	G	G	P	P	N	F	F	P	G	F	P-F	F	F
Norton <sup>®</sup>		G	G	N	G	N	F	N	N	N	G	G	G	N	N	G	N
Prowl <sup>®</sup> /Pendimax <sup>®</sup>		G	G	G	G	G	N	N	N	N	G	P	G	G	P	P	P
Pursuit <sup>®</sup>		P	P	P	G	P	P	P	G	F	F	G	G	G	P	G	F
Sandea <sup>®</sup>		P	P	P	P	P	G	G	G	P	G	P	G	F	G	G	G
Sencor <sup>®</sup>		F	F	F	F-G	F	N	N	G	F	G	N	G	G	G	G	G
Sinbar <sup>®</sup>		G	G	G	F-G	G	P	F-G	G	G	G	G	F-G	G	G	G	G
Solicam <sup>®</sup>		G	G	G	G	G	F	N	G	N	F	F	F	F	G	F	F
Spartan <sup>®</sup>		F	F	F	F	F	G	G	G	G	G	F	F	G	N	G	F
Strategy <sup>®</sup>		G	G	G	G	G	N	F	P	F	G	P	F	F	F	F	G
Surpass <sup>®</sup> , TopNotch <sup>®</sup>		G	G	G	G	G	G	P	G	P	G	G	G	F	F	P	P
<b>Postemergent Herbicides</b>		2,4-D	N	N	N	N	N	N	G	G	F	G	G	P	G	P	F
	Accent <sup>®</sup>	G	P	G	G	G	P	G	P	G	P-F	P	G	P	P	G	
	Aim <sup>®</sup>	N	N	N	N	N	N	G	N	N	G	G	F-G	N	F	F	G
	Assure II <sup>®</sup> , Targa <sup>®</sup>	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
	atrazine + oil	G	G	F	F-G	G	G	F-G	G	G	G	G	G	G	G	G	G
	Basagran <sup>®</sup>	N	N	N	N	N	N	G	F	G	G	F	P	P	F-G	F	G
	Buctril <sup>®</sup>	N	N	N	N	N	N	G	N	G	G	G	F	P	G	G	G
	Cadet <sup>®</sup>	N	N	N	N	N	N	N	N	F	F	F	F	N	N	N	G
	Callisto <sup>®</sup>	N	N-P	N	N	N	N	F	G	G	G	G	G	N	F	G	G
	Clarity <sup>®</sup>	N	N	N	N	N	N	N	G	G	F	G	G	G	G	G	G
	Evik <sup>®3</sup>	G	G	G	G	G	F	G	G	G	G	F	G	F	G	G	G
	Fusilade <sup>®</sup>	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
	glyphosate	G	G	G	G	G	F	G	G	G	G	G	G	G	G	G	G
	Goal <sup>®</sup>	P	P	P	P	P	N	F	G	G	F	G	F	G	G	F	F
	Impact <sup>®</sup>	F	F	P	P-F	F	N	P	G	G	G	G	G	N	G	G	G
	Laudis <sup>®</sup>	G	G-F	F	F-G	G	N	F	G	P	G	G	G	N	G	G	G
	Lorox <sup>®</sup>	F	F	F	F	F	N	G	F	G	G	G	G	G	G	F	G
	Matrix <sup>®</sup>	G	P-F	G	G	G	F	F	N	N	F	P	G	F	P-F	F	F
	Option <sup>®</sup>	G	F	G	G	G	P	F	P	G	G	G	G	G	G	F	G
	paraquat	G	G	G	G	G	G	G	F-G	G	G	G	G	G	G	G	G
	Permit <sup>®</sup> , Sandea <sup>®</sup>	N	N	N	N	N	N	N	G	N	P	N	F-G	N	G	F-G	G
	Poast <sup>®</sup>	G	F-G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
	Pursuit Plus <sup>®</sup>	G	G	N	G	N	P-F	P-F	N	G	F	G	G	F	P-F	G	G
	Raptor <sup>®</sup>	G	G	N	G	N	P-F	P-F	N	G	F	G	G	F	P-F	G	G
	Reflex <sup>®</sup>	N	N	N	N	N	N	N	N	N	N	F-G	N	N	F-G	N	N
	Select <sup>®</sup>	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
	Sencor <sup>®</sup>	F	F	F	F	F	N	F-G	G	F	G	P	G	G	G	G	G
	Spin-aid <sup>®</sup>	N	N	N	N	N	N	F	G	F	G	F	P	G	G	G	F
	Stinger <sup>®</sup>	N	N	N	N	N	N	N	G	G	P	F	P	N	G	F	N

<sup>1</sup> For pre-packaged mixtures, see ratings for individual components. <sup>2</sup> Excellent against quackgrass. <sup>3</sup> Post-directed spray.

**Table 20. Preharvest Intervals (Days) and Entry Intervals (Hours) for Herbicides**

	2,4-D	Accent®	Aim®	alachlor	Assure II®/Targa®	atrazine	Balan®	Basagran®	Bicep II Magnum®	Buctril®	Cadet®	Callisto®	Casoron®	Chateau®	Clarity®	Command 3ME®	Curbit®	Dacthal®	Devrinol®	diuron	Dual (II) Magnum®	FulTime®	Eptam®	Eradicnae®	Frontier®	Fusilade®	glyphosate	Goal®, Galigan®	Guardsman Max®	Impact®	Kerb®		
Asparagus	X											X		X	1				X	X							1	X					
Beet			X																									X					
Broccoli			X															X									X	X					
Cabbage			X													45		X									X	X					
Carrot			X																								45	X					
Cauliflower			X															X									X	X					
Collard			X															X									X						
Cucumber			X													45	X	X									X						
Dry Bean			X		30													X			X		X			70	X						
Eggplant			X															X	X								X						
Endive/Escarole			X																								28	X					56
Garlic			X							112				X				X								45	X	60					
Horseradish			X															X									X						
Kale			X															X									X						
Leek			X																								X						
Lettuce			X				X																				X						55
Lima Bean			X					30														X					X						
Mint					30		X		70					80	84												X	X					
Muskmelon			X													X	X	X									X						
Mustard			X															X									X						
Onion, dry bulb			X							X				45				X									45	X	45				
Onion, green bunching			X							X								X									X						
Parsley			X																								X						
Parsnip																											X						
Pea			X		30			30														X					X						
Pepper			X													X		X	X								X						
Potato			X															X				40-60		45			X						
Pumpkin			X														X										X						
Radish			X																								X						
Rhubarb			X									X	X														X						
Snap Bean			X		15			30								45		X			X		X				X						
Spinach			X																								X						
Squash			X													45	X	X									X						
Sweet Corn	X	X	X	X		X	X	X		40	45											X	X		X	50	X			50	45		
Sweet Potato			X													95		X									55	X					
Tomato			X															X	X			90					X						
Turnip, greens			X															X									X						
Turnip, root			X															X									X						
Watermelon			X													X	X	X									X						
Re-Entry Intervals (hours)	48	4	12	12	12	12	12	12	24	24	12	12	12	12	24	12	24	12	12	12	12	12	12	12	12	12	12	12	24	12	12	24	

Registered for Use on Midwest Vegetables in 2009<sup>1</sup>

	Keystone® (L.A)	Laddok®	Laudis®	Lorox®	Matrix®	Nortron®	Option®	Outlook®	paraquat	pendimethalin	Permit®	Poast®	Prefar®	Pursuit®	Pursuit Plus®	Pyramin®	Raptor®	Reflex®	Ro-Neef®	Sandea®	Select®	Sencor®	Sinbar®	Solicam®	Sonalan®	Spartan®	Spin-Aid®	Stinger®	Strategy®	Surpass®, TopNotch®	trifluralin	Valor®				
Asparagus				1					6			1									1	14	5	14								X				
Beet						X						60				X				X		30					60	30								
Broccoli												30	X									30											X			
Cabbage									X			30	X									30											X			
Carrot				14						X		30										30	60										X			
Cauliflower												30	X									30											X			
Collard												30	X									14											X			
Cucumber												14	X								30	14								45						
Dry Bean								70	X	X		30		60	X		X	45			30	30			X								X			
Eggplant									X			20	X								30	20											X			
Endive/Escarole												15	X																					X		
Garlic						X		30	X	45		30	X									45														
Horseradish								40				60										30					X									
Kale												30	X									14												X		
Leek												30																								
Lettuce									X			15-30	X									X														
Lima Bean										X		15			X		X				30													X		
Mint									X			20										21	60			X		45						X		
Muskmelon									X			14	X								57	14								X						
Mustard												30	X									14												X		
Onion, dry bulb						X		30	60	45		30	X									45												60		
Onion, green bunching								30				30																								
Parsley				30								15	X																							
Parsnip				X								14										30														
Pea										X		15		X	X		X																	X		
Pepper									X	X		20	X									30	20												X	
Potato				X	60			40		X		30										30	60												X	
Pumpkin									X			14	X									30	14							X						
Radish												14										15													X	
Rhubarb												30										30														
Snap Bean										X		15					X	30			30														X	
Spinach												15										14								21						
Squash									X			14	X									30	14								45					
Sweet Corn	X	X	X				45	50	X	X		30																		30	X					
Sweet Potato																						30														X
Tomato					45				30	X		20									30	20	7												X	
Turnip, greens												14										14								15						
Turnip, root												14										30							30							
Watermelon									X			20	X								57	14	70							X						
Re-Entry Intervals (hours)	12	48	12	24	4	12	12	12	12-24	24	12	12	12	12	24	12	4	24	12	12	12	12	12	12	24	12	24	12	24	12	12	12	12	12		

X=check label for details. <sup>1</sup>Check label directions before applying any of these pesticides.

**Table 21. Common Names of Registered Herbicides<sup>1</sup>**

Common Name	Trade Name	Producer	HRAC Group <sup>2</sup>	Formulation
2,4-D Amine	many	many	O	4L, 75WSG
acetochlor	Surpass <sup>®</sup> , TopNotch <sup>®</sup>	Dow AgroSciences	K3	6.4EC, 3.2ME
acetochlor+atrazine	FulTime <sup>®</sup> , Keystone <sup>®</sup> , Keystone LA <sup>®</sup>	Dow AgroSciences	K3, C1	2.4+1.6ME, 3+2.25 SC, 4+1.5 SC
alachlor	Lasso <sup>®</sup> , Partner <sup>®</sup>	Monsanto	K3	4E, 65WDG
ametryn	Evik <sup>®</sup>	Syngenta	C1	76DF
atrazine	many	many	C1	many
atrazine+bentazon	Laddok S-12 <sup>®</sup>	Sipcam	C1, C3	2.5+2.5S
atrazine+dimethenamid-P	Guardsman Max <sup>®</sup>	BASF	C1, K3	3.3+1.75L
atrazine+s-metolachlor	Bicep (II) Magnum <sup>®</sup>	Syngenta	C1, K3	3.1+2.4E
benefin	Balan <sup>®</sup>	United Agri-Products	K1	60DF
bensulide	Prefar <sup>®</sup>	Gowan	N	4E
bentazon	Basagran <sup>®</sup>	BASF	C3	4L
bromoxynil	Buctril <sup>®</sup>	Bayer CropScience	C3	2E, 4EC
butylate	Sutan+ 6.7E <sup>®</sup>	Helm Agro	N	6.7E
carfentrazone	Aim <sup>®</sup>	FMC	E	40DF, 40EW
clethodim	Prism <sup>®</sup> , Select <sup>®</sup> , Select Max <sup>®</sup>	DuPont, Valent	A	0.94EC, 2EC, 0.97EC
clomazone	Command <sup>®</sup>	FMC	F3	3ME
clomazone+ethalfuralin	Strategy <sup>®</sup>	UAP/Platte	F3, K1	0.5+1.6 EC
clopyralid	Stinger <sup>®</sup>	Dow Agrosciences	O	3E
cycloate	Ro-Neet <sup>®</sup>	Helm Agro	N	6E
DCPA	Dacthal <sup>®</sup>	AMVAC	K1	75W
dicamba	Clarity <sup>®</sup>	BASF	O	4L
dichlobenil	Casoron <sup>®</sup>	Chemtura	L	4G
dimethenamid-P	Outlook <sup>®</sup>	BASF	K3	6E
diquat	Diquat <sup>®</sup> , Reglone <sup>®</sup>	Syngenta	D	2E
diuron	Karmex <sup>®</sup> , Direx <sup>®</sup> , Diuron <sup>®</sup>	Griffin, Drexel, others	C2	80DF, 4L
EPTC	Eptam <sup>®</sup> , Eradicane <sup>®</sup>	Gowan	N	7E, 20G, 6.7E
ethalfuralin	Curbit <sup>®</sup> , Sonalan <sup>®</sup>	United Agri-Products, Dow Agrosciences	K1	3EC
ethofumesate	Nortron SC <sup>®</sup>	Bayer CropScience	N	4SC
fluazifop-butyl	Fusilade DX <sup>®</sup>	Syngenta	A	2E
flufenacet	Define DF <sup>®</sup>	Bayer CropScience	K3	60DF
flumioxazin	Chateau WDG <sup>®</sup> , Chateau SW <sup>®</sup> , Valor SX <sup>®</sup>	Valent	E	51WDG
fluthiacet-methyl	Cadet <sup>®</sup>	FMC	E	0.91L
fomesafen	Reflex <sup>®</sup>	Syngenta	E	2L
foramsulfuron	Option <sup>®</sup>	Bayer CropScience	B	35WDG
glufosinate	Rely 200 <sup>®</sup>	Bayer CropScience	G	1.67L
glyphosate	many	many	G	many
halosulfuron	Permit <sup>®</sup> , Sandea <sup>®</sup>	Monsanto, Gowan	B	75WSG
imazamox	Raptor <sup>®</sup>	BASF	B	1EC
imazethapyr	Pursuit <sup>®</sup>	BASF	B	70DG
imazethapyr+pendimethalin	Pursuit Plus <sup>®</sup>	BASF	B, K1	EC
linuron	Lorox <sup>®</sup> , Linex <sup>®</sup>	Griffin	C2	50DF, 4L
mesotrione	Callisto <sup>®</sup>	Syngenta	F2	4L
mesotrione+ s-metolachlor	Camix <sup>®</sup>	Syngenta	F2, K3	0.33+3.34EC
mesotrione+ s-metolachlor+atrazine	Lumax <sup>®</sup> , Lexar <sup>®</sup>	Syngenta	F2, K3, C1	0.268+ 2.68+1EC; 0.224+1.74+1.74EC
s-metolachlor	Dual (II) Magnum <sup>®</sup>	Syngenta	K3	7.6E
metribuzin	Sencor <sup>®</sup>	Bayer CropScience	C1	4F, 75DF
napropamide	Devrinol <sup>®</sup>	United Phosphorous	K3	50DF, 2E
nicosulfuron	Accent <sup>®</sup>	DuPont	B	75DF
norflurazon	Solicam <sup>®</sup>	Syngenta	F1	80DF
oxyfluorfen	Goal <sup>®</sup> , Galigan <sup>®</sup>	Dow Agrosciences Makhteshim-Agan	E	2E



**Table 21. Common Names of Registered Herbicides<sup>1</sup>** (continued)

Common Name	Trade Name	Producer	HRAC Group <sup>2</sup>	Formulation
paraquat	Firestorm <sup>®</sup> , Gramoxone Inteon <sup>®</sup> , Parazone <sup>®</sup>	Chemtura, Syngenta, Makteshim Agan NA	D	3L, 2L, 3L
pelargonic acid	Scythe <sup>®</sup>	Dow Agrosciences	Z	4.2L
pendimethalin	Prowl <sup>®</sup> , Pendimax <sup>®</sup>	BASF, Dow Agrosciences	K1	3.3E, 3.8ACS
phenmedipham	Spin-Aid <sup>®</sup>	Bayer Cropscience	C1	1.3E
pronamide	Kerb <sup>®</sup>	Dow Agrosciences	K3	50W
pyrazon	Pyramin <sup>®</sup>	BASF	C1	65DF, 4.5SC
quizalofop	Assure II <sup>®</sup> , Targa <sup>®</sup>	DuPont, Gowan	A	0.88E
rimsulfuron	Matrix <sup>®</sup>	DuPont	B	25DF
sethoxydim	Poast <sup>®</sup> , Ultima 160 <sup>®</sup>	BASF	A	1.5E
sulfentrazone	Spartan <sup>®</sup>	FMC	E	75DF
tembotrione	Laudis <sup>®</sup>	Bayer Cropscience	F2	3.5SC
terbacil	Sinbar <sup>®</sup>	DuPont	C2	80W
topramezone	Impact <sup>®</sup>	Amvac	F2	2.8EC
trifluralin	Treflan HFP <sup>®</sup> , Trilin <sup>®</sup> , Trifluralin <sup>®</sup>	Dow Agrosciences, Griffin, Gowan, Drexel, UAP, and others	K1	4E, 10G

<sup>1</sup> See inside front cover for abbreviations. <sup>2</sup> Herbicide Resistance Action Committee Groups: Herbicides in the same HRAC group have similar modes of action for killing weeds. To reduce the risk of herbicide resistance, do not rely on herbicides in a single HRAC group year after year.

## Disease Management Strategies

### Disease Diagnosis

Before making any management decisions, always make sure to get the right diagnosis of your problem first.

Accurate diagnoses can save time and money because some diseases look alike but have very different management strategies. Moreover, there are several plant health issues (nutritional problems, herbicide injuries, and others) that mimic plant diseases. Unwittingly treating a nutrient deficiency with pesticides wastes time and money, and does not solve the underlying condition.

Submitting samples to a diagnostic laboratory is the best way to ensure the correct diagnosis. For a list of labs, see Page 12.

### Healthy Plant Material

Contaminated seed or transplants can introduce diseases, so saving vegetable seeds for next year's crop is not recommended. Table 22 lists some diseases that may be transmitted by seed to transplants.

Whether you are purchasing transplants or producing them yourself (see Transplant Production, page 8, be certain to inspect seedlings regularly.

### Disease-Resistant Varieties

Whenever possible, use varieties resistant to diseases. Some varieties may not be completely resistant to particular diseases, however, incomplete or partial resistance may be available. Some seed catalogs may refer to tolerance. Table 22 presents information about the availability of resistant varieties.

### Tillage and Crop Rotation

In most situations, crop rotation and fall tillage are the biggest factors in disease management. This is because most pathogens overwinter in crop residues and are unable to survive once the residue decomposes. Tillage (especially fall tillage) helps control diseases by reducing the amount of inoculum (pathogen structures) that survives the winter.

Rotating fields to different crops each year also helps control diseases by preventing the build-up of certain plant pathogens in the soil. Table 22 provides tillage and crop rotation recommendations. A general rule states that crops should not be rotated to others in the same botanical family. Table 15 identifies botanically related crops.

There are three kinds of soilborne diseases that are unaffected by rotation.

## ***Disease Management Strategies (continued)***

The first group of these diseases is caused by pathogens that produce resilient survival structures that can withstand the effects of time and nonhost crops. Examples include Fusarium wilt, and root knot nematode.

The next group of these diseases has a broad host range, so they can survive indefinitely on many host crop and weed species. Examples include Sclerotinia, Rhizoctonia, and Verticillium diseases.

The third group of these diseases overwinters in Gulf Coast states, and then spread north by wind during the growing season. Examples include sweet corn rust and downy mildew of cucurbits.

Consider all options before making management decisions. Rotation is a good general practice that improves or maintains good soil tilth. Tillage (especially fall tillage) often is not in accord with recommended soil management and conservation practices.

### **Other Cultural Practices**

Other practices, such as altering planting times, modifying irrigation methods or schedules, using raised beds, or altering plant density, also can make conditions less favorable for disease. Some of these practices are listed under comments in Table 22.

### **Chemical Control: Fungicides, Bactericides, Nematicides, Fumigants**

Fungicides can be classified as either contact or systemic.

Contact fungicides, also called protectant fungicides, provide a “coat” of protection on the plant’s surface when applied properly. These fungicides are designed to

kill fungi on the surface of plants on contact — hence, the name.

Systemic fungicides, sometimes called eradicator or curative fungicides, don’t merely coat the surface, they also enter into the plant. They can sometimes eradicate or cure a portion of existing infections.

Both contact and systemic fungicides are most effective if they are applied before disease develops. Some worry that using fungicides may lead to pathogens becoming resistant to the chemical. Most contact fungicides have multiple modes of action, so fungal pathogens are unlikely to develop resistance to all of these different modes of action at the same time. For this reason, alternating contact fungicides is unnecessary. Most systemic fungicides have a single mode of action, so the risk of pathogens developing resistance to these products is greater. Always read and follow label directions that list how to alternate systemic fungicides and minimize the resistance development. Table 25 lists several fungicides and their modes of action to help in resistance management.

Bactericides (copper and antibiotic compounds) can help reduce the risk of early-season bacterial disease epidemics, but are most effective when used with other control methods. Copper compounds also are mediocre fungicides and are handled similar to protectant fungicides. Antibiotics serve a similar purpose in certain crops.

Nematicides and fumigants are designed to reduce nematode and soilborne fungus populations before crops are planted. Like other disease-control chemicals, they are most effective when combined with cultural control options such as extended crop rotations and resistant varieties.



Growers should schedule overhead irrigation so that the time when leaves are wet does not overlap with the dew period.

## Table 22. Summary of Cultural Management Strategies for Disease

This table describes several diseases listed by crop. This list is not exhaustive, but represents important Midwest diseases. Also listed are the cultural management options available for each disease. The management options are described in more detail in the text. Note that some pathogens have races. The reaction of a particular race of fungus or bacterium will depend on the cultivar or variety grown. Rotation refers to the number of years that the field should be planted to a different crop.

Crop	Disease	Tillage <sup>1</sup>	Seedborne	Rotation	Resistance	Comments
Cabbage	Alternaria Leaf Spot	3	Yes	3-4	No	
	Black Rot	3	Yes	2-3	No	
	Yellows	2	Yes	>6	Yes	Fusarium fungus is soilborne.
Carrot	Alternaria Leaf Blight	3	Yes	2	Yes	
	Bacterial Blight	3	Yes	2-3	No	
Cucumber	Angular Leaf Spot	3	Yes	2	Yes	
	Anthracnose	3	Yes	2	Yes	
	Bacterial Wilt	1	No	NE <sup>2</sup>	No	Spread by cucumber beetles.
	Phytophthora Blight	2	No	>3	No	Water management is important. Avoid rotations with solanaceous crops.
	Scab	3	Yes	3	Yes	Favored by cool (<70°F), wet weather.
Muskmelon	Alternaria Leaf Blight	3	No	2	No	
	Anthracnose	3	Yes	2	No	
	Bacterial Wilt	1	No	NE <sup>2</sup>	No	Spread by cucumber beetles.
	Gummy Stem Blight	3	Yes	3	No	Also affects pumpkin, watermelon.
	Phytophthora Blight	2	No	>3	No	Water management is important. Avoid rotations with solanaceous crops.
	Powdery Mildew	2	No	2	Yes	
	Root Knot	2	No	>6	No	Wide host range.
Pepper	Anthracnose	3	Yes	3	No	
	Bacterial Spot	3	Yes	2	Yes	Races.
	Phytophthora	2	Yes	3	Yes	Races.
	PVY	1	No	2	Yes	Aphid transmission (reflective mulch).
	TEV	1	No	2	Yes	Aphid transmission (reflective mulch).
	TMV	1	No	2	Yes	Mechanical transmission.
Potato	Early Blight	3	No	3-4	Partial	More disease on early maturing cultivars.
	Late Blight	3	Yes	2-3	Partial	Survives on cull piles and volunteers.
Pumpkin	Bacterial Fruit Spot	3	Yes	2	No	Also affects squash.
	Black Rot	3	Yes	2	No	Same as gummy stem blight on muskmelon, watermelon.
	Downy Mildew	1	No	NE <sup>2</sup>	No	The causal fungus must blow into the Midwest from the southern United States.
	Fusarium Fruit Rot	2	Yes	>4	No	See comments in cucurbit section.
	Phytophthora Blight	2	No	>3	No	Water management is an important tool. Avoid rotations with Solanaceous crops.

<sup>1</sup> 1=tillage is not effective, 2=tillage is of limited help, 3=tillage is an important control

<sup>2</sup> NE=not effective

**Disease Management Strategies** (continued)

Table 22. Summary of Cultural Management Strategies for Disease (continued)

Crop	Disease	Tillage <sup>1</sup>	Seedborne	Rotation	Resistance	Comments
Pumpkin (continued)	Plectosporium Blight	3	No	3-4	No	May be managed like black rot.
	Powdery Mildew	2	No	2	Partial	
	Virus Diseases (several)	1	No	NE <sup>2</sup>	No	Aphids spread virus. All cucurbits affected. Pumpkins planted by June 20 (southern Indiana) set fruit before disease becomes severe.
Snap Bean	Rhizoctonia Root Rot	3	No	NE <sup>2</sup>	No	Deep plow residue.
Sweet Corn	Stewart's Wilt	1	Yes	NE <sup>2</sup>	Partial	Spreads and survives in flea beetles.
Tomato	Anthracnose	3	Yes	2-3	No	Stake and mulch.
	Bacterial Spot	3	Yes	2-3	No	
	Canker	3	Yes	3-4	No	
	Early Blight	3	Yes	3-4	Partial	Some resistance to stem canker.
	Fusarium Crown Rot	2	No	>6	No	
	Fusarium Wilt	2	Yes	>6	Yes	Three races exist.
	Powdery Mildew	2	No	2	No	
	Root Knot	2	No	>6	Yes	Wide host range.
	Septoria Leaf Spot	3	No	2-3	No	
	Speck	3	Yes	2	Yes	
	TMV	1	No	2	Yes	Can be spread by contact.
Verticillium	2	No	>6	Yes		
Vegetables (all)	Damping Off	1	No	NE <sup>2</sup>	No	Warm soils, greenhouse sanitation.
Watermelon	Anthracnose	3	Yes	3	No	
	Bacterial Fruit Blotch	3	Yes	2	No	Volunteer watermelon and cucurbit weeds can spread disease next season.
	Fusarium Wilt	2	Yes	>6	Partial	Three races exist.
	Gummy Stem Blight	3	Yes	3	No	Also affects muskmelon, pumpkin, and squash.
	Phytophthora Blight	2	No	>3	No	Water management is important. Avoid rotations with solanaceous crops.
Root Knot	2	No	>6	No	Wide host range.	
Broadleaf Vegetables	Sclerotinia	2	No	With grasses 3-4	No	Flood. 23-45 days.

<sup>1</sup> 1=tillage has limited effect, 2=tillage is of limited help, 3=tillage is an important control

<sup>2</sup> NE=not effective

**Table 23. Preharvest Intervals (Days) and Re-Entry Intervals for Fungicides Registered for Use on Midwest Vegetables in 2009<sup>a</sup>**

	acibenzolar-S-methyl	azoxystrobin	boscalid	boscalid/pyraclostrobin	chlorothalonil	cyazofamid	cymoxanil/famoxadone	cyprodinil/fludioxonil	dimethomorph	fixed copper	fluopicolide	Aluminum trisofetyl-A	iprodione	mancozeb	mandipropamid	mandi./difenoconazole	maneb	myclobutani	phosphorous acid	propamocarb	propiconazole	pyraclostrobin	quinoxfen	tebuconazole	thiophanate methyl	trifloxystrobin	triflumizole	
Asparagus		100			190							110		180				180	0					100				
Bean, Lima		0	7		14			7		0			b				30		0					14	14			
Bean, Snap		0	7		7			7		0			b					0	0					7	14			
Beet		0								0																	7	
Broccoli	7	0	0		7			7	0	0		3	0		1		7		0				0					
Brussels Sprouts	7	0	0		7			7	0	0		3			1		7		0				0					
Cabbage	7	0	0		7			7	0	0		3	0		1		7		0				0					
Cabbage, Chinese	7	0	c		7			7	0	0		3			1		7		0				0					
Cantaloupe		1	0	0	0	0	3		0	0	2	1/2		5	0		5	0	0	2			0	3		1	0	0
Carrot		0	0	0	0			7		0			0								14	0					7	
Cauliflower	7	0	0		7			7	0	0		3	0		1		7		0				0					
Celery		0			7			0		0	2	3			1				0		14	0					7	
Collard	7	0	14					7	0	0		3			1				0									
Cucumber		1	0	0	0	0	3		0	0	2	1/2		5	0		5	0	0	2			0		7	1	0	0
Eggplant		0	0						0	0	2					1	5		0				0				3	
Endive		0						0			2	3					10						0					
Kale	7	0	14					7	0			3			1		10		0									
Lettuce, Head		0	14				3	0	0		2	3	14		1		10		0	2			0			1		
Lettuce, Leaf		0	14					0	0		2	3	14		1		10		0	2			0			1		
Mint		7			80																30							
Mustard		0	14					7	0	0		3			1				0									
Onion, Bulb		0	7	7	7			7	0	0		7	7	7	7		7		0		14	7			7	0		
Onion, Green		0	7	7	14			7	0	0					7		7		0		0	7				0		
Parsley		0						0		0		3							0				0					
Parsnip		0			10																		0				7	
Peas		0	d							0									0									
Pepper		0	0				3		0	0	2				1	1	7		0	5			0				3	
Potato		14	10		7	7	14		4	0			14	14		14	14		0	14		3				21	7	
Pumpkin		1	0	0	0	0	3		0	0	2	1/2		5	0		5	0		2			0		7	1	0	0
Radish		0																					0					
Spinach	7	0								0	2	3			1				0				0					
Squash, Summer		1	0	0	0	0	3		0	0	2	1/2		5	0		5	0		2			0		7	1	0	0
Squash, Winter		1	0	0	0	0	3		0	0	2	1/2			0		5	0		2			0		7	1	0	0
Sweet Corn		7			14									7			7				14				7			
Tomato	14	0	0		0	0	3		4	0	2	14		5	1	1	5	0	0	5			0				3	
Turnip	7	0								0													0				7	
Watermelon		1	0	0	0	0	3		0	0	2	1/2		5	0		5	0	0	2			0	3	7	1	0	0
Re-Entry Interval (hr)	12	4	12	12	12	12	12	12	12	24	12	12	24	24	12	12	24	24	4	12	12	12	12	12	12	12	12	12

<sup>a</sup>Check label directions before applying any of these pesticides.

<sup>b</sup>Do not apply past peak bloom.

<sup>c</sup>0-day PHI for Napa Chinese Cabbage, 14-day PHI for bok choy.

<sup>d</sup>Succulent only, 7-day PHI

**Table 24. Common Names of Registered Fungicides**

Common Name	Trade Name	Producer	Formulation <sup>1,2</sup>
acibenzolar-S-methyl	Actigard <sup>®</sup>	Syngenta	50WG
fosetyl-Al	Aliette <sup>®</sup>	Bayer	80WP
azoxystrobin	Amistar <sup>®</sup> , Quadris <sup>®</sup>	Syngenta	80WP, 2.08SC
azoxystrobin, chlorothalonil	Quadris Opti <sup>®</sup>	Syngenta	0.5+5.0F
azoxystrobin, propiconazole	Quilt <sup>®</sup>	Syngenta	0.62+1.04F
boscalid	Endura <sup>®</sup> , Pristine <sup>®</sup>	BASF	70WG, 38WG
chlorothalonil	Bravo 500 <sup>®</sup>	Syngenta	500F
	Bravo Ultrex <sup>®</sup>	Syngenta	82.5DG
	Bravo Weather Stik <sup>®</sup>	Syngenta	720F
	Bravo Zn <sup>®</sup>	Syngenta	500F
	Equus <sup>®</sup>	Griffin	DF, 720F
	Echo <sup>®</sup>	Sipcam	720F
Coniothyrium minitans	Contans <sup>®</sup>	Prophyta	5.3WG
copper hydroxide <sup>3</sup>	Kocide 101 <sup>®</sup> , 4.5F, DF	Griffin	50WP, 4.5F, 61DF
	Champion <sup>®</sup>	Agtrol	50WP
	Champ <sup>®</sup>	Agtrol	4.5F
copper sulfate basic <sup>3</sup>	Basicop <sup>®</sup>	Griffin	53WP
	Cuprofix Disperse Ultra <sup>®</sup>	United Phosphorus, Inc.	20DF, 40DF
	Tribasic Copper <sup>®</sup> Sulfate <sup>®</sup>	Citco	53WP
copper resinate	Citcop 5E <sup>®</sup>	Tennessee Chemical	5EC (5%)
cymoxanil	Curzate DF <sup>®</sup>	DuPont	60DF
cymoxanil, famoxadone	Tanos <sup>®</sup>	Dupont	50WDG
cyazofamid	Ranman <sup>®</sup>	ISK Biosciences	400 SC
cyprodinil/fludioxonil	Switch <sup>®</sup>	Syngenta	62.5 WG
fenamidone	Reason <sup>®</sup>	Bayer	500SC
dichloro-nitroaniline	Botran <sup>®</sup>	Gowan	75WP
dimethomorph	Acrobat <sup>®</sup> , Forum <sup>®</sup>	BASF	50WP, 4.18SC
fluopicolide	Presidio <sup>®</sup>	Valent	4SC
iprodione	Rovral <sup>®</sup>	Bayer	50WP
kresoxim-methyl	Sovran <sup>®</sup>	BASF	50WG
mancozeb	Gavel <sup>®</sup> , Dithane M-45 <sup>®</sup> , DF	Rohm & Haas, Dow Agroscience	75DF, 80WP, 80DG
	Manzate 200DF <sup>®</sup>	Griffin	80 DG
	Penncozeb <sup>®</sup>	United Phosphorus, Inc.	80WP
	Penncozeb DF <sup>®</sup>	United Phosphorus, Inc.	75DF
mandipropamid	Revus <sup>®</sup> , Revus Top <sup>®</sup>	Syngenta	2.09SC
maneb	Manex II <sup>®</sup>	Griffin	4F
	Maneb 80 <sup>®</sup>	United Phosphorus, Inc.	80WP, 75DF
	Manex <sup>®</sup>	Griffin	4F
mefenoxam	Ridomil Gold Copper <sup>®</sup>	Syngenta	65WP
	Ridomil Gold Bravo <sup>®</sup>	Syngenta	76WP
	Ridomil Gold EC <sup>®</sup>	Syngenta	47EC
	Ridomil Gold MZ <sup>®</sup>	Syngenta	68WP
myclobutanil	Rally <sup>®</sup>	Dow Agroscience	40WSP
PCNB	Terrachlor <sup>®</sup>	Uniroyal Chemical	10DG, 75WP, 40F
phosphorous acid	Agri-Fos <sup>®</sup>	Agrichem	400FL
	Phostrol <sup>®</sup>	Nufarm	53.6 DF
	Prophyt <sup>®</sup>	Luxembourg	54.5 F
propamocarb	Previcur Flex <sup>®</sup>	Bayer Agroscience	66F
propiconazole	Tilt <sup>®</sup> , Propimax <sup>®</sup>	Syngenta, Dow Agroscience	3.6F
pyraclostrobin	Cabrio <sup>®</sup> , Headline EC <sup>®</sup> , Pristine <sup>®</sup>	BASF	20EG, 2.09EC, 38WG
pyrimethanil	Scala <sup>®</sup>	Bayer	55SC
quinoxifen	Quintec <sup>®</sup>	Dow Agroscience	2.08SC
tebuconazole	Folicur <sup>®</sup>	BayerCropScience	3.6F
thiophanate methyl	Topsin M <sup>®</sup>	United Phosphorus, Inc.	70WSB
triphenyltin hydroxide	Super-tin <sup>®</sup>	Griffin	80WP
trifloxystrobin	Flint <sup>®</sup>	Bayer	50WDG
	Gem <sup>®</sup>	Bayer	25WDG, 500SC
triflumizole	Procure 50WS <sup>®</sup>	Uniroyal Chemical	50WS
zoxamide	Gavel 75DF <sup>®</sup>	Dow Agroscience	75DF

<sup>1</sup> DF=dry flowable, DG=dispersible granules, EC=emulsifiable concentrate, F=flowable suspension, LC=liquid concentrate, SC=soluble concentrate, WP=wettable powder, WSB=water soluble bag

<sup>2</sup> Fungicides are sold commercially as a mixture of active ingredient (that which kills the fungus) and other substances (i.e., carriers, diluents, solvents, wetting agents, emulsifiers, etc.). The formulation indicates the portion of the product that is active ingredient and the physical form of the product. For WP and DG formulations, the number before the abbreviation indicates the percentage of the product that is active ingredient. For example, "50WP" describes a wettable powder that is 50% active ingredient, and "4F" describes a flowable product that contains 4 lbs. of active ingredient per gallon of product.

<sup>3</sup> The number preceding the type of formulation for copper products indicates the percentage or amount of metallic copper in the product. For example, "53WP" describes a wettable powder product that is 53% metallic copper, and "4.5F" describes a flowable product containing 4.5 lbs. of metallic copper per gallon.

## Table 25. Fungicide Resistance Management

Disease-causing fungi may become resistant to fungicides if label precautions are not followed carefully. This table is designed to help growers alternate applications between fungicides with different modes of action to avoid or delay development of fungicide resistance in fungi. Many product labels use the same letters and numbers as those listed in the MOA Code column below. This list is not exhaustive, but does contain many of the fungicides used in the Midwest.

Trade Names	Common Name	Risk of Resistance	MOA Code <sup>1</sup>
Acrobat <sup>®</sup> , Forum <sup>®</sup>	dimethomorph	medium	15 <sup>3</sup>
Actigard <sup>®</sup>	acibenzolar-S-methyl	none-low	P <sup>2</sup>
Aliette <sup>®</sup>	fosetyl-A1	low	33 <sup>3</sup>
Amistar <sup>®</sup> , Quadris <sup>®</sup>	azoxystrobin	high	11 <sup>3</sup>
Bravo <sup>®</sup> , Echo <sup>®</sup> , Equus <sup>®</sup>	chlorothalonil	none-low	M <sup>4</sup>
Cabrio <sup>®</sup> , Headline <sup>®</sup>	pyraclostrobin	high	11 <sup>3</sup>
copper (several)	copper	none-low	M <sup>4</sup>
Curzate <sup>®</sup>	cymoxanil	medium-high	27 <sup>3</sup>
Dithane <sup>®</sup> , Manzate <sup>®</sup> , Penncozeb <sup>®</sup>	mancozeb/maneb	none-low	M <sup>4</sup>
Endura <sup>®</sup>	boscalid	medium	7
Flint <sup>®</sup> , Gem <sup>®</sup>	trifloxystrobin	high	11
Folicur <sup>®</sup>	tebuconazole	medium	3
Gavel <sup>®</sup>	mancozeb (M) + zoxamide (22)	low-medium	M <sup>2</sup> , 22
Maneb <sup>®</sup> , Manex <sup>®</sup>	mancozeb/maneb	none-low	M <sup>2</sup>
Messenger <sup>®</sup>	harpin	none-low	NA <sup>5</sup>
Microthiol <sup>®</sup> , Thiolux Jet <sup>®</sup>	sulfur	none-low	M <sup>2</sup>
Presidio <sup>®</sup>	fluopicolide	medium-high	43
Previcur Flex <sup>®</sup> , Propimax <sup>®</sup>	propamocarb	low-medium	28
Pristine <sup>®</sup>	boscalid (7) + pyraclostrobin (11)	medium-high	7, 11
Procure <sup>®</sup>	triflumizole	medium	3
Quintec <sup>®</sup>	quinoxifen	medium	13
Rally <sup>®</sup>	myclobutanil	medium	3
Ranman <sup>®</sup>	cyazofamid	medium-high	21
Reason <sup>®</sup>	fenamidone	high	11
Revus <sup>®</sup>	mandipropamid	medium-high	40
Revus Top <sup>®</sup>	mandipropamid difenoconazole	low-medium	40 3
Ridomil <sup>®</sup>	mefenoxam	high	4
Rovral <sup>®</sup>	ipridione	medium	2
Scala <sup>®</sup>	pyrimethanil	medium	9
Sovran <sup>®</sup>	kresoxim-methyl	high	11
Switch <sup>®</sup>	cyprodinil (9) + fludioxonil (12)	low-medium	9, 12
Tanos <sup>®</sup>	cymoxanil (27) + famoxadone (11)	medium	27, 11
Tilt <sup>®</sup>	propiconazole	medium	3
Topsin M <sup>®</sup>	thiophanate-methyl	high	1
Ziram <sup>®</sup>	ziram	none-low	M <sup>2</sup>

<sup>1</sup> MOA=mode of action, or FRAC code

<sup>2</sup> P=host plant defense inducers

<sup>3</sup> Fungicides with a numbered MOA code have very specific activity sites and may cause resistance to develop in fungi. These fungicides should be alternated with fungicides with different MOA codes. Read product labels to determine resistance management strategies.

<sup>4</sup> M=multi-site activity. Fungicides with mode of action code M are contact fungicides. It is not necessary to alternate these fungicides for resistance management.

<sup>5</sup> NA=not available

# Plant Parasitic Nematode Management Strategies

## Disease Diagnosis

Plant parasitic nematode management hinges on detection and population density estimation. Before selecting a field for vegetable production, submit a soil sample to a lab with a trained nematologist to analyze the soil for the presence and quantity of plant parasitic nematodes. Root-knot nematodes (*Meloidogyne* spp.) and soybean cyst nematodes (*Heterodera glycines*) are the most important nematode pests commonly found in the Midwest.

## Disease-Resistant Varieties

Resistance to *Meloidogyne incongnita* is available with the Mi gene in tomato, but few other vegetable crops presently have resistant genes for root-knot nematodes. Nematode resistance in tomatoes is indicated by the “N” designation. Resistant varieties should be used whenever possible to reduce yield loss. It is important to have multiple disease resistance genes when more than one important pathogen is present in a field, such as with tomatoes where root-knot nematodes, *Verticillium*, and *Fusarium* can interact.

## Crop Rotation

Plant parasitic nematodes overwinter in the soil or in association with plant material. Crop rotation and weed control are very important in managing plant parasitic nematodes. Root-knot nematodes have a very wide vegetable, field crop, and weed host range. Soybean cyst nematodes have a much narrower host range, but when both nematode species are present, a rotation ideal for soybean cyst nematode reduction may favor buildup of root-knot nematodes.

## Other Cultural Practices

Adequate water and fertilizer can minimize plant parasitic nematode damage. Plant parasitic nematodes reduce the plant root system’s ability to take up water and nutrients. Adequate water and fertilizer do not

reduce nematode density but help plants to cope better with nematode damage, and might increase yield and reduce the symptoms of nematode damage.

Anything that moves soil can spread plant parasitic nematodes to other fields and within the same field. Thus, preventing infested soil and plant material from infesting fields will help with nematode management.

## Chemical Control

Seedling diseases, root diseases, and vascular wilts caused by soilborne fungi and nematodes can be destructive problems in the field and greenhouse. Soil-applied fumigants or nematicides may help prevent serious losses to soilborne disease when combined with long-term management practices.

Soil fumigants are chemicals that are injected into the soil and emit toxic fumes that penetrate air spaces in the soil and kill microorganisms. Fumigants must be sealed into the soil with water or a plastic tarp to ensure that a lethal concentration and exposure time. Because fumigants are harmful to all living plants, a certain amount of time (from two weeks to two months) must pass between treatment and planting to avoid crop damage. Several nonfumigant nematicides are available for several vegetable crops. These generally are systemic compounds that also may provide good insect control.

A number of factors affect the performance of these products, including soil temperature, soil moisture, soil tillage, organic matter, soil type, and time of application. Consult the product label for specific details on safe handling and application methods.

A brief description of several common soil treatments is given in Table 26.



**Table 26. Nematode Soil Treatments**

Chemical	Fumigant/ Nematicide	Application	Plant Back Time	Crops	Comments
methyl bromide (RUP)	F	Preplant, tarped, or mulched for 24-48 hours.	10-14 days	most vegetables	Formulations with 98% methyl bromide and 2% chloropicrin are appropriate for nematode control.
Mocap®, ethroprop (RUP)	N	Soil only. Applied with water by soil injection, sprinkler system, flood irrigation, over soil surface with sprinkling can.		cabbage, sweet corn, cucumbers, potatoes, sweet potatoes, snap beans, lima beans	Mobile in sand soils. Crop injury can occur if used in furrow.
SMDC: sodium methyldithio carbamate (Vapam®, etc.)	F	Preplant tarped. Don't enter within 48 hours.	14-21 days after treatment	general use fumigant	Vapam is more effective when applied with considerable water.
Vydate® (RUP)	N	Soil and foliage treatment.	NA	carrots, celery, cucurbits, eggplants, peppers, potatoes, sweet potatoes, tomatoes	Foliar applications are not effective for moderate and high populations of nematodes.
Telone® (RUP)	F	Soil treatment only.	2-3 weeks	most vegetables	Formulations with high percentages chloropicrin are needed to control soilborne fungal diseases.
Nemacur®, fenamiphos (RUP)	N	Soil treatment only.	NA	cabbage, Brussels sprouts, bok choy, okra, garlic	

F=fumigant  
 N=nematicide  
 RUP=restricted use pesticide

## Slug and Snail Control

Occasionally, slugs and snails seriously damage seedlings; tender, low-growing leafy vegetables; or ripening fruit that are on the ground. Slug and snail feeding damage (hollowed-out areas) can be found anywhere on fruit, but is usually concentrated near the stem. Slugs leave behind telltale slime trails (silvery trails) on the surfaces of fruit or leaves. Slugs and snails are active at night or cloudy days.

Slugs and snails favor continuously moist soil and organic mulch. They lay eggs in groups in moist soil, and overwinter in organic mulch. Slugs can complete their entire life cycle in a field.

If slugs are a problem, their hiding places (i.e., boards, stones, weedy areas), should be eliminated. Heavy


mulching creates favorable slug habitats, so should be thinned so the soil can become warm and dry. Raised beds that can dry out more readily than flat beds reduce slug problems. Using black plastic mulch discourages slug build-up because it causes the soil to heat up and dry out.

As a last resort, metaldehyde bait (e.g., Clean Crop, 3.5G® at 30-40 lbs./A or Clean Crop 7.5G® at 15-20 lbs./A) can be used and is usually very effective. Follow label instructions carefully for application methods for each particular vegetable crop. Apply bait in evening after a rain or irrigation. For an organic alternative, spread diatomaceous earth around plants in a band 1 inch high and 3 inches wide. However, slug control with diatomaceous earth has been poor to fair.

# Organic Vegetable Production

Organic vegetable farming is a production system that relies on biological processes and natural materials to manage soil fertility and pest populations, and to promote healthy crop growth. With the federal Organic Foods Production Act, use of the term “organic” to describe an agricultural product in the marketplace is regulated. Vegetables sold as “organic” must be grown and handled according to the National Organic Rule and any applicable state regulations. The National Organic Rule prohibits the use of most synthetic chemicals (fertilizers, pesticides, etc.), and requires farmers to write and follow organic production plans, as well as keep farm and field records. Fields used to grow organic crops may not have had any prohibited material applied to them in the previous three years. In addition, USDA-accredited organic certification agents must inspect and certify all operations with more than \$5,000 in gross annual income from sales of products labeled “organic.”

Growers interested in transitioning to organic production should educate themselves about practices used in their area and plan carefully. Experience suggests that it can take a number of years for pest populations and soil nutrient cycles to adjust enough for successful organic production. Portions of this guide related to soil sampling, nutrient availability, and crop nutrient requirements include information relevant to organic production, as do the overviews of “Insect Management Strategies,” “Disease Management Strategies,” and “Weed Management Strategies.”

In this guide, products that may be allowed in organic production are denoted by the symbol: . Growers should always check with their organic certification agents before using any product to make sure it meets their certifier’s criteria.

## Other organic production resources include:

*Organic Vegetable Production* (Purdue Extension publication ID-316) is an introductory guide covering the basics of soil fertility and pest management (available online at [www.ces.purdue.edu/extmedia/ID/ID\\_316.pdf](http://www.ces.purdue.edu/extmedia/ID/ID_316.pdf)).

*Organic Vegetable Production Techniques* (University of Missouri Extension Guide G6220) provides an introduction to organic production techniques (available online at <http://muextension.missouri.edu/xplor/agguides/hort/g06220.htm>).

*Resource Guide for Organic Insect and Disease Management* (Cornell University) provides specific recommendations for pests and diseases of major vegetable crops (available online at [www.nysaes.cornell.edu/pp/resourceguide](http://www.nysaes.cornell.edu/pp/resourceguide)).

Appropriate Technology for Rural Areas (ATTRA) offers a number of publications on their Web site: [www.attra.org](http://www.attra.org).

The New Ag Network Web site offers a newsletter on organic and sustainable agriculture solutions at [www.new-ag.msu.edu](http://www.new-ag.msu.edu).

The National Organic Program (NOP) has a list of materials allowed for use in organic production, plus a complete list of accredited certification agents on their Web site: [www.ams.usda.gov/nop](http://www.ams.usda.gov/nop).

Consult your local Extension office for other resources available in your area.

The Organic Materials Review Institute (OMRI) publishes a list of products they have found to meet certified organic production criteria. For details, visit [www.omri.org](http://www.omri.org).

If you desire organic certification, you should contact a certification agent during the period of transition to organic production. The organizations on page 51 have been accredited by the USDA as of October 2007. Contact them directly for information about fees and the certification procedure. Additional accredited organizations are listed at [www.ams.usda.gov/nop/CertifyingAgents/Accredited.html](http://www.ams.usda.gov/nop/CertifyingAgents/Accredited.html).



Vegetables sold as “organic” must be grown and handled according to the National Organic Rule and state regulations. USDA-accredited organic certification agents must inspect and certify all operations with more than \$5,000 in gross annual income from sales of products labeled “organic.”

## **Organic Certification Agents**

### **Indiana**

#### **Indiana Certified Organic**

8364 SSR 39  
Clayton, IN 46118  
(317) 539-4317  
indianacertifiedorganic.com  
icoinfo@earthlink.net

### **Iowa**

#### **Certified Organic, Inc.**

Nanette Rambo  
500 First St.  
Keosauqua, IA 52565  
(866) 581-6428  
www.certifiedorginc.org  
certifiedorg@netins.net

#### **Iowa Department of Agriculture and Land Stewardship**

Organic Program  
Maury Wills  
502 East 9th Street  
Des Moines, IA 50319  
(515) 281-5783  
www.agriculture.state.ia.us/agdiv/organic.htm  
maury.wills@idals.state.ia.us

### **Kansas**

There is no agency in Kansas, however some growers use the Indiana agency or the Nebraska agency listed below.

#### **OCIA International, INC**

1340 North Cotner  
Lincoln, NE 68505  
Phone: (402) 477-2323  
Fax: (402) 477-4325  
E-mail: info@ocia.org  
www.ocia.org

### **Minnesota**

#### **Minnesota Crop Improvement Association**

Brenda Rogers  
1900 Hendon Ave.  
St. Paul, MN 55108  
(612) 625-7766  
(218) 342-2747  
www.mncia.org  
brenda.rogers@mncia.org

### **Missouri**

#### **OneCert Missouri**

Sue Baird, Program Manager  
PO Box 53  
McGirk, MO 65055  
(660) 427-5555  
sue@onecert.net  
www.onecert.net

### **Ohio**

#### **Ohio Ecological Food and Farm Association**

Certification Program  
41 Croswell Road  
Columbus, OH 43214  
(614) 262-2022  
www.oeffa.org  
organic@oeffa.org

# Asparagus

## Varieties

All male hybrids: Jersey Giant, Jersey Knight, Jersey King, Jersey Supreme.

Other hybrids: Atlas and Purple Passion (specialty markets only).

Open pollinated: Viking KB3, Mary Washington. Hybrid varieties have improved vigor, disease tolerance, and higher yields, and are grown from seeds or crowns.

Order well in advance.

## Planting and Spacing

**Crowns:** Use only 1-year old crowns. Transplant April 15 to May 15. Use 4- to 5-foot rows with crowns 12 to 16 inches apart. Set the crowns in 8-inch furrows in light soils and 5- to 6-inch furrows in heavy soils. Cover with 2 to 3 inches of soil. Select deep, well-drained sandy loam soils. Hybrids should be planted slightly deeper. Start cultivating when spears begin to emerge, and continue periodically until furrows are level at end of first season.

**Seedling transplant:** 10- to 14-week old seedling transplants can be mechanically transplanted. Apply 4 ounces of transplant solution (10-52-17 or 9-45-15) to each transplant. Transplant in either the spring or fall.

## Disease Control

Diseases Controlled	Treatment	Comments
Fusarium Crown and Root Rot	Several mancozeb formulations, including Dithane®, Manzate®, and Penncozeb®, are labeled for treating roots by dipping. Most dry formulations are labeled at 1 lb. per 100 gallons of water. Most liquid formulations are labeled at 0.8 qt. per 100 gallons water.	Avoid fields with a history of crown and root rot. Disease is promoted by acid (low pH) and poorly drained soil.
Rust and Leaf Spot (Cercospora)	Several chlorothalonil products are labeled for rust and Cercospora leaf spot including Bravo®, Echo®, and Equus®. Apply 1.8-3.6 lbs. per acre for most dry formulations and 2-4 pts. per acre for most flowable formulations.	Apply chlorothalonil formulations after harvest and at 14-28 day intervals. Protecting ferns during summer months is essential for good yields. 190-day PHI.

## Harvesting

Harvest only 2 or 3 times in spring 1 year after transplanting. Thereafter, harvest for about 2 months in the spring. Harvest asparagus early in the morning for best quality. Allow the ferns to grow vigorously after this period to accumulate food reserves for the next season. As much care should be put into maintaining a healthy fern as into harvest.

## Fertilizing

**Lime:** To maintain a soil pH of 6.7 to 7.0. If possible, apply lime the year before planting.

**Preplant:** N: 70 pounds per acre. P<sub>2</sub>O<sub>5</sub>: 25 to 200 pounds per acre. K<sub>2</sub>O: 0 to 250 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. Broadcast the fertilizer, and plow it under when preparing the land for the planting furrows. Before planting new crowns, apply 100 pounds per acre of 8-32-0, or similar high phosphate starter fertilizer, in the bottom of the trench. Cover with 1 inch of soil before setting crowns.

**Yearly:** Each year after harvest, apply 50 pounds N per acre by broadcasting and incorporate by lightly tilling. No P<sub>2</sub>O<sub>5</sub> or K<sub>2</sub>O is necessary if adequate fertilization was achieved prior to planting.

Diseases Controlled	Treatment	Comments
Rust and Leaf Spot (Cercospora) (continued)	Dithane®, Manzate®, or Penncozeb® at 2 lbs. per acre for dry (WP, DF, or DG) formulations or 1.6 qts. per acre for flowable (F) formulations.	Apply after harvest at 10-day intervals. Protecting ferns during summer months is essential for good yields the following season. 180-day PHI.
	Folicur 3.6F® at 4-6 fl. oz. per acre. <b>Rust only.</b>	100-day PHI.
	Rally 40WSP® at 5 oz. per acre. <b>Rust only.</b>	Begin applications to the developing ferns after harvest. Repeat on a schedule of less than 14 days. 180-day PHI.
Phytophthora Crown and Spear Rot	Agri-Fos® at 1.25-25 qts. per acre.	Note ratio of rate and water volume. Do not apply to ferns beginning to senesce.
	Aliette WDG® at 5 lbs. per acre.	Apply once per season to fully expanded ferns. 110-day PHI.
	Phostrol® at 2.5-5 pts. per acre.	Note ratio of rate and water volume. Do not apply to ferns beginning to senesce.
	Ridomil Gold 4EC® at 1 pt. per acre over bed.	Apply 30-60 days before first cutting. 1-day PHI.

## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals (emerged) — treatment applied before crop emergence or after final harvest	Gramoxone Inteon® 2L at 2.5-4 pts. per acre, or Gramoxone Max 3L® at 1.3-2.7 pts. per acre.	Include 1 qt. of COC, or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply before crop emergence or after last harvest. <b>RUP.</b> 6-day PHI.
Annuals and Perennials (emerged) — treatment applied before crop emergence or after final harvest	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations that contain 3 lbs. ae/gal. (equivalent to 4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre; or formulations that contain 4.5 lbs. ae/gal. (equivalent to 5 lbs. potassium salt/gal.) at 0.66-3.3 qts. per acre.	Apply to emerged weeds at least 7 days before spears emerge or immediately after the last harvest. Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. If spears are allowed to regrow, delay application until ferns have developed. Delayed treatments must be applied as a directed or shielded spray. Direct contact of the spray with asparagus fern may result in serious crop injury.
Broadleaves and Grasses (not emerged)	Chateau WDG® at 6 oz. per acre.	Apply to dormant asparagus at least two weeks before spears emerge. May be tank-mixed with paraquat to control emerged weeds. Do not exceed 6 oz. per acre per growing season.
	Diuron products at 0.8-3 lbs. a.i. per acre. Use 80DF formulations at 1-4 lbs. per acre, or 4L formulations at 1.6-3 qts. per acre. <b>Do not apply to young plants during first year.</b>	Use lower rates on light-colored soils with less than 2% organic matter. Apply after tillage or chopping fern in the spring and again after harvest, if necessary. 6-8 weeks residual activity. Do not exceed 6 lbs. per acre per year.
	Sencor 4F® at 0.5-2 qts. per acre, or Sencor 75DF® at 0.6-2.6 lbs. per acre. <b>Do not apply to young plants during first year.</b>	Apply after tillage or chopping fern in the spring and again after harvest, if necessary. Use lower rates for split applications. 6-8 weeks residual activity. Do not exceed 2 qts. or 2.6 lbs. per acre per year. 2 sprays necessary for seasonlong sandbur control. 14-day PHI.
	Solicam DF® at 2.5-5 lbs. per acre. <b>Do not apply within 12 months of planting.</b>	Apply preemergence to soil free of weeds and debris. 14-day PHI.
	Trifluralin products at 1-1.5 lbs. a.i. per acre. Use 4EC formulations at 1-1.5 qts. per acre. <b>Established plantings only.</b>	Apply and incorporate 1-2 inches early in the spring when spears are at least 4 inches below soil surface. Use higher rates on heavier soils. 4-6 weeks residual activity.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and Grasses (not emerged or newly emerged)	<p>Lorox 50DF<sup>®</sup> at the following rates:  <b>Established beds or newly planted crowns, preemergence:</b> 2-4 lbs. per acre.  <b>Established beds, postemergence:</b> 1-3 lbs. per acre, up to 3 applications. Apply before cutting season or immediately after cutting.  <b>Newly planted crowns, postemergence:</b> 1-2 lbs. per acre, up to 2 applications. Apply when ferns are 6-18 inches tall.</p>	<p>Do not use on sand, loamy sand, or soils with less than 1% organic matter. Maximum 4 lbs. or 3 applications per acre per year. 1-day PHI.</p>
	<p>Sinbar 80W<sup>®</sup> at 0.62-1.5 lbs. per acre.  <b>Established crowns or directed seeded plants only.</b></p>	<p>Do not use on sandy soil or on soil with less than 1% organic matter. Apply in spring after cutting fern and prior to spear emergence. For seeded crops apply activated charcoal at 300 lbs. per acre in a 1-inch band over the row before Sinbar<sup>®</sup> application. Do not plant other crops within 2 years of application. 8-12 weeks residual activity. 5-day PHI.</p>
Broadleaves (not emerged or emerged)	<p>Callisto 4L<sup>®</sup> at 3 fl. oz. per acre to control emerged weeds or 6-7.7 fl. oz. per acre to control weeds that have not emerged.</p>	<p>Apply in spring before spears emerge after mowing, disking, or tilling; after final harvest; or both. For postharvest applications: use drop nozzles or other equipment that will minimize contact with crop. Adding COC or NIS (alone, or with UAN or AMS) will improve emerged weed control and increase crop injury risk in postharvest applications. Do not exceed 2 applications per year, or 7.7 fl. oz. per acre per year.</p>
Broadleaves (emerged)	<p>2,4-D amine at 3-4 pts. per acre.</p>	<p>Apply before, during, or after the harvest season. During harvest season apply immediately after cutting. Discard deformed spears. Use drop nozzles for treatments after harvest to avoid spraying the fern.</p>
	<p>Clarity 4L<sup>®</sup> at 0.5-1 pt. per acre. Apply at 40-60 gals. per acre immediately after cutting.</p>	<p>Discard crooked spears at harvest. Clarity can injure nearby broadleaf crops and garden plants. Maximum 1 pt. per acre per year. 24-hour PHI.</p>
	<p>Savage WSG<sup>®</sup> at 1.5-2 lbs. per acre.</p>	<p>Apply before, during, or after the harvest season. During harvest season apply immediately after cutting. Discard deformed spears. Use drop nozzles for treatments after harvest to avoid spraying the fern.</p>
Broadleaves (emerged) and Nutsedge	<p>Sandea 75W<sup>®</sup> at 0.5-1.5 oz. per acre.</p>	<p>Apply before, during, or after harvest. Drop nozzles and using COC or nonionic surfactant are recommended for applications after harvest. For first year transplants, do not apply sooner than 6 weeks after fern emergence. Do not exceed 2 applications per crop cycle, or 2 oz. per acre per 12-month period. Has residual soil activity. 1-day PHI.</p>
Grasses (emerged)	<p>Fusilade DX 2E<sup>®</sup> at 8-12 fl. oz. per acre.</p>	<p>Include 1-2 pts. of COC or 0.5-1 pt. of nonionic surfactant per 25 gallons of spray solution. Spray on actively growing grass. Rates may be doubled if asparagus will not be harvested for 12 months. Wait at least 14 days between applications. Do not exceed 48 fl. oz. per acre per season on bearing asparagus. 1-day PHI.</p>
	<p>Poast 1.5E<sup>®</sup> at 1-1.5 pts. per acre, plus 1 qt. COC per acre.</p>	<p>Spray on actively growing grass. Use high rate on quackgrass. Do not exceed 5 pts. per acre per season. 1-day PHI.</p>

<sup>1</sup> For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup> Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects Controlled	Treatment	Comments
Asparagus Beetles and Cutworms	For control on spears during harvest, to prevent egg laying and feeding injury:	
	Lannate SP® at 0.5-1 lb. per acre.	Do not exceed 8 applications per crop. Use high rate for white cutworm. 1-day PHI. <b>RUP.</b>
<b>Insect Thresholds</b>	Lorsban 4E® at 2 pts. per acre, or Lorsban 75WG® at 1.33 lbs. per acre.	Do not make more than 1 preharvest application. Broadcast with ground equipment. 1-day PHI. <b>RUP.</b>
<b>Insect Thresholds Harvest</b>	Malathion 5EC® at 2 pts. per acre. <b>Asparagus beetles only.</b>	1-day PHI.
<b>Asparagus Beetle:</b> 5-10% plants infested or 2% of spears with eggs	Pounce 25WP® at 3.2-6.4 fl. oz. per acre.	Do not exceed 0.4 lb. a.i. per season. 1-day PHI. <b>RUP.</b>
	Sevin XLR PLUS® at 1-2 qts. per acre, or Sevin 5B® at 40 lbs. per acre.	Do not treat more than once every 3 days. Bait for cutworms only. 1-day PHI.
<b>Cutworms:</b> 5% of crowns infested	For control on seedlings and fern growth after harvest is over (use lower rates for seedlings):	
	Dimethoate 400® or Dimethoate 4E® at 1 pt. per acre. <b>Asparagus beetles only.</b>	Do not exceed 5 pts. per acre per year. 180-day PHI
<b>Fern</b>	Entrust® at 1.25-2.0 oz. per acre. <b>Asparagus beetles only.</b>	Do not exceed 5.6 oz. per acre per season. 60-day PHI.
<b>Asparagus Beetle:</b> 10% defoliation or 50% of plants with larvae	Sevin XLR PLUS® at 2-4 qts. per acre.	Do not treat more than once every 7 days. Do not exceed 5 applications per year to spears and ferns combined.
	SpinTor 2SC® at 4-6 fl. oz. per acre. <b>Asparagus beetles only.</b>	Do not exceed 18 fl. oz. per acre per season. 60-day PHI.
<b>Fall</b>		
<b>Cutworms:</b> 1 larva per 20 plants		



*Asparagus spears prior to grading. Asparagus is an example of a crop that benefits from a short turnaround from harvest to consumer.*

# Brassica and Leafy Greens

*Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Collards, Kale, Mustard, and Turnip Greens*

BROCCOLI Varieties	Maturity	Comments
Leprechaun	early	Large beads, slightly domed
Regal	early	Medium to small beads, firm domed heads, side shoots
Green Comet	early	Excellent center head and large side shoots
Emperor	early-mid	Few side shoots
Green Valiant	mid	Small beads, firm head
Premium Crop	mid	Large center heads, few side shoots
Goliath	mid	Large, tight heads
Gypsy	mid	Smooth, domed heads
Marathon	late	Domed
Triathlon	late	Excellent crown cut or bunching broccoli in Missouri
Arcadia	late	Small beads, very domed

BRUSSELS SPROUTS Varieties	Maturity	Comments
Prince Marvel	medium	Medium sprouts, large plants
Oliver	early	Large sprouts, short plants
Dasher	late	Medium sprouts
Jade Cross	early	

CABBAGE Varieties	Season	Head Size	Yellows Resistance	Remarks
<b>Green</b>				
Stone Head	very early	small	no	Solid head for an early type
Head Start	early	medium	no	Excellent field holding for an early type
Charmant	early	small	yes	Flattened round head. Tolerant to tipburn, black speck
Conquest	main	medium	yes	
Gourmet	main	medium-large	yes	Fair to good holding ability, moderately susceptible to thrips
Bronco	late	medium	yes	
Green Cup	main	medium-large	yes	High tolerance to black rot' tolerant to thrips, tipburn, heat, cold.
Blue Pak	main	medium-large	yes	Good tip burn tolerance, very thrips tolerant
Cheers	late	large	yes	
Rio Verde	late	large	yes	
Hinova	late		yes	For processing, flat, rounded heads, resistant to tipburn; tolerant to black rot, black speck; susceptible to thrips
<b>Red</b>				
Red Acre	main	small	no	A firm head, open pollinated
Regal Red	early	medium	no	Early for a red cabbage
Ruby Perfection	late	small	no	Deep red color, thrips tolerant

CAULIFLOWER Varieties	Season	Comments
Snow Crown-F1 Hybrid	early	Good and reliable for spring and early fall production
Fremont F1	2nd early	
Snowball Y improved op	main	Forming heads should be blanched
Andes op	main	Forming heads should be blanched
White Sails F1	main	Forming heads should be blanched
Self-Blanche op	late	No tying necessary if plants are fertilized properly
Silver Streak	late	For fall harvest
For trial only: Candid Charm (2nd early), Cashmere (early), Cumberland (main), Majestic (early)		



## Spacing

**Broccoli:** Rows 3 feet apart. Plants 12 to 18 inches apart in row.

**Brussels sprouts:** Rows 3 feet apart. Plants 18 to 24 inches apart in row.

**Cabbage for Market:** Rows 2 to 3 feet apart. Plants 12 to 15 inches apart in row.

**Cabbage for Kraut:** Rows 3 feet apart. Plants 18 inches apart in row.

**Cauliflower:** Rows 3 feet apart. Plants 15 to 18 inches apart in row.

**Collards:** Rows 3 to 3.5 feet apart. Plants 18 to 24 inches apart in row. Seed 1 to 2 pounds per acre.

**Kale:** Rows 2 to 3 feet apart. Plants 8 to 16 inches apart in row. Seed 2 to 4 pounds per acre.

**Mustard:** Rows 1 to 1.5 feet apart. Plants 10 to 12 inches apart in row. Seed 3 to 5 pounds per acre.

**Turnip greens:** Rows 6 to 12 inches apart. Plants 1 to 4 inches apart in row.

Raised beds (6 inches high, 40 inches wide, with 2 rows 11 inches apart on beds) may be desirable under certain conditions.

## Fertilizing

**Lime:** To maintain a soil pH of 6.0 to 6.5.

### Preplant

#### **Cole crops (broccoli, cabbage, cauliflower, and Brussels sprouts)**

**N:** 120 pounds per acre if soil organic matter less than 3 percent, and 80 pounds per acre if soil organic matter greater than 3 percent. **P<sub>2</sub>O<sub>5</sub>:** 25 to 200 pounds per acre. **K<sub>2</sub>O:** 0 to 250 pounds per acre. Cole crops, particularly cauliflower, are responsive to B on low organic matter soils, sandy soils, or where the pH is greater than 7.0. If B is needed, apply 1 to 2 pounds B per acre broadcast. Soil test and/or perform plant analysis on the previous crop to be sure B is needed. High soil B can be detrimental to rotational crops such as sweet corn, peas, or beans.

#### **Greens (collards, kale, and mustard)**

**N:** 60 pounds per acre. **P<sub>2</sub>O<sub>5</sub>:** 0 to 150 pounds per acre. **K<sub>2</sub>O:** 0 to 200 pounds per acre.

#### **All crops**

Adjust recommendations according to soil type, previous management, and soil test results for your state. For transplants, set each plant with 1 cup (8

ounces) of starter solution. See page 7 for fertilizer type suggestions. If the transplant flat receives a heavy fertilizer feeding just prior to setting, the starter solution can be eliminated.

### Sidedress N

#### **Cole crops**

60 pounds N per acre, two to three weeks after setting the transplants and when rapid growth has begun. Eliminate sidedressing if following soybeans. If leaching is likely on sandy soils, apply an additional 30 pounds N as a sidedress. Avoid excessive N fertilization with broccoli as it can cause too rapid growth and a hollow flower stalk.

#### **Greens**


30 pounds N per acre on soils with more than 3 percent organic matter and following soybeans, alfalfa, or a grass-legume hay crop. For greens on soils with less than 3 percent organic matter and following those crops, apply 45 pounds N per acre. For greens following corn, small grains, or a vegetable crop, apply 60 pounds N per acre.


## Harvesting

**Broccoli:** Harvesting is done by hand while the head is still compact and before the flowers open. The central heads should be dark blue or green and 4 to 6 inches across when mature. If harvesting too late or when the heads are over mature, woodiness in the stems will develop. Depending on your marketing requirements, the main head is cut with 8 to 10 inches of stem. Sometimes a second harvest of side shoots can be obtained. Broccoli for processing should be cut with less attached stem (6 to 7 inches) and with few or no leaves. Fresh market broccoli should be cut longer, with little trimming. Broccoli quality is based on the degree of compactness, leafiness, head trimness, damage, and freedom from insects and extraneous debris.

**Cauliflower:** When ready to harvest, the heads should be compact and clear white. The heads become discolored and develop an undesirable flavor when exposed to sunlight. The longest leaves are normally tied loosely together over the head to “blanch” and prevent the head from being exposed to the sun. The desirable harvest size is a diameter of approximately 6 inches. Delaying harvest usually will not result in obtaining larger heads. Instead, consider proper cultivar selection and plant spacing. Cauliflower should be hand-harvested and cut with 1 to 2 whorls of leaves to protect the head.

## Disease Control

Diseases Controlled	Treatment	Comments
Alternaria Leaf Spot	3-4 year crop rotation.	Rotate to non-cruciferous crops.
	Amistar® at 2-5 oz per acre.	Do not apply more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
	Cabrio® at the following rates: <b>Turnip greens:</b> 8-12 oz. per acre. <b>All others:</b> 12-16 oz. per acre.	3-day PHI for collard, kale, and mustard. 0-day PHI for all others.
	Several chlorothalonil (e.g., Bravo®, Echo®, Equus®) formulations are labeled at 1.4 lbs. per acre for most dry formulations (WP, DF, or DG) and 1.5 pts. per acre for most flowable (F) formulations. <b>Not for use on collard, kale, mustard, or turnip greens.</b>	7-day PHI.
	Endura 70WG® at 6-9 oz. per acre. <b>Not for turnip greens.</b>	14-day PHI for collard, kale, and mustard. 0-day PHI for all others.
	Several Maneb® formulations (e.g., Maneb®, Manex®) are labeled at various rates depending on crop and formulation.	10-day PHI for kale; 14-day PHI for collard, mustard, and turnip greens; 7-day PHI for all others.
Black Leg	Does not occur on leafy greens.	
	3-4 year crop rotation.	Rotate to non-cruciferous crops.
	Plant disease-free seeds or transplants.	Hot water seed treatment helps eliminate seed-borne pathogens.
	Cabrio® at 12-16 oz. per acre. <b>Not for collard, kale, mustard, or turnip greens.</b>	0-day PHI
	Rovral® at 2 pts. per acre for flowable (F) formulations or 1.3 lbs. per acre for dry formulations <b>Broccoli only.</b>	Apply to young plants (2-4 leaf stage) immediately after thinning. A second application may be made until the day of harvest. 0-day PHI.
Black Rot	3-4 year crop rotation.	Rotate to non-cruciferous crops.
	Plant disease-free seeds or transplants.	Hot water seed treatment helps eliminate seed-borne pathogens.
	Plant disease-resistant cabbage varieties.	Several varieties with partial resistance are available.
	Actigard® at 1 oz. per acre. <b>Suppression only.</b>	See label restrictions if downy mildew present. Do not apply to stressed plants. 7-day PHI.
	 Fixed copper formulations at various rates. Read labels carefully to make sure your crop is included.	Copper applications may slow the spread of black rot.
Club Root	Plant only disease-free transplants.	Club root may be brought in with diseased transplants.
	Cultural controls.	Rotate crops 7 years or more with a non-cruciferous crop between plantings. Avoid poorly drained soils with a history of club root. Serious losses can be avoided by raising the pH to 7.2-7.5.
	Terraclor® flowable fungicide. <b>Rate depends on application method.</b> <b>Not for turnip.</b>	Terraclor® may be used in a transplant solution or in a band or broadcast application at planting.

 May be acceptable for use in certified organic production. Check with your certifier before use.

Diseases Controlled	Treatment	Comments
Downy Mildew	2-3 year crop rotation.	Rotating to non-cruciferous crops may reduce pathogen populations and increase fungicide efficacy.
	Plant disease-resistant broccoli varieties.	Several broccoli varieties with resistance are available.
	Actigard® at 1 oz. per acre.	Do not apply to plants stressed by drought, herbicide injury or other factors. See label for other important information. 7-day PHI.
	Aliette® at 2-5 lbs. per acre. <b>Not for turnip greens.</b>	Label includes several different crops, PHIs, resistance instructions, and other important information.
	Agri-Fos 400® at 1.25-2.5 qt. per acre. <b>Not for turnip greens.</b>	Label includes several different crops, PHIs, resistance instructions, and other important information.
	Amistar® at 2-5 oz per acre.	Do not apply more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
	Cabrio® at the following rates: <b>Turnip greens:</b> 8-12 oz. per acre. <b>All others:</b> 12-16 oz. per acre.	3-day PHI for collard, kale, and mustard. 0-day PHI for all others.
	Several chlorothalonil (e.g., Bravo®, Echo®, Equus®) formulations are labeled for use at a variety of rates. <b>Not for collard, kale, mustard or turnip greens.</b>	7-day PHI.
	Phostrol® at 2.5-5 pt. per acre <b>Not for turnip greens.</b>	Label includes several different crops, PHIs, resistance instructions, and other important information.
	Prophyt® at 2-4 pt. per acre. <b>Not for turnip greens.</b>	Label includes several different crops, PHIs, resistance instructions, and other important information.
	Quadris® at 6.2-15.4 oz per acre.	Do not apply more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
	Fusarium Yellows	Plant yellows-resistant varieties.
Powdery Mildew	Cabrio® at the following rates: <b>Turnip greens:</b> 8-12 oz. per acre. <b>All others:</b> 12-16 oz. per acre.	3-day PHI for collard, kale, and mustard; 0-day PHI for all others.
	Endura 70WG® at 6-9 oz. per acre. <b>Not for turnip greens.</b>	0-day PHI for broccoli, Brussels sprouts, cabbage, and cauliflower; 14-day PHI for all others. No more than 2 applications per season.
	Microthiol Special® at 3-10 lbs. per acre.	Apply at early leaf stage and repeat every 10-14 days or as needed.
Rhizoctonia Bottom Rot	Cabrio® at 12-16 oz. per acre. <b>Not for turnip greens.</b>	3-day PHI for collard, kale, and mustard. 0-day PHI for all others.
	Endura 70 WG® at 6-9 oz. per acre. <b>Not for turnip greens.</b> <b>Suppression only.</b>	0-day PHI for broccoli, Brussels sprouts, cabbage, and cauliflower; 14-day PHI for all others. No more than 2 applications per season.
Sclerotinia Stem Rot	Endura 70WG® at 6-9 oz. per acre. <b>Not for turnip greens.</b>	0-day PHI for broccoli, Brussels sprouts, cabbage, and cauliflower; 14-day PHI for all others. No more than 2 applications per season. 0-day PHI.
Wirestem	Terraclor® flowable fungicide. <b>Rate depends on application method.</b> <b>Not for collard, kale, mustard, or turnip.</b>	Terraclor® may be used in a transplant solution or in a band or broadcast application at planting. Raise seedlings in seedbeds that are disinfected by steam or chemical fumigants.

## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals (emerged) — treatment applied before crop emergence or transplanting	Gramoxone Inteon® 2L at 2-4 pts. per acre, or Gramoxone Max 3L® at 1.3-2.7 pts. per acre. <b>Not for turnip greens.</b>	Include 1 qt. of COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply before seeding or transplanting, or after seeding but before crop emergence. <b>RUP.</b>
Annuals and Perennials (emerged) — crop not present or protected from spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs. potassium salt/gal.) at 0.66-3.3 qts. per acre. <b>Not for turnip greens.</b>	Broadcast before seeding or transplanting, after seeding but before crop emergence, or apply between crop rows with hooded or shielded sprayers. Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. 14-day PHI.
Broadleaves and Grasses (not emerged)	Command 3ME® at the following rates: <b>Directed-seeded crops:</b> 0.67 pt. per acre. <b>Transplants:</b> up to 1.3 pts. per acre. <b>Cabbage only.</b>	45-day PHI.
	Devrinol 50DF® at 2 lbs. per acre. <b>Not for collards, kale, mustard greens, or turnip greens.</b>	Apply and incorporate 1-2 inches before seeding or transplanting or apply after seeding and irrigate to wet soil 2-4 inches deep. After harvest or prior to planting succeeding crops, deep moldboard or disk plow. Do not seed alfalfa, small grains, sorghum, corn, or lettuce for 12 months after application.
	Trifluralin products at 0.5-0.75 lbs. a.i. per acre. Use 4EC formulations at 1-1.5 pts. per acre. <b>Not for turnip greens.</b>	Use low rate on soils with less than 2% organic matter. Apply before seeding or transplanting and incorporate 2-3 inches immediately. Not effective on muck or high organic matter soils. Delayed emergence or stunting may occur when soil is cool.
Broadleaves (not emerged)	Goal 2XL® at 1-2 pts. per acre. <b>Not for direct-seeded crops. Not for use on Brussels sprouts, collards, kale, mustard greens, or turnip greens.</b>	Use lower rate on coarse-textured soils. Apply after preparing soil but before transplanting. Transplant within 7 days of application.
Grasses (not emerged)	Dacthal W-75® at 6-14 lbs. per acre, or Dacthal Flowable® at 6-14 pts. per acre.	Apply at seeding or transplanting. May be incorporated. May be applied over top of transplants.
	Prefar 4E® at 5-6 qts. per acre. <b>Not for turnip greens.</b>	Use low rate on soils with less than 1% organic matter. Apply before planting and incorporate 1-2 inches or apply after seeding before crop emerges and irrigate within 24 hours.
Broadleaves (emerged)	Aim EC® at 0.5-2 fl. oz. per acre.	Apply with hooded sprayers as a directed application between crop rows. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not allow spray to contact crop. Do not exceed 6.1 fl. oz. per acre per season.
Grasses (emerged)	Poast 1.5E® at 1-1.5 pts. per acre, plus 1 qt. COC per acre.	Spray on actively growing grass. Use high rate on quackgrass. Do not exceed 2.5 pts. per acre per season for turnip greens, or 3 pts. per acre per season for other crops. 14-day PHI for turnip greens. 30-day PHI for other crops.
	Select Max® at 12-16 fl. oz or Select 2EC® at 6-8 fl. oz. per acre for annual grasses. Use high rate for perennial grasses.	Include 1 qt. of COC per 25 gallons of spray solution (1% v/v). Spray on actively growing grass. Wait at least 14 days between applications. Do not exceed 64 fl. oz. Select MAX® or 32 fl. oz. Select 2EC® per acre per season. 14-day PHI for greens. 30-day PHI for cole crops.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects Controlled	Treatment	Comments
Aphids, Leafminers	Conserve natural enemies.	Limit the use of insecticides to conserve predators and parasites.
	Actara® at 1.5-3 oz. per acre.	Do not exceed 11 oz. per acre pre season. 0-day PHI for broccoli, Brussels sprouts, cabbage and cauliflower. 7-day PHI for leafy greens.
	Admire PRO® at 4.4-10.5 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. per acre per season. 21-day PHI.
	Assail 70WP® at 0.8-1.7 oz per acre.	Do not exceed 0.375 lb. a.i. per acre. 7-day PHI.
	Diazinon AG500® at 0.5-1 pt. per acre, or Diazinon 50W® at 0.5-1 lb. per acre.	Do not exceed 5 applications per season. 7-day PHI for broccoli, Brussels sprouts, and cauliflower. 21-day PHI for cabbage. 10-day PHI for collards, kale, and mustard. <b>RUP.</b>
	Dimethoate 400® or Dimethoate 4E® at 0.5-1 pt. per acre, or Dimethoate 2.67EC® at 0.75-1.5 pts. per acre.	7-day PHI for broccoli and cauliflower. 14-day PHI for kale and mustard.
	Endosulfan 3EC® at the following rates: <b>Cole crops, collards, and mustard:</b> 1-1.33 qts. per acre. <b>Kale:</b> 1 qt. per acre.	<b>Cole crops:</b> Do not exceed 4 qts. per acre per season. 7-day PHI for cabbage and broccoli. 14-day PHI for Brussels sprouts and cauliflower. <b>Collards, kale, and mustard:</b> Do not exceed 1 application. 21-day PHI.
	Entrust® at 2-3 oz. per acre. <b>Leafminers only.</b>	Do not exceed 9 oz. per acre per season. 1-day PHI.
	Fulfill® at 2.75 oz. per acre.	Do not exceed 5.5 oz. per acre per crop per season. 7-day PHI.
	Movento at 4-5 fl. oz. per acre.	1-day PHI.
	M-Pede® at 1-2% by volume.	Must contact aphids to be effective. 0-day PHI.
	Orthene 97® at 0.5-1.0 lb. per acre. <b>Brussels sprouts and cauliflower only.</b>	Do not exceed 2 1/8 lbs. per acre per season. 14-day PHI. <b>RUP.</b>
	Platinum® at 5-11 fl. oz. per acre.	30-day PHI.
	Provado 1.6F® at 3.8 fl. oz. per acre.	Do not exceed 0.23 lb. a.i. per acre per season. 7-day PHI.
	Rimon 0.83EC® at 6-12 fl. oz. per acre. <b>Leafminers only.</b>	Do not exceed 24 fl. oz. per acre per season. 7-day PHI.
	SpinTor 2SC® at 4-10 fl. oz. per acre. <b>Leafminers only.</b>	Do not exceed 29 fl. oz. per acre per season. 1-day PHI.
Trigard® at 2.66 oz. per acre. <b>Leafminers only.</b>	Do not exceed 6 applications per season. 7-day PHI.	
Caterpillars (Imported Cabbageworms, Cabbage Loopers, Diamondback Moth Larvae. Cross-Striped Cabbageworms)	Use when tiny worms and/or loopers first appear:	Use of some insecticides may reduce populations of beneficial insects that suppress caterpillar populations.
	Ambush 25W® at 3.2-12.8 oz. per acre. Rate varies with crop. See label.	Do not exceed 0.8 lb. a.i. per acre per season to broccoli, cauliflower, collards, and Brussels sprouts. Do not exceed 1 lb. a.i. per acre per season for cabbage. 1-day PHI. <b>RUP.</b>
	Asana XL® at 2.9-9.6 fl. oz. per acre. <b>Cole crops and collards only.</b>	<b>Cole crops:</b> Do not exceed 0.4 lb. a.i. per acre per season. 3-day PHI. <b>Collards:</b> Do not exceed 0.2 lb. a.i. per acre per season. 7-day PHI. <b>RUP.</b>
	Avaunt 30WDG® at 2.5-3.5 oz. per acre.	Do not exceed 14 oz. per acre per season. 3-day PHI.

**Brassica and Leafy Greens** (continued)

Insect Control (continued)

Insects Controlled	Treatment	Comments
Caterpillars (Imported Cabbageworms, Cabbage Loopers, Diamondback Moth Larvae. Cross-Striped Cabbageworms) <b>(continued)</b>	Several <i>Bacillus thuringiensis</i> products (Agree <sup>®</sup> , Biobit <sup>®</sup> , Dipel <sup>®</sup> , Javelin <sup>®</sup> , Lepinox <sup>®</sup> , Xentari <sup>®</sup> ) are available. Follow label directions.	Begin applications when worms are small. Using <i>Bt</i> products will help conserve beneficial insects. 0-day PHI.
	Baythroid <sup>®</sup> at 1.6-3.2 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Brigade 2EC <sup>®</sup> at 2.1-6.4 fl. oz., or Brigade WBS <sup>®</sup> at 5.3-16 oz. per acre.	Do not exceed 0.5 lb a.i. per acre per season. 7-day PHI. <b>RUP.</b>
	Confirm 2F <sup>®</sup> at 6.0-8.0 fl. oz. per acre.	Do not exceed 56 fl. oz. per season. 7-day PHI.
	Coragen <sup>®</sup> at 3.5-5.0 fl. oz. per acre.	Do not exceed 15.4 fl. oz. per acre per season. 3-day PHI.
	Diazinon AG500 <sup>®</sup> at 0.5-1 pt. per acre, or Diazinon 50W <sup>®</sup> at 0.5-1 lb. per acre. <b>Diamondback moth and imported cabbageworms only.</b>	Do not exceed 5 applications per season. 7-day PHI for broccoli, Brussels sprouts, and cauliflower. 21-day PHI for cabbage. 10-day PHI for collards, kale, and mustard. <b>RUP.</b>
	Endosulfan 3EC <sup>®</sup> at the following rates: <b>Cole crops, collards, and mustard:</b> 1-1.33 qts. per acre. <b>Kale:</b> 1 qt. per acre kale.	Do not exceed 4 qts. per acre per season. 7-day PHI for cabbage and broccoli. 14-day PHI for Brussels sprouts and cauliflower. 21-day PHI for collards, kale, and mustard.
	Entrust <sup>®</sup> at 1.0-2.0 oz. per acre.	Do not exceed 9 oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
	Lannate SP <sup>®</sup> at 0.5-1 lb. per acre. Add wetting agent.	Do not exceed 6.3 lbs. a.i. per acre per season for broccoli. Do not exceed 5.4 lbs. a.i. per acre per season for Brussels sprouts and collards. Do not exceed 7.2 lbs. a.i. per acre per season for cabbage and cauliflower. Do not exceed 3.6 lbs. a.i. for kale and mustard. 1-day PHI for cabbage. 3-day PHI for broccoli, Brussels sprouts and cauliflower. 10-day PHI for collards, kale, and mustard. <b>RUP.</b>
	Larvin 3.2 <sup>®</sup> at 16-40 fl. oz. per acre. <b>Broccoli, cabbage, and cauliflower only.</b>	Do not exceed 160 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>
	Mustang MAX <sup>®</sup> at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. Allow 7 days between applications. 1-day PHI. <b>RUP.</b>
	Orthene 97 <sup>®</sup> at 1 lb. per acre. <b>Brussels sprouts and cauliflower only.</b>	Do not exceed 2 lbs. per acre per season. 14-day PHI.
	Pounce 25WP <sup>®</sup> at 3.2-12.8 oz. per acre. Rate varies with crop. See label.	Do not exceed 0.8 lb. a.i. per acre per season to broccoli, cauliflower, collards, and Brussels sprouts. Do not exceed 1 lb. a.i. per acre per season for cabbage. 1-day PHI. <b>RUP.</b>
	Proclaim <sup>®</sup> at 2.4-4.8 oz. per acre.	Do not exceed 28.8 oz. per acre per season. Allow at least 7 days between applications. 7-day PHI for brassica head and stem vegetables. 14-day PHI for brassica leaf vegetables. <b>RUP.</b>
	Rimon 0.83EC <sup>®</sup> at 6-12 fl. oz. per acre.	Do not exceed 24 fl. oz. per acre per season. 7-day PHI.
Sevin XLR PLUS <sup>®</sup> at 1-2 qts. per acre.	Do not exceed 6 qts. per acre per crop. 3-day PHI for broccoli, Brussels sprouts, cabbage, and cauliflower. 14-day PHI for collards, kale, and mustard.	
SpinTor 2SC <sup>®</sup> at 1.5-6 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1-day PHI.	
Warrior <sup>®</sup> at 1.92-3.84 fl. oz. per acre. <b>Cole crops only.</b>	Do not exceed 0.24 lb. a.i. per acre per season. 1-day PHI. <b>RUP.</b>	

## Caterpillar Thresholds

Crop	Stage	% Infested	
		Diamondback Moth Larvae	Imported Cabbageworm & Cabbage Looper
Cabbage — Fresh	seed bed	not applicable	not applicable
	transplant to cupping	50% with $\geq 5$ larvae/plant	30%
	cupping to early head	50% with $\geq 5$ larvae/plant	20%
	early head to harvest	10% with $\geq 1$ larva/plant	10%
Broccoli, Cauliflower	seedbed	10%	10%
	transplant to first curd	40%	20%
	first curd to harvest	10%	10%

Insects Controlled	Treatment	Comments
Flea Beetles	Actara® at 1.5-3 oz. per acre.	Do not exceed 11 oz. per acre pre season. 0-day PHI for broccoli, Brussels sprouts, cabbage and cauliflower. 7-day PHI for leafy greens.
	Ambush 25W® at 3.2-12.8 oz. per acre.	Do not exceed 1 lb. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Ammo 2.5EC® at 2.5-5 fl. oz. per acre.	Do not exceed 0.6 lb. a.i. per acre per season for cole crops. Do not exceed 0.4 lb. a.i. per acre per season for collards, kale, and mustard. 1-day PHI. <b>RUP.</b>
	Asana XL® at 5.8-9.6 fl. oz. per acre. <b>Cole crops and collards only.</b>	<b>Cole crops:</b> Do not exceed 0.4 lb. a.i. per acre per season. 3-day PHI. <b>Collards:</b> Do not exceed 0.2 lb. a.i. per acre per season. 7-day PHI. <b>RUP.</b>
	Baythroid® at 2.4-3.2 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Brigade 2EC® at 2.1-6.4 fl. oz. per acre, or Brigade WBS® at 5.3-16 oz. per acre.	Do not exceed 0.5 lb. a.i. per acre per season. 7-day PHI. <b>RUP.</b>
	Endosulfan 3EC® at the following rates: <b>Cole crops, collards, and mustard:</b> 1-1.33 qts. per acre. <b>Kale:</b> 1 qt. per acre.	Do not exceed 4 qts. per acre per season for cole crops. Do not exceed 1 application for collards, kale, and mustard. 7-day PHI for cabbage and broccoli. 14-day PHI for Brussels sprouts and cauliflower. 21-day PHI for collards, kale, and mustard.
	Kryocide® at 8-16 lbs. per acre.	Do not exceed 96 lbs. per acre per season. 7-day PHI for broccoli, Brussels sprouts, and cauliflower. 14-day PHI for cabbage and collards.
	Larvin 3.2® at 16-32 fl. oz. per acre. <b>Broccoli, cabbage and cauliflower only.</b>	Do not exceed 160 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>
	Mustang MAX® at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. Allow 7 days between applications. 1-day PHI. <b>RUP.</b>
	Pounce 25WP® at 3.2-12.8 oz. per acre.	Do not exceed 1 lb. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Prokil Cryolite 50D® at 15-30.5 lbs. per acre.	Do not exceed 184 lbs. per acre per season. 7-day PHI for broccoli, Brussels sprouts, and cauliflower. 14-day PHI for cabbage and collards.
	Provado 1.6F® at 3.8 fl. oz. per acre.	Do not exceed 18.8 fl. oz. per acre per season. 7-day PHI.
	Sevin XLR PLUS® at 0.5-1 qt. per acre.	Do not exceed 6 qts. per acre per crop. 3-day PHI for broccoli, Brussels sprouts, cabbage, and cauliflower. 14-day PHI for collards, kale, and mustard.
Warrior® at 2.56-3.84 fl. oz. per acre. <b>Cole crops only.</b>	Do not exceed 0.24 lb. a.i. per acre per season. 1-day PHI. <b>RUP.</b>	

**Brassica and Leafy Greens** (continued)

Insect Control (continued)

Insects Controlled	Treatment	Comments
Root Maggots	Cabbage maggot injury is usually more severe when fields have decaying organic matter present, such as plowed down cover crop, or when cool, wet conditions prevail.	
	For use in transplanting water, mix any one of the following in 50 gallons of water. Refer to Comments or product labels regarding drench application):	The transplant mixture application (insecticide plus water) will require about 200-300 gallons of water per acre, based on the number of plants set per acre.
	Diazinon AG500® at 2-3 qts. per acre, or Diazinon 50W® at 4-6 lbs. in 50 gals. of water (for drench application).	Water treatments may reduce stands due to plant stress at time of transplanting. Make drench application at the rate of 0.5-1 cup per plant, either by hand or tractor-mounted sprayer with drop nozzles to direct spray to base of plants. In some areas, cabbage maggots are exhibiting resistance to diazinon, resulting in control failures. 7-day PHI for broccoli, Brussels sprouts, and cauliflower. 10-day PHI for collards, kale, and mustard. 21-day PHI for cabbage. <b>RUP.</b>
	Lorsban® products at the following rates: <b>Cauliflower:</b> Lorsban 4EC® at 1.6-2.4 fl. oz. per 1,000 linear ft. of row, or Lorsban 75WG® at 1.1-1.6 fl. oz. per 1,000 linear ft. of row. <b>Broccoli, Brussels sprouts, cabbage, collards, and kale:</b> Lorsban 4EC® at 1.6-2.75 fl. oz. per 1,000 linear ft. of row, or Lorsban 75WG® at 1.1-1.8 fl. oz. per 1,000 linear ft. of row.	Apply as a water-based spray directed at the base of plants immediately after setting in field. Use a minimum of 40 gallons of total spray per acre. Do not apply as a foliage application. Do not exceed one application per acre per season. 21-day PHI. <b>RUP.</b>
Stink bugs	Baythroid® at 2.4-3.2 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Brigade 2EC® at 2.1-6.4 fl. oz., or Brigade WBS® at 5.3-16 oz. per acre.	Do not exceed 0.5 lb. a.i. per acre per season. 7-day PHI. <b>RUP.</b>
	Endosulfan 3EC® at 1-1.33 qts. per acre.	Do not exceed 3 lbs. a.i. per acre per season. 7-day PHI for broccoli and cabbage. 14-day PHI for Brussels sprouts and cauliflower. 21-day PHI for collards, kale or mustard.
	Malathion 5EC® or Malathion 57EC® at 1 pt. per 100 gallons water per acre. <b>Harlequin bug on collards only.</b>	7-day PHI.
	Mustang MAX® at 3.2-4 oz. per acre.	Do not exceed 0.3 lb. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Rimon 0.83EC® at 6-12 fl. oz. per acre.	Do not exceed 24 oz. or 2 applications per acre per season. 7-day PHI.
	Sevin XLR PLUS® at the following rates: <b>Harlequin bug:</b> 0.5-1 qt. per acre. <b>Other stink bugs:</b> 1-2 qts. per acre.	Do not exceed 6 qts. per acre per season. 3-day PHI.
	Warrior® at 2.56-3.84 fl. oz. per acre. <b>Cole crops only.</b>	Do not exceed 0.24 lb. a.i. per acre per season. 1-day PHI. <b>RUP.</b>



Insects Controlled	Treatment	Comments
Thrips	Plant resistant varieties, such as Bantly, Bravo, Brutus, King Cole, Little Rock, Manrico, Rio Granda, Rio Verde, Ruby Perfection, Starski, Stonar, SuperKraut, Titanic 90, Zerlina, and others.	Some cabbage varieties are resistant to thrips.
	Actara® at 3-5.5 oz. per acre.	Do not exceed 11 oz. per acre pre season. 0-day PHI for broccoli, Brussels sprouts, cabbage and cauliflower. 7-day PHI for leafy greens.
	Ambush 25W® at 3.2-12.8 oz. per acre. Rate varies with crop. See label.	Do not exceed 0.8 lb. a.i. per acre per season for broccoli, cauliflower, Brussels sprouts, and collards. Do not exceed 1 lb. a.i. per acre per season for cabbage. 1-day PHI. <b>RUP.</b>
	Ammo 2.5EC® at 3.75-5 fl. oz. per acre.	Do not exceed 0.6 lb. a.i. per acre per season for cole crops. Do not exceed 0.4 lb. a.i. per acre per season for collards, kale, and mustard. 1-day PHI. <b>RUP.</b>
	Baythroid® at 0.8-1.6 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Brigade 2EC at 2.1-6.4 fl. oz. per acre, or Brigade WBS® at 5.3-16 oz. per acre.	Do not exceed 0.5 lb. a.i. per acre per season. 7-day PHI. <b>RUP.</b>
	Entrust® at 2-3 oz. per acre.	Do not exceed 9 oz. per acre per season. 1-day PHI.
	Mustang 1.5EC® at 3.4-4.3 fl. oz. per acre, or Mustang MAX® at 3.2-4.0 fl. oz. per acre.	Do not exceed 0.3 lb. a.i. Mustang 1.5EC®, or 0.15 lb. a.i. Mustang MAX® per acre per season. Allow 7 days between applications. 1-day PHI. <b>RUP.</b>
Thrips (continued)	Pounce 25WP® at 3.2-12.8 oz. per acre. Rate varies with crop. See label.	Do not exceed 0.8 lb. a.i. per acre per season for broccoli, cauliflower, Brussels sprouts, and collards. Do not exceed 1 lb. a.i. per acre per season for cabbage. 1-day PHI. <b>RUP.</b>
	Rimon 0.83EC® at 6-12 fl. oz. per acre.	Do not exceed 24 oz. or 3 applications per acre per season. 7-day PHI.
	SpinTor 2SC® at 4-10 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. 1-day PHI.
	Warrior® at 2.56-3.84 fl. oz. per acre. <b>Cole crops only.</b>	Do not exceed 0.24 lb. a.i. per acre per season. 1-day PHI. <b>RUP.</b>



*Planting cabbage on black plastic mulch helps to control weeds, maintains soil moisture, and results in higher soil temperatures.*

# Cucurbit Vegetables — Cucumber, Muskmelon, and Watermelon

MUSKMELON Varieties	Season	Quality	Remarks
Aphrodite	early-mid	excellent	Good shipper, 6-9 lbs.
Athena	early-mid	excellent	Medium net, oval very firm flesh
Crescent Moon	early-mid	good	Heavy net, oval, deep sutures
Eclipse	mid-late	excellent	Heavy net, round, very firm flesh
Odyssey	early-mid	excellent	Round to oval, firm, local market only
Saticoy	late	very good	Good eating quality for direct sales
Starfire (HM 2608)	mid-late	very good	Very large fruit, good netting
Starship	early-mid	very good	Excellent size and net, uniform fruit
Superstar	early	good	Very large fruit, excellent netting
Vienna	early-mid	excellent	Oblong, shallow sutures, holds well
Green-fleshed muskmelons: Galileo, Levigal, Passport			
Honeydew melons for trial: Daybreak, Early Dew, Moonshine.			

WATERMELON varieties	Maturity (days)	Ring Color and Pattern	Shape	Approx. wt. (lb.)
<b>Large, Red-Fleshed, Seeded</b>				
Crimson Sweet (open pollinated)	88	green, striped	blocky round	20-30
Fiesta	88	dark green, striped	blocky	22-26
Jamboree	88	dark green, broken light green stripes	long blocky	23-27
Raspa	83	medium green, dark green stripes	blocky	22-24
Regency	82	dark green, striped	blocky oblong	18-22
Royal Majesty	90	green, thin stripes	long oval	30
Royal Sweet	85	light green, striped	blocky oval	20-25
Sangria	85	dark green, striped	long blocky oval	20-26
Stars and Stripes	88	dark green, striped	long, blocky, oval	20-26
Summer Flavor 500	88	medium green, striped	blocky oblong	25-35
Summer Flavor 790	88	dark green, light green stripes	oblong blocky	24-28
Summer Flavor 800	88	dark green, striped	blocky oval	22-26
Top Gun	83	medium green, dark green stripes	globe	21-24
WX 264	88	dark green stripes on light green background	blocky	21-25
<b>Large, Red-Fleshed, Seedless<sup>1</sup></b>				
Afternoon Delight	87	mottled stripe	Round	16-20
Crimson Trio	85	medium green, striped	globe	14-16
Freedom	88	light green, striped	blocky oblong	16-22
Genesis	85	dark green, striped	round	15-18
Gypsy	85	light green, striped	round to globe	13-17
Imagination	80	Solid dark green	round	12-15
Indiana	76	Jubilee stripe/dark background	round-oval	13-15
Millionaire	90	light green, striped	oblong	13-20
Nova	85	dark green, striped	round	14-16
Revolution	84	wide dark stripes on medium background	blocky	18-22
Shadow	90	dark green, striped	round oval	15-18
SummerSweet 5244	90	light green, striped	round oval	16-20
SummerSweet 7167	90	light green, striped	oval	15-17
SW 4502	84	allsweet type	oval	16-20
Sweet Delight	88	light green with dark green stripes	oval	17-19
Trillion	95	light green, striped	oval	16-18
Tri-X-313	90	light green, striped	round oval	16-20
Tri-X-Palomar	86	medium green, striped	round	14-17
Wrigley	90	light green with dark green stripes	oval	16-20
WX 28	88	wide medium green, light green background	elongated	23-28

<sup>1</sup> Pollenizers must be planted with seedless varieties. Use a long watermelon, such as Royal Jubilee, Royal Sweet, Sangria, or SF 500 as the pollinating variety. Crimson Sweet works well as a pollenizer, but its fruit will be seeded and have a similar appearance to most seedless varieties. Fruitless pollenizer varieties are available. Check with Extension specialists or seed company representatives for more information.

<b>WATERMELON varieties</b>	<b>Maturity (days)</b>	<b>Ring Color and Pattern</b>	<b>Shape</b>	<b>Approx. wt. (lb.)</b>
<b>Small (“Ice-Box” Size), Red-Fleshed, Seeded</b>				
Jade Star	72	dark green	round	10-12
Sweet Beauty	77	dark green, striped	oblong	5-7
Tiger Baby	80	light green, striped	round	7-10
<b>Small (‘Personal’ Size), Red-Fleshed, Seedless — For Trial</b>				
Bibo	77	medium green, striped	round	5-7
Miniput	80	dark green	round	6-10
Petite Perfection	77	medium green, striped	round	5-7
<b>Yellow-Fleshed Seeded</b>				
AU-Golden Producer	88	light green, striped	blocky round	20-30
Yellow Baby	68	light green, striped	round	9-12
<b>Yellow-Fleshed, Seedless</b>				
Amarillo	80	medium green, striped	round	12-14
Butterball	90	light green, striped	round	15-18

### **Watermelon Variety Resistance to Fusarium Wilt<sup>1</sup>**

<b>Variety</b>	<b>Company</b>	<b>Type</b>	<b>Resistance<sup>2</sup></b>
Afternoon Delight	Dwayne Palmer	triploid	+1/2
Black Diamond	OP <sup>3</sup>	diploid	+
Calhoun Gray	OP <sup>3</sup>	diploid	+++1/2
Crimson Sweet	OP <sup>3</sup>	diploid	+
Dixie Lee	OP <sup>3</sup>	diploid	++++
Fiesta	Syngenta Seeds	diploid	++1/2
HSR 3005	Hollar Seeds	triploid	+
Indiana	Seedway	triploid	++
Millionaire	Harris-Moran	triploid	+1/2
Palomar	Syngenta Seeds	triploid	+
Raspa	Willhite Seeds	diploid	+
Regency	Seminis	diploid	++++
Royal Sweet	Seminis	diploid	++
SR 8020	Shamrock Seeds	triploid	+
Summer Flavor 790	Abbott & Cobb	diploid	+++
Summer Sweet 5244	Abbott & Cobb	triploid	++
Summer Sweet 7167	Abbott & Cobb	triploid	+
SW 4502	Seedway	triploid	+1/2
Trillion	Abbott & Cobb	triploid	+1/2
Tri-X-313	Syngenta Seeds	triploid	+1/2
Wrigley	Seminis	triploid	++
WX 28	Willhite Seeds	triploid	+++1/2
WX 264	Willhite Seeds	diploid	+++

<sup>1</sup> Inclusion of these varieties does not imply endorsement or criticism of any variety or company. Refer to company literature for information on host resistance claims.

<sup>2</sup> The resistance ratings provided here are averages based on two years of greenhouse research (2004 and 2005). In that research, each watermelon variety was observed after receiving an artificial inoculation with a race 1 strain of the disease. +++++ = good resistance; +++ = moderate resistance; ++ = some resistance; + = little or no resistance.

<sup>3</sup> OP=open pollinated variety included for comparison.

A. CUCUMBER — Slicing Varieties	Season	Disease Resistance <sup>1</sup>
Dasher II	early	1-2-3-4-5-6
General Lee	main	3-4-5-6
Lightning	very early	3-4-6
Speedway	very early	1-2-3-4-5-6
Thunder	very early	3-4-6-7

Beit alpha type (for trial): Socrates

Burpless (for trial): Tasty Green, Burpless 26. Staking recommended. Tasty Green has tolerance to powdery mildew.

<sup>1</sup>Degree of resistance varies according to variety. Disease resistance codes are: 1=angular leaf spot, 2=anthracnose, 3=cucumber mosaic virus, 4=scab, 5=downy mildew, 6=powdery mildew, 7=zucchini yellow mosaic virus.

B. CUCUMBER — Pickling Varieties	Season	Spine Color	Disease Resistance <sup>1</sup>
Calypso	early-mid	white	1-2-3-4-5-6
Carolina	mid	white	1-2-3-4-5-6
Fancipak M	early-mid	white	1-2-3-4-5-6
Green Spear 14	mid	white	1-3-4-5-6
Score <sup>2</sup>	early	white	1-2-3-4-5

<sup>1</sup>Degree of resistance varies according to variety. Disease resistance codes are: 1=angular leaf spot, 2=anthracnose, 3=cucumber mosaic virus, 4=scab, 5=downy mildew, 6=powdery mildew, 7=zucchini yellow mosaic virus.

<sup>2</sup>Machine harvest only.

## Spacing

**Muskmelons:** Rows 5 to 7 feet apart. Plants 3 to 5 feet apart in row. 1 to 2 plants per hill. Plastic mulch is recommended. Clear mulch is suggested only for earliest plantings in northern areas.

**Watermelons:** Rows 6 to 12 feet apart. Plants 3 to 6 feet apart in row. One plant per hill.

**Mini- or “personal” watermelons:** Rows 6 to 10 feet apart. Plants 1.5 to 2 feet apart in row to allow 12 to 15 square feet per plant. Plastic mulch is recommended for all transplanted watermelons.

**Cucumbers for fresh market:** Rows 4 to 6 feet apart. Plants 15 to 18 inches apart in row.

**Pickles (machine harvest):** Rows 18 to 20 inches apart. Plants 5 to 7 inches apart in row.

All cucumbers should be planted after the danger of frost is past since they are not frost tolerant. For proper germination, soil temperature must be above 60°F. Planting too early (when the soil is too cold and wet) will result in poor seedling emergence.

## Fertilizing

**Lime:** To maintain a soil pH of 6.0 to 6.5. Muskmelon is particularly sensitive to low soil pH and should be limed to 6.3 to 6.8. If your soil test indicates less than 70 ppm magnesium, use dolomitic limestone, or apply 50 pounds/acre Mg broadcast preplant incorporated.

**Preplant:** N: 40 to 60 pounds per acre. P<sub>2</sub>O<sub>5</sub>: 0 to 150 pounds per acre. K<sub>2</sub>O: 0 to 200 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. For transplants, a starter solution at the rate of 1 cup (8 ounces) per plant is

recommended. See page 7 for fertilizer type suggestions. If the transplant flat receives a heavy fertilizer feeding just prior to setting, the starter solution can be eliminated.

**Sidedress N:** Apply 45 pounds N per acre in a band to either side of the row when plants are rapidly vining. For direct seeded watermelon, the preplant N application can be replaced by an early sidedressing of 40 pounds N per acre when plants show the first set of true leaves followed by the 45 pounds N rate at the rapid vining stage of growth. If heavy rains occur in June, 30 pounds N per acre should be applied through the irrigation system at fruit set (late June to early July).

For muskmelons and cucumbers grown on plastic mulch, the N rate can be reduced because N losses from leaching are greatly reduced. For this culture system, apply 50 pounds N per acre broadcast preplant over the row just prior to laying the plastic. Sidedress 30 pounds N per acre on either side of the plastic at vining when plant roots have reached the edge of the plastic (mid-June). If you are using trickle irrigation, apply the 50 pounds N per acre preplant and apply 0.5 to 1 pound N per acre daily, or 3 to 6 pounds N weekly through the trickle system until fruit are about 2 inches in diameter.

## Irrigation

**Cucumbers:** Maximum yields and fruit quality will result only if plants receive adequate and timely moisture. Depending on your soil type, obtaining high quality cucumbers requires approximately 1 to 2 inches of water per week. An irregular water supply, particularly during blossoming and fruit development,

can affect fruit quality detrimentally and result in increased nubbins or hooked fruit.

**Muskmelons:** Muskmelons are moderately deep rooted and require adequate soil moisture with good drainage. Natural rainfall may not be adequate, so supplemental irrigation may be required, particularly in the early stages of growth. When irrigating, irrigate the soil in the effective root zone to field capacity. A good, steady moisture supply is critical for good melon production. After melons have attained a good size, it is best to reduce irrigation. Reduced irrigation at this time can, in some cases, increase the mature fruit's sugar content. Excessive moisture during fruit ripening can result in poor quality.

**Watermelons:** Watermelons are deep-rooted plants, so natural rainfall often is adequate, and irrigation may not be cost effective on heavier soils. Adequate soil moisture in the early growth stages will help ensure vigorous growth. Soil moisture also is critical during blossoming and fruit development.

## Harvesting

**Cucumbers:** Unless a once-over mechanical harvester is being used, cucumbers should be harvested at 2 to 4 day intervals to prevent losses from oversized and over mature fruit. Desired harvest sizes range from 5 to 8 inches long and 1.5 to 2 inches in diameter for fresh market. If growing for processors, be sure to understand the specific terms of their contracts at the beginning of the growing season. Prices received are related to the quantity of fruit within specific size ranges as established by either USDA guidelines or by the processor.

**Muskmelons:** Harvesting is done manually, and great care must be exercised at picking to harvest only the

physiologically mature plants. Fruits must be in the half or full slip state. Fruit harvested prior to the half slip stage will be too green and will not ripen properly. Shipping under mature fruit has been a problem and should be avoided.

**Watermelons:** Harvesting watermelons at the correct stage of maturity is critical and difficult. While each cultivar is different, maturity can be determined in several ways, including ground spots changing from white to yellow, browning of tendrils nearest the fruit, ridges appearing on the rind surface, and a hollow or dull sound when "thumped." Melons should be cut from the plant to avoid vine damage and prevent stem-end rot. Leave 1 to 2 inches of stem attached.

## Disease Management with the MELCAST System

MELCAST is a disease warning system that can help Indiana farmers schedule their fungicide applications for control of certain diseases of watermelons and muskmelons. The system was developed by researchers in the Purdue University Department of Botany and Plant Pathology.

MELCAST is available throughout the summer at:

<http://btny.agriculture.purdue.edu/melcast>  
and  
**(800) 939-1604**

Each winter, Purdue Extension plant pathology specialists conduct educational programs that address the system. For more information about MELCAST, contact Dan Egel (Southwest Purdue Agricultural Research Program) at (812) 886-0198, or Rick Latin (Purdue University) at (765) 494-4639.



Bacterial fruit blotch causes small, water-soaked lesions on muskmelon that may affect fruit quality.

# Cucurbit Vegetables — Squash and Pumpkin

Varieties		
<b>Summer Squash</b>	Golden Zucchini	Goldfinger, Gold Rush, Golden Delight
	Middle Eastern	Lita, Bonita
	Yellow Crookneck	Dixie, Prelude 2
	Yellow Straightneck	Lemondrop L, Multipick, General Patton, Monet, Liberator III
	Zucchini	Revenue, Dividend, Spineless Beauty, Jaguar, Puma, Independence III
<b>Winter Squash</b>	Acorn	Table Ace, Seneca Autumn Queen, Taybelle, Table Star (PM*), Mesa Queen
	Butternut	Butternut Supreme, Zenith, Waltham, Early Butternut, Butterboy
	Buttercup	Autumn Cup, BonBon, Buttercup, Burgess, Sweet Mama (Kabocha hybrid)
	Hubbard	Blue Hubbard, Red Kuri (small, red fruits)
	Spaghetti	Vegetable Spaghetti, Tivoli
	Other	Bush Delicata, Sugar Loaf, Carnival, Sweet Dumpling
<b>Pumpkin</b>	Miniature	Apprentice (PM*), Baby Boo (white), Gold Dust (PM*), Gold Speck (PM*), Jack Be Little, Mini-Jack, Munchkin, Sweetie Pie, Wee-B Little
	Small size	Baby Bear, Cannonball (PM*), Hybrid Pam, Iron Man (PM*), Mystic Plus (PM*), Oz, Prankster (PM*), Small Sugar, Spookie, Spooktacular
	For trial	Field Trip (PM*), Gargoyle (PM*)
	Medium size	Gold Fever, Gold Standard, Magician (PM*), Sorcerer, Tom Fox, Wizard
	For trial	New Rocket
	Medium-large and large size	20 Karat Gold (PM*), Aladdin (PM*), Appalachian, Dependable, Gladiator (PM*), Gold Medallion, Harvest Time, Howden Biggie, Magic Lantern (PM*), Merlin (PM*)
	For trial	18 Karat Gold (PM*), Autumn King, Big Rock, Camaro (PM*), Expert (PM*), Gold Challenger, Magic Wand (PM*), Spartan (PM*), Super Herc (PM*), Trojan, Warlock (PM*)
	Very large size	Atlantic Giant, Big Max, Big Moon, Prize Winner
	Specialty types	Buckskin, Fairytale, Jarradale, Rouge Vif D'Etampes (Cinderella)
Hull-less/naked seed	Trick-or-Treat, Triple Treat, Snack Jack	

\*PM=powdery mildew resistant.

## Spacing and Seeding

**Bush Types:** Rows 4-6 feet apart. Plants 18-24 inches apart in row. Seed: 4-6 pounds per acre.

**Vining Types:** Rows 6-8 feet apart. Plants 2-5 feet apart in row. Seed: 2-3 pounds per acre.

## Fertilizing

**Lime:** To maintain a soil pH of 6.0-6.8.


**Preplant:** N: 50 pounds per acre; P<sub>2</sub>O<sub>5</sub>: 0-150 pounds per acre; K<sub>2</sub>O: 0-200 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. For summer squash transplants, a starter solution at a rate of 1 cup (8 ounces) per plant is recommended. See page 7 for fertilizer type suggestions. If the transplant flat receives a heavy fertilizer feeding just prior to setting, the starter solution can be eliminated.


**Sidedress N:** For soils with more than 3 percent organic matter and following soybeans, alfalfa, or a grass-


legume hay crop, no N is needed. For soils with less than 3 percent organic matter with the same rotation or a rotation of corn, rye, oats, wheat, or a vegetable crop, apply 30-40 pounds N per acre when the vines begin to run. For sandy soils, the preplant N application can be replaced by an early sidedressing of 40 pounds N per acre when the plants show the first set of true leaves. Apply the second sidedressing of 45 pounds N per acre at onset of rapid vining.


For crops grown from transplants on plastic mulch, N losses from leaching are greatly reduced. For this culture system, apply 50 pounds N per acre broadcast preplant over the row just before laying the plastic. If sidedress N is recommended (see above), apply up to 30 pounds N per acre on either side of the plastic at vining when the plant roots have reached the edge of the plastic. If you are using trickle irrigation, apply the 50 pounds N per acre preplant, and apply 0.5-1 pound N per acre daily, or 3-6 pounds N weekly through the trickle system if additional N is needed.

## Disease Control


Diseases Controlled	Treatment	Comments
Alternaria Leaf Blight (muskmelon)	3-4 year crop rotation.	Rotation with non-cucurbit crops will significantly reduce the threat of Alternaria in future melon crops.
	Amistar 80WP® at 3.5-5 oz. per acre.	Do not apply more than one time before alternating to a fungicide with a different mode of action. Note: Amistar® has the same active ingredient as Quadris®. See label for tank mix caution. 1-day PHI.
	Cabrio EG® at 12-16 oz. per acre.	Begin applications before disease development. Do not apply Cabrio® more than once before switching to a fungicide with a different mode of action. See label to avoid practices that could result in crop injury. 0-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates. Note that rates vary for different diseases.	Apply protective fungicide beginning when vines touch within rows or when disease threatens. Use a 7-10 day application interval. 0-day PHI.
	Gavel 75DF® at 1.5-2 lbs. per acre.	Some muskmelon varieties are sensitive to Gavel 75DF®. See label for details. 5-day PHI
	Several mancozeb formulations (e.g., Dithane®, Penncozeb®) are available for use at various rates.	5-day PHI.
	Several maneb formulations (e.g., Maneb®, Manex®) are available for use at various rates.	5-day PHI.
	Pristine 38WG® at 12.5-18.5 oz. per acre.	See label concerning the use of Pristine® with additives or adjuvants, particularly with muskmelon. See label for tank mix caution. Do not make more than one application of Pristine® before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris 2.08SC® at 11.0-15.5 fl. oz. per acre.	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. 7-14 day application interval. See label for tank mix caution. 1-day PHI.
	Quadris Opti® at 3.2 pts. per acre.	Do not apply Quadris Opti® more than once before alternating to a fungicide with a different mode of action. See label for tank mix caution. 1-day PHI.
	Reason® at 5.5 fl. oz. per acre.	Do not apply more than once before alternating to a fungicide with a different mode of action. You must wait 30 days after last application before planting wheat. You must wait 1 year after last application to plant any crop not on the label (this includes field corn and soybeans). 14-day PHI.
	Tanos 50WG® at 8 oz. per acre.	Tanos® must be mixed with a contact fungicide with a different mode of action, (e.g., chlorothalonil, mancozeb, copper). Do not make more than one application of Tanos® before alternating to a fungicide with a different mode of action. 3-day PHI.
Angular Leaf Spot (cucumber, muskmelon, and watermelon)	Plant resistant varieties. <b>Cucumber only.</b>	Several cucumber varieties have genetic resistance to angular leaf spot.
	 Several copper-based bactericides are effective against angular leaf spot.	Angular leaf spot is a cool weather disease, normally restricted to the spring or early summer.


 May be acceptable for use in certified organic production. Check with your certifier before use.

Diseases Controlled	Treatment	Comments
Anthracnose (cucumber, muskmelon, and watermelon)	Plant resistant varieties. <b>Cucumber only.</b>	Many cucumber varieties have genetic resistance to anthracnose. Some watermelon varieties list resistance to race 1; however, race 2 is the predominant race affecting watermelon in the Midwest.
	3-4 year crop rotation.	Rotation with non-cucurbit crops will decrease the threat of anthracnose in future years.
	Amistar® at 3.5-5 oz. per acre.	See comments for Amistar® under Alternaria leaf blight. See label for tank mix caution. 1-day PHI.
	Cabrio EG® at 12-16 oz. per acre.	See comments for Cabrio® under Alternaria leaf blight. Do not apply Cabrio® more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates. Note that rates vary for different diseases.	0-day PHI.
	Several mancozeb formulations (e.g., Dithane®, Penncozeb®) are available for use at various rates.	5-day PHI.
	Pristine 38WG® at 18.5 oz. per acre.	See comments for Pristine® under Alternaria leaf blight. Note higher rate for anthracnose. 0-day PHI.
	Quadris 2.08SC® at 11.0-15.5 fl. oz. per acre.	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. See label for tank mix caution. 1-day PHI.
	Quadris Opti® at 3.2 pts. per acre.	Do not apply Quadris Opti® more than once before alternating to a fungicide with a different mode of action. See label for tank mix caution. 1-day PHI.
	Tanos 50WG® at 8 oz. per acre.	See comments for Tanos® under Alternaria leaf blight. 3-day PHI.
Bacterial Fruit Blotch (Primarily muskmelon and watermelon)	Plant uncontaminated watermelon/muskmelon seed. Sanitize the greenhouse thoroughly after each generation of transplants.	The pathogen is primarily seedborne (introduced with contaminated seed), but may overwinter on infested plant material in greenhouses and in the field.
	Contaminated fields should be fall-plowed and planted to crops other than cucurbits for at least 2 years. Subsequent grain crops are suggested for the rotation so that broadleaf herbicides will kill volunteer seedlings in the spring.	Muskmelons may be infected, but they do not appear as disease-prone as watermelons.
	 In situations where fruit blotch threatens, applying copper products at 10-14-day intervals beginning at fruit set or first observation of leaf lesions may help reduce the rate of the disease's spread. <b>Note: many copper products are listed for suppression only.</b>	Copper applications may be effective in reducing losses only if the disease is diagnosed early, and sprays are applied before widespread infection has occurred. Repeated copper use may reduce yield. Copper will not provide acceptable control of fungal diseases such as anthracnose or gummy stem blight. Transplant facility treatment: copper bactericides that are specifically labeled for use in the greenhouse may help slow the spread of bacterial fruit blotch. Growers should be careful to adapt label rates and practices to greenhouse use.
	Tanos 50WDG® at 8-10 oz. per acre. <b>Disease suppression only.</b>	See comments under Alternaria leaf blight.

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Diseases Controlled	Treatment	Comments
Bacterial Leaf and Fruit Spot (pumpkin and squash) 	2-year crop rotation. Avoid fields with a history of bacterial leaf and fruit spot. We suggest 3-4 weekly applications of copper applied at 10-day intervals beginning when fruit are approximately 4 inches in diameter.	Use uncontaminated seed. Disease organism may survive on crop residue. All squash and pumpkin varieties appear to be susceptible.
Bacterial Wilt (cucumber and muskmelon)	A systemic insecticide, such as Furadan® or Admire® (see insect section), should be used. Contact insecticides should be applied to seedlings before transplanting and then continued on a regular basis after the systemic insecticide loses effectiveness (2-3 weeks).	Disease control depends on control of striped and spotted cucumber beetles. Regularly scout fields for beetles. Apply insecticides only when beetles are present. When large numbers are present, treatments may be required twice weekly.
Damping-Off	Practice good greenhouse sanitation.	The best way to prevent damping off of seedlings in the greenhouse is to keep the greenhouse area clean. See section on transplant production on page 8.
	Plant in warm field soils.	The fungi responsible for damping off in field soils cause more loss when the seedling is slow to emerge.
	Seed fungicide treatments.	Most seeds come with fungicide treatments.
	Previcur Flex®. See label for rates.	Damping off caused by <i>Pythium</i> species may be managed with Previcur Flex®. See label for details.
Downy Mildew	Plant resistant varieties. <b>Cucumber only.</b>	Several cucumber varieties have genetic resistance to downy mildew. However, during the 2006 season, some varieties that had previously been reported with some resistance were severely affected.
<b>Resistance Possible</b> Some downy mildew fungus strains that blow into the Midwest may be resistant to specific systemic fungicides. Strobilurin fungicides (e.g., Amistar®, Cabrio®, Flint®, Pristine®, Quadris®, Reason®) and fungicides with the active ingredient mefenoxam (e.g., Ridomil®) are particularly susceptible to resistance. If applying systemic fungicides after August 1, tank mixing with a contact fungicide is recommended in case downy mildew threatens. See Table 25, page 47, Fungicide Resistance Management for more information.	Downy mildew does not overwinter in the Midwest. Crop rotation cannot be used to manage this disease. Acrobat 50WP® at 6.4 oz. per acre. Agri-Fos 400® at 1.25 qt. per acre. Aliette® at 2-5 lbs. per acre. Amistar 80WP® at 3.5-5 oz. per acre. Cabrio EG® at 8-12 oz. per acre.	The North American Disease Forecast Center provides a cucurbit downy mildew forecast Web page showing areas of known outbreaks at <a href="http://www.ces.ncsu.edu/depts/pp/cucurbit">www.ces.ncsu.edu/depts/pp/cucurbit</a> . Must be applied as a tank mix with a fungicide active against downy mildew. Do not make more than 2 sequential applications before alternating to a fungicide with a different mode of action. Do not make more than 5 applications per season. 0-day PHI. Label includes several different crops, PHIs, resistance instructions, and other important information. Some manufacturers recommend tank mixing. 0-day PHI. Use 2-3-lb. rate when tank mixed with another fungicide registered for use on cucurbits. Use 3-5-lb. rate when used alone. 3-day PHI. See comments for Amistar® under Alternaria leaf blight. See label for tank mix caution. 1-day PHI. Begin applications before disease development. Apply on a 7-14 day interval. Use no more than 4 applications of Cabrio® per season. Do not apply Cabrio® more than once before alternating to a fungicide with a different mode of action. See label to avoid practices that could result in crop injury. 0-day PHI.

 May be acceptable for use in certified organic production. Check with your certifier before use.

**Cucurbit Vegetables** (continued)

Disease Control (continued)

Diseases Controlled	Treatment	Comments
Downy Mildew (continued)	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates. Note that rates vary for different diseases.	It may be useful to tank mix or alternate these products with the systemic products listed here. 0-day PHI.
<p><b>Resistance Possible</b> Some downy mildew fungus strains that blow into the Midwest may be resistant to specific systemic fungicides. Strobilurin fungicides (e.g., Amistar®, Cabrio®, Flint®, Pristine®, Quadris®) and fungicides with the active ingredient mefenoxam (e.g., Ridomil®) are particularly susceptible to resistance.</p> <p>If applying systemic fungicides after August 1, tank mixing with a contact fungicide is recommended in case downy mildew is a threat.</p> <p>See Table 25, page 48, Fungicide Resistance Management for more information.</p>	Curzate 60 DF® at 3.2 oz. per acre.	Use only in combination with a labeled rate of a contact fungicide such as copper compounds, mancozeb, or chlorothalonil. 3-day PHI.
	Flint® at 4.0 oz. per acre.	Use a 7-14 day interval. Do not apply Flint® more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
	Forum 4.18SC® at 6 fl. oz. per acre.	Must be applied as a tank mix with a fungicide active against downy mildew. Do not make more than 2 sequential applications before alternating to a fungicide with a different mode of action. Do not make more than 5 applications per season. 0-day PHI.
	Gavel 75DF® at 1.5-2 lbs. per acre. Not for use on pumpkins.	Some muskmelon varieties are sensitive to Gavel 75DF®. See label for details. 5-day PHI.
	Formulations containing maneb such as Maneb 75 DF® or Manex® are labeled at various rates. Formulations containing mancozeb such as Dithane®, Manzate® or Penncozeb® are labeled at various rates. Fungicides containing mancozeb may not be used with pumpkins.	5-day PHI.
	Phostrol® at 2.5-5 pt. per acre.	Label includes several different crops, PHIs, resistance instructions, and other important information. Some manufacturers recommend tank mixing. 0-day PHI.
	Presidio 4SC® at 3-4 fl. oz. per acre.	Must be tank mixed with a product with a different mode of action. 2-day PHI.
	Previcur Flex® at 1.2 pts. per acre.	When applying at intervals of longer than 7 days, alternate use with a contact fungicide. 2-day PHI.
	Pristine 38WG® at 12.5 to 18.5 oz. per acre.	See comments for Pristine® under Alternaria leaf blight. 0-day PHI.
	Prophyt® at 2- 4 pt. per acre.	Label includes several different crops, PHIs, resistance instructions, and other important information. Some manufacturers recommend tank mixing. 0-day PHI.
	Quadris 2.08® at 11-15.5 fl. oz. per acre.	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. See label for tank mix caution. 1-day PHI.
	Quadris Opti® at 3.2 pts. per acre.	Do not apply Quadris Opti® more than once before alternating to a fungicide with a different mode of action. See label for tank mix caution. 1-day PHI.
	Ranman 400SC® at 2.1-2.75 fl oz per acre.	Alternate each application of Ranman® with a fungicide with a different mode of action. 0-day PHI.
Reason® at 5.5 fl. oz. per acre.	Do not apply more than once before alternating to a fungicide with a different mode of action. You must wait 30 days after last application before planting wheat. You must wait 1 year after last application to plant any crop not on the label (this includes field corn and soybeans). 14-day PHI.	
Revus 2.09SC® at 8 fl. oz. per acre. <b>Suppression only.</b>	Make no more than 1 application before switching to another non-group 40 fungicide. 0-day PHI.	
Ridomil Gold Bravo® at 2 lbs. per acre. Ridomil Gold MZ® at 2 lbs. per acre (dry), or 2.5 pts per acre (flowable). Do not use Ridomil Gold MZ® with pumpkins.	Alternate with protective fungicide. 0-day PHI for Ridomil Gold Bravo®. 5-day PHI for Ridomil Gold MZ®.	
Tanos® at 8 oz. per acre.	See comments for Tanos® under Alternaria leaf blight. 3-day PHI.	

Diseases Controlled	Treatment	Comments
Fusarium Fruit Rot	Long rotations of non-cucurbit crops will help to slowly reduce Fusarium populations in the soil. Avoid fields with a history of the problem.	No resistant varieties are available. Fruit with Fusarium fruit rot are often observed from fields where other disease or cultural problems are present. It has been reported that growing pumpkins in cover crops may help avoid Fusarium fruit rot. This disease may be transmitted on seed.
Fusarium Wilt (muskmelon)	Plant resistant muskmelon cultivars.	Several cultivars have good resistance to strains of Fusarium found in Indiana and Illinois.
Fusarium Wilt (watermelon)	Plant watermelon cultivars with partial resistance. Check table on page 67.	Rotation with non-cucurbit crops will decrease wilt incidence.
Gummy Stem Blight/Black Rot	3-4 year crop rotation.	Rotation with other crops will significantly decrease the threat of gummy stem blight in future years.
	Amistar® at 3.5-5 oz. per acre.	See comments for Amistar® under Alternaria leaf blight. See label for tank mix caution. 1-day PHI.
	Cabrio EG® at 12-16 oz. per acre.	Begin applications before disease development. Do not apply Cabrio® more than once before alternating to a fungicide with a different mode of action. See label to avoid practices that could result in crop injury. See label for tank mix caution. 0-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates. Note that rates vary for different diseases.	0-day PHI.
	Folicur 3.6F® at 4-6 fl. oz. per acre.	7-day PHI.
	Several mancozeb formulations (e.g., Dithane®, Penncozeb®) are labeled for use at various rates. <b>Do not apply mancozeb products to pumpkins.</b>	5-day PHI.
	Pristine® at 12.5-18.5 oz. per acre.	See comments for Pristine® under Alternaria leaf blight. Strains of the gummy stem blight fungus have been discovered in Indiana that are resistant to boscalid (one of the active ingredients in Pristine®). Pristine® may fail to control gummy stem blight caused by such resistant strains. 0-day PHI.
	Quadris 2.08SC® at 11.0-15.5 fl. oz. per acre.	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. 7-14 day application schedule. See label for tank mix caution. 1-day PHI.
	Quadris Opti® at 3.2 pts. per acre.	Do not apply Quadris Opti® more than once before alternating to a fungicide with a different mode of action. See label for tank mix caution. 1-day PHI.
Nematodes (muskmelon and watermelon)	Methyl bromide is the active ingredient under a number of trade names. Generally, it is unavailable. <b>RUP.</b>	Methyl bromide and sodium methyl dithiocarbamate give best results when nematode populations are moderate to high. Vydate® gives adequate control when nematode populations are low to moderate and most of the product is applied under plastic mulch. Apply Vydate® before planting in the spring.
	Telone II® or Telone C-35®. <b>RUP.</b>	
	Vydate L® at 1-2 gallons per acre in 20 gallon water broadcast. Incorporate 2-4 inches. <b>RUP.</b>	
	Vapam®. See label for rates.	
Phytophthora and Pythium Fruit and Root Rot, and Foliar Blight	4 or more year crop rotation.	Turban squash is extremely susceptible. No resistant variety is available.
	Avoid fields with a history of a disease on cucurbits, eggplants, peppers, and tomatoes.	
	Acrobat 50WP® at 6.4 fl. oz. per acre.	See comments for Acrobat® and Forum® under downy mildew. 0-day PHI.
	Apron XL LS® at 6.4 fl. oz. per 100 lbs. seed.	Only for direct seeded plants.
	Forum 4.18SC® at 6 fl. oz. per acre.	See comments for Acrobat® and Forum® under downy mildew. 0-day PHI.
	Presidio 4SC® at 3-4 fl. oz. per acre.	Must be tank mixed with a product with a different mode of action. 2-day PHI.

<b>Diseases Controlled</b>	<b>Treatment</b>	<b>Comments</b>
Phytophthora and Pythium Fruit and Root Rot, and Foliar Blight (continued)	Ranman 400SC® at 2.75 fl oz per acre.	Alternate each application of Ranman® with a fungicide with a different mode of action. 0-day PHI.
	Revus 2.09SC® at 8 fl. oz. per acre. <b>Suppression only.</b>	Make no more than 1 application before switching to another non-group 40 fungicide. 0-day PHI.
Plectosporium Blight (pumpkin and squash)	3-4 year crop rotation.	Rotation with non-cucurbit crops.
	Management activities that control black rot should also control Plectosporium blight.	
	Amistar 80WP® at 3.5-5 oz. per acre.	See comments for Amistar® under Alternaria leaf blight. See label for tank mix caution. 1-day PHI.
	Cabrio EG® at 12-16 oz. per acre.	Do not apply more than once before alternating to a fungicide with a different mode of action. See label to avoid practices that could result in crop injury. 0-day PHI.
	Flint® at 1.5-2.0 oz per acre.	Do not apply more than once before alternating to a fungicide with another mode of action. 0-day PHI.
	Quadris 2.08SC® at 11.0-15.5 fl. oz. per acre.	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. See label for tank mix caution. 1-day PHI.
Powdery Mildew (watermelon are generally unaffected by powdery mildew)	Plant resistant varieties whenever possible.	Partially resistant cucumber, muskmelon and pumpkin varieties are available.
	Amistar 80WP® at 3.5-5 oz. per acre.	See comments for Amistar® under Alternaria leaf blight. See label for tank mix caution. 1-day PHI.
<p><b>Alternate Fungicides</b> Unless precautions are taken, the fungi that cause powdery mildew may become resistant to the systemic fungicides listed here.</p> <p>Some labels require alternation between fungicides with different modes of action. Whether required by the label or not, it is a good idea to alternate between fungicides with different modes of action. Refer to the Fungicide Resistance Management Table on page 47 for help in making resistance management decisions.</p>	Cabrio EG® at 12-16 oz. per acre.	See comments for Cabrio® under Alternaria leaf blight. Use no more than 4 applications of Cabrio® per season. Do not apply Cabrio® more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
	Flint® at 1.5-2.0 oz. per acre.	See comments for Flint® under downy mildew. Alternate with fungicides with a different mode of action. 0-day PHI.
	Folicur 3.6F® at 4-6 fl. oz. per acre.	7-day PHI.
	Pristine 39WG® at 12.5-18.5 oz. per acre.	See comments for Pristine® under Alternaria leaf blight. 0-day PHI.
	Procure 50WS® at 4-8 oz. per acre.	0-day PHI.
	Quadris 2.08SC® at 11.0-15.5 fl. oz. per acre	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. See label for tank mix caution. 1-day PHI.
	Quadris Opti® at 3.2 pts. per acre.	Do not apply Quadris Opti® more than one time before alternating to a fungicide with a different mode of action. See label for tank mix caution. 1-day PHI.
	Quintec® at 4-6 fl. oz. per acre. Muskmelon and watermelon only.	If more than one application is made per crop, at least one application must tank mixed with a product effective against powdery mildew that has a mode of action. 3-day PHI.
	Rally 40WSP® at 2.5-5 oz. per acre.	0-day PHI.
	Topsin M 70WP®SB® at 1/2 lb. per acre or Topsin 4.5 FL® at 10 fl oz. per acre.	For resistance management, tank mix or alternate with a fungicide that has a different mode of action. 1-day PHI

Diseases Controlled	Treatment	Comments
Scab (cucumber)	Plant resistant varieties.	0-day PHI.
	3-4 year crop rotation.	Rotation will significantly reduce the threat of scab infection in subsequent cucumber crops.
	Bravo 500® at 2.75-4.25 pts. per acre, or Bravo Ultrex® at 1.8-2.7 lbs. per acre, or Bravo WS® at 2-3 pts. per acre.	0-day PHI.
	Dithane M45® or Dithane DF® at 2-3 lbs. per acre, or Dithane F45® at 1.2-2.4 qts. per acre.	Apply on a 7-14 day schedule. 5-day PHI.
	Echo®. See label for rates.	0-day PHI.
	Maneb 75DF® or Maneb 80WP® at 1-2 lbs. per acre.	Apply on a 7-14 day schedule. 5-day PHI.
	Manex® at 1.2-1.6 qts. per acre.	Apply on a 7-14 day schedule. 5-day PHI.
	Penncozeb 75DF® at 2-3 lbs. per acre.	Apply on a 7-14 day schedule. 5-day PHI.
	Terranil®. See label for rates.	0-day PHI.
Virus Diseases	Control insects responsible for the virus (see Common Cucurbit Viruses and Transmission Sources table below). For squash mosaic virus, plant virus free seed.	Most viruses that occur in the Midwest are transmitted by aphids (see Common Cucurbit Viruses and Transmission Sources table below). However, insect control will not effectively reduce virus incidence in late-season cucurbits. Early planting will best control pumpkin viruses so fruit can set before virus diseases become apparent. For example, southern Indiana growers should plant by June 20. Proper virus diagnosis is critical. Chemical drift sometimes mimics virus symptoms.

Common Cucurbit Viruses and Transmission Sources		
Virus	Host Range	Transmission Source
Cucumber Mosaic Virus	wide	aphids <sup>1</sup>
Papaya Ring Spot Virus	<i>Cucurbitaceae</i>	aphids <sup>1</sup>
Squash Mosaic Virus	<i>Cucurbitaceae</i> , <i>Chenopodiaceae</i>	seeds, cucumber beetles
Watermelon Mosaic Virus	<i>Cucurbitaceae</i> , weeds	aphids <sup>1</sup>
Zucchini Yellow Mosaic Virus	<i>Cucurbitaceae</i>	aphids <sup>1</sup>

<sup>1</sup>Aphidborne viruses are non-persistent, thus aphids can begin transmitting the virus after seconds of feeding, and may transmit the virus for only a few hours.

## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals (emerged) — treatment applied before crop emergence or transplanting	Gramoxone Inteon 2L <sup>®</sup> at 2-4 pts per acre, or Gramoxone Max 3L <sup>®</sup> at 1.3-2.7 pts. per acre.	Include 1 qt. of COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply before seeding or transplanting, or after seeding but before crop emergence. <b>RUP.</b>
Annuals and Perennials (emerged) — crop not present or protected from spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs. potassium salt/gal.) at 0.66-3.3 qts. per acre.	Broadcast at least 3 days before seeding or transplanting, or apply between crop rows with hooded or shielded sprayer. Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. Remove herbicide residue from plastic mulch prior to transplanting. 14-day PHI.
Broadleaves (emerged) — crop not present or protected from spray	Aim EC <sup>®</sup> at 0.5-2 fl. oz. per acre.	Apply prior to transplanting or apply between crop rows with hooded sprayer. Do not apply before direct seeding. Do not allow spray to contact crop. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not exceed 6.1 fl. oz. per acre per season.
Broadleaves and Grasses (not emerged)	Command 3ME <sup>®</sup> at the following rates: <b>Muskmelon and watermelon:</b> 0.4-0.67 pt. per acre. <b>Cucumbers:</b> 0.4-1.0 pt. per acre. <b>Summer squash:</b> 0.67-1.33 pts. per acre. <b>Winter squash and processing pumpkins:</b> 0.67-2 pts. per acre. <b>Not for jack-o-lantern pumpkins.</b>	See label for sensitive varieties. Apply prior to seeding or transplanting, or after seeding before crop emergence. Does not control pigweed and related species. Rates below 1 pt. will only suppress weeds. May cause temporary bleaching of crop leaves. 45-day PHI for cucumbers and squash.
	Curbit 3EC <sup>®</sup> at 3-4 pts. per acre.	Use lower rates on coarse soils. <b>Direct-seeded crops:</b> apply to soil surface within 2 days after seeding. Do not incorporate. <b>Transplants:</b> apply as a banded spray between rows. Does not control large-seeded broadleaves. Needs 0.5 in. water within 5 days of application to be effective. If no rain occurs, cultivate shallowly. Do not apply over or under hot caps, row covers, or plastic mulch. Do not broadcast over top of plants. Under cool temperatures may cause crop injury or failure.
	Strategy <sup>®</sup> at 2-6 pts. per acre.	Strategy <sup>®</sup> is a premix containing the active ingredients of Command <sup>®</sup> and Curbit <sup>®</sup> . <b>Direct-seeded crops:</b> apply to soil surface within 2 days after seeding. Do not incorporate. <b>Transplants:</b> apply as a banded spray between rows. Does not control large-seeded broadleaves. Needs 0.5 in. water within 5 days of application to be effective. If no rain occurs, cultivate shallowly. Do not apply over or under hot caps, row covers, or plastic mulch. Do not broadcast over top of plants. Under cool temperatures may cause crop injury or failure. 45-day PHI for cucumbers and squash.
	Trifluralin products at 0.5-1 lb. a.i. per acre. Use 4EC formulations at 1-2 pts. per acre.	Use lowest rate on coarse soils. Apply as a directed spray between rows after plants have 3-4 leaves and incorporate. 60-day PHI for watermelons. 30-day PHI for other cucurbits.
Broadleaves (not emerged)	Sinbar <sup>®</sup> at 2-4 oz. per acre. <b>Watermelons only.</b>	Do not use on sand or gravel soils. Not recommended on soils with less than 1% organic matter due to crop injury potential. Apply pre-transplant to bare ground, or pre-transplant under plastic mulch, or to row middles. For direct-seeded crops on bare ground apply after planting before crop emerges. Do not allow spray to contact crop. 70-day PHI. Do not plant other crops within 2 years of application.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and Nutsedge (not emerged or emerged)	Sandea® at the following rates:	Use lower rates on coarse soils with low organic matter. Add 0.5-1 pt. nonionic surfactant per 25 gallons of spray solution if emerged weeds are present. Not recommended for use under cool temperatures due to potential for crop injury. May delay crop maturity. Avoid contact with surface of plastic mulch if present. Preemergence and pretransplant applications are allowed on watermelons in Indiana, Illinois, Kansas, and Missouri. Do not exceed 2 applications per crop cycle. Check label for maximum quantity Sandea® permitted per crop cycle and year. 30-day PHI for cucumbers, squash and pumpkins. 57-day PHI for cantaloupes and watermelons. <b>Not for use before planting summer squash or over the top of summer squash or watermelons.</b>
	<b>Row-middle applications:</b> 0.5-1.0 oz. per acre.	Apply between rows of crop, avoiding contact with crop.
	<b>Preemergence:</b> <i>Direct-seeded pumpkins and winter squash on bare ground:</i> 0.5-0.75 oz. per acre. <i>Direct-seeded cucumbers, cantaloupes, and processing pumpkins on bare ground:</i> 0.5-1 oz. per acre.	Apply after seeding but prior to cracking.
	<b>Pre-transplant:</b> <i>Cucumbers, cantaloupes, pumpkins, and winter squash:</i> 0.5-0.75 oz. per acre. <i>Cucumbers and cantaloupes:</i> up to 1 oz. per acre.	Apply to soil surface after final soil preparation or bed shaping and just before applying plastic mulch. Wait 7 days after application and lay mulch before transplanting.
	<b>Postemergence:</b> <i>Pumpkins and winter squash on bare ground:</i> 0.5-0.67 oz. per acre. <i>Cucumbers, cantaloupes, and processing pumpkins on bare ground:</i> 0.5-1 oz. per acre.	Apply after the crop has 3-5 true leaves but before female flowers open.
Grasses (not emerged)	Dacthal W-75® at 6-14 lbs. per acre, or Dacthal Flowable® at 6-14 pts. per acre. <b>Direct-seeded melons, cucumbers, and squash only.</b>	Apply when plants have 4-5 true leaves and growing conditions favor good plant growth. Crop injury may occur if applied under unfavorable growing conditions or earlier than recommended.
	Prefar 4E® at 5-6 qts. per acre.	Use low rate on soils with less than 1% organic matter. Apply before planting and incorporate 1-2 in. or apply after seeding before crop emerges and irrigate within 24 hours.
Grasses (emerged)	Poast 1.5E® at 1-1.5 pts. per acre.	Use with 1 qt. of COC per acre. Spray on actively growing grass. Do not exceed 3 pts. per acre per season. 14-day PHI.
	Select Max® at 12-16 fl. oz. per acre, or Select 2EC® at 6-8 fl. oz. per acre for annual grasses. Use high rate for perennial grasses.	Use with 1 qt. of COC per 25 gallons of spray solution (1%v/v). Spray on actively growing grass. Wait at least 14 days between applications. Do not exceed 64 fl. oz. Select MAX® or 32 fl. oz. Select 2EC® per acre per season. 14-day PHI.

<sup>1</sup> For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup> Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects Controlled	Treatment	Comments
Aphids and Leafhoppers	Conserve natural enemies.	Limiting insecticide use will conserve predators and parasites that help control aphid populations.
	Monitoring.	Look for the presence of predators or parasitized aphids. Several predators per aphid colony will probably bring the aphid population under control without insecticide. Killing aphids with insecticides cannot prevent the virus diseases they carry.
	Actara® at 1.5-3 oz. per acre. <b>Aphids only.</b>	Do not exceed 11 oz. per acre per season. 0-day PHI.
	Admire PRO® at 7.0-10.5 fl. oz. per acre.	Apply pre-plant in a band 2 inches or less, as an in-furrow spray at planting, as a post-plant drench, as a sidedress application, or through trickle irrigation water. Do not exceed 10.5 fl. oz. per acre per season. 21-day PHI.
	Asana XL® at 5.8-9.6 fl. oz. per acre. <b>Leafhoppers only.</b>	Do not exceed 0.25 lb. a.i. per acre per season. 3-day PHI. <b>RUP.</b>
	Assail 70WP at 1.1-1.7 oz. per acre.	Do not exceed 5 applications per season. 0-day PHI.
	Baythroid® at 0.8-1.6 fl. oz. per acre. <b>Potato leafhoppers only.</b>	Do not exceed 11.2 fl. oz. or 4 applications per acre per season. Allow 7 days between applications. 0-day PHI. <b>RUP.</b>
	Brigade 2EC® at 2.6-6.4 fl. oz. per acre, or Brigade WSB® at 8-16 oz. per acre. <b>Leafhoppers only.</b>	Do not exceed 19.2 fl. oz. per acre per season. 3-day PHI. <b>RUP.</b>
	Danitol 2.4EC® at 10.67-16 fl. oz. per acre. <b>Leafhoppers only.</b>	Do not exceed 42.67 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>
	Diazinon AG500® at 0.5-1.5 pts. per acre, or Diazinon 50W® at 1-1.5 lbs. per acre. <b>Muskmelon and watermelon only.</b>	Do not exceed 5 applications per season. 3-day PHI. <b>RUP.</b>
	Dimethoate 400® or Dimethoate 4E® at 0.5-1 pt. per acre, or Dimethoate 2.67EC® at 0.75-1.5 pts. per acre. <b>Muskmelons and watermelons only.</b>	3-day PHI.
	Endosulfan 3EC® at 0.67-1.33 qts. per acre.	Do not exceed 4 applications per acre per season. 2-day PHI.
	Fulfill® at 2.75 oz. per acre. <b>Aphids only.</b>	Do not exceed 5.5 oz. per acre per season. 0-day PHI.
	Lannate SP® at 0.5-1 lb. per acre. <b>Aphids only.</b>	1-day PHI for applications of 0.5 lb. 3-day PHI for applications of more than 0.5 lb. <b>RUP.</b>
	Malathion 5EC® at 1.5-2.0 pts. per acre. <b>Aphids only. Not for use on melons.</b>	Ground application only. 1-day PHI for cucumber and squash. 3-day PHI for pumpkin.
	M-Pede® at 1-2% by volume. <b>Aphids only.</b>	Must contact aphids to be effective. 0-day PHI.
Platinum® at 5-11 fl. oz. per acre. <b>Aphids only.</b>	30-day PHI.	
Pounce 25WP® or Ambush 25W® at 6.4-12.8 oz. per acre. <b>Leafhoppers only.</b>	Apply a minimum of 4 gallons finished spray per acre by air, or 20 gallons finished spray per acre with ground equipment. Do not exceed 1.6 lbs. a.i. per acre. 0-day PHI. <b>RUP.</b>	
Cucumber Beetles only (preplant)	Admire PRO® at 7.0-10.5 fl. oz. per acre.	Apply pre-plant in a band 2 inches or smaller, as an in-furrow spray at planting, as a post-plant drench, as a sidedress application, or through trickle irrigation water. Do not exceed 24 fl. oz. per acre per season. 21-day PHI.



<b>Insects Controlled</b>	<b>Treatment</b>	<b>Comments</b>
Cucumber Beetles only (preplant) <b>(continued)</b>	Furadan 4F® at 2.4 fl. oz. per 1,000 linear ft. of row. <b>Indiana, Illinois, Iowa, and Missouri only.</b>	Apply directly into seed furrow or as a 7-inch band over the row. This application is for seedling protection and beetle control after seedlings emerge or as transplants become established. <b>RUP.</b>
Cucumber Beetles, Squash Bugs, and Squash Vine Borers	Monitoring.	Fields should be monitored frequently (2-3 times per week) to detect mass emergence of beetles in the spring. Focus insecticide applications on periods of heavy beetle activity. Evening sprays will reduce bee kill.
	Apply throughout the season when beetles exceed threshold.	If Furadan 4F® was applied just before or during transplanting, plants will need one spray to protect plants until plant uptake of Furadan® has occurred.
<b>Traps for Sampling</b> Muskmelon growers may consider using unbaited AM Yellow Sticky Traps for sampling cucumber beetles.	Ambush 25W® at 6.4-12.8 oz. per acre.	Apply a minimum of 4 gallons finished spray per acre by air or 20 gallons finished spray per acre with ground equipment. Do not exceed 1.6 lbs. a.i. per acre. 0-day PHI. <b>RUP.</b>
	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not exceed 0.25 lb. a.i. per acre per season. 3-day PHI. <b>RUP.</b>
	Baythroid® at 2.4-2.8 fl. oz. per acre. <b>Cucumber beetles only.</b>	Do not exceed 11.2 fl. oz. or 4 applications per acre per season. Allow 7 days between applications. 0-day PHI. <b>RUP.</b>
	Brigade 2EC® at 2.6-6.4 fl. oz. per acre, or Brigade WSB® at 8-16 oz. per acre.	Do not exceed 19.2 fl. oz. per acre per season. 3-day PHI. <b>RUP.</b>
	Danitol 2.4EC® at 10.67-16 fl. oz. per acre. <b>Cucumber beetles only.</b>	Do not exceed 42.67 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>
	Diazinon AG500® at 0.5-1.5 pts. per acre, or Diazinon 50W® at 0.5-1.5 lbs. per acre. <b>Muskmelon and watermelon only.</b>	Do not exceed 5 applications per season. 3-day PHI. <b>RUP.</b>
	Endosulfan 3EC® at 0.67-1.33 qts. per acre.	Do not exceed 4 applications per season. 2-day PHI.
	Kryocide® at 8-16 lbs. per acre.	Do not exceed 64 lbs. per acre per season. 7-day PHI for summer squash. 14-day PHI for other cucurbits.
	Mustang Max® at 2.8-4 fl. oz. per acre.	Do not exceed 24 fl. oz. per acre per season. 1-day PHI.
	Pounce 25WP® at 6.4-12.8 oz. per acre.	Apply a minimum of 4 gallons finished spray per acre by air or 20 gallons finished spray per acre with ground equipment. Do not exceed 1.6 lbs. a.i. per acre. 0-day PHI. <b>RUP.</b>
	Prokil Cryolite 50D® at 15-30.5 lbs. per acre.	Do not exceed 153 lbs. per acre per season. 7-day PHI for summer squash. 14-day PHI for other cucurbits.
	Sevin XLR PLUS® at 1 qt. per acre. <b>Not for squash vine borer.</b>	When applied during hot, humid conditions, carbaryl may cause some phytotoxicity, especially on seedlings and newly set plants. Carbaryl may be highly toxic to bees visiting plants during bloom. Do not exceed 6 qts. per acre per season. 3-day PHI.
Warrior at 2.56-3.84 fl. oz. per acre.	Do not exceed 23 fl. oz. per acre per season. 1-day PHI.	
Mites	Acramite 50WS® at 0.75-1 lb. per acre.	One application per season only. Do not apply less than 50 gallons of water per acre. 3-day PHI.
	Agri-Mek 0.15 EC® at 8-16 fl. oz. per acre.	Do not exceed 48 fl. oz. per acre per season. Allow at least 7 days between applications. Do not make more than 2 sequential applications. Do not apply less than 20 gallons of water per acre. 7-day PHI.
	Danitol 2.4EC® at 10.67-16 fl. oz. per acre.	Do not exceed 42.67 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>

**Cucurbit Vegetables** (continued)  
 Insect Control (continued)

Insects Controlled	Treatment	Comments
Mites (continued)	Diazinon AG500® at 0.5-1.5 pts. per acre, or Diazinon 50W® at 1-1.5 lbs. per acre. <b>Muskmelons and watermelons only.</b>	Do not exceed 5 applications per season. 3-day PHI. <b>RUP.</b>
	Epi-mek 0.15EC® at 8-16 fl. oz. per acre.	Do not exceed 48 fl. oz. per acre per season. Allow at least 7 days between applications. Do not make more than 2 sequential applications. Do not apply less than 20 gallons of water per acre. 7-day PHI.
	Kelthane 50WSP® at 1.25 lbs. per acre.	Do not exceed 2 applications per season. 2-day PHI.
	Malathion 5EC® at 1.5 pts. per acre. <b>Not for melons.</b>	Ground application only. 1-day PHI for cucumber and squash. 3-day PHI for pumpkin.
	Oberon 2SC® at 7.0-8.5 fl. oz. per acre.	Do not exceed 25.5 fl. oz. per acre per season. 7-day PHI.
Seed Corn Maggots and Cucumber Beetles (in seed beds)	Treat seeds with a combination fungicide/insecticide, such as captan-lindane, at 1 oz. per 25 lbs. of seed.	Early clean plowing of cover crops will generally result in less damage to seedling plants in the field.
Thrips	Admire PRO® at 7-10.5 fl. oz. per acre.	Apply preplant in a band 2 inches or less, as an in-furrow spray at planting, as a post-plant drench, as a sidedress application, or through trickle irrigation water. Do not exceed 10.5 fl. oz. per acre per season. 21-day PHI.
	Danitol 2.4EC® at 10.67-16 fl. oz. per acre.	Do not exceed 42.67 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>
	Diazinon AG500® at 0.5-1.5 pts. per acre, or Diazinon 50W® at 1-1.5 lbs. per acre. <b>Muskmelon and watermelon only.</b>	Do not exceed 5 applications per season. 3-day PHI. <b>RUP.</b>
	Dimethoate 400® or Dimethoate 4E® at 1 pt. per acre, or Dimethoate 2.67EC® at 1.5 pts per acre. <b>Melons only.</b>	3-day PHI.
	Entrust® at 1.25-3 oz. per acre.	Do not exceed 9 oz. per acre per season. 1-day PHI.
	Platinum® at 5-11 fl. oz. per acre.	30-day PHI.
	SpinTor 2SC® at 6-8 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. 1-day PHI for cucumbers. 3-day PHI for other cucurbits.
Whiteflies	Actara® at 3-5.5 oz. per acre.	Do not exceed 11 oz. per acre per season. 0-day PHI.
	Admire PRO® at 7-10.5 fl. oz. per acre.	Apply pre-plant in a band 2 inches or less, as an in-furrow spray at planting, as a post-plant drench, as a sidedress application, or through trickle irrigation water. Do not exceed 10.5 fl. oz. per acre per season. 21-day PHI.
	Align® according to label directions.	0-day PHI.
	Assail 70WP® at 1.1-2.3 oz. per acre.	Do not exceed 5 applications per season. 0-day PHI.
	Brigade 2EC® at 5.2-6.4 fl. oz. per acre, or Brigade WSB® at 12.8-16.0 oz. per acre.	Do not exceed 19.2 fl. oz. per acre per season. 3-day PHI. <b>RUP.</b>
	Danitol 2.4EC® at 10.67-16 fl. oz. per acre.	Do not exceed 42.67 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>
	Fulfill® at 2.75 oz. per acre.	Do not exceed 5.5 oz. per acre per season. 0-day PHI.
	M-Pede® at 1-2% by volume.	Must contact whiteflies to be effective. 0-day PHI.
	Neemix® according to label directions.	0-day PHI.
	Oberon 2SC® at 7-8.5 fl. oz. per acre	Do not exceed 25.5 fl. oz. per acre per season. 7-day PHI.
	Platinum® at 5-11 fl. oz. per acre.	30-day PHI.

# Fruiting Vegetables

## Fruiting Vegetables — Eggplant

Varieties	Season	Comments
Dusky	extra-early	Good, but low yielding because of small fruit size
Classic	early	Long, slim, tapered
Epic	early	Oval
Ichiban	early	Long, slender
Little Fingers	early	Small, slender, borne in clusters
Millionaire	early	Slender, black, purple calyx
Kiko	early main	Holds color in fall
Nadia	main	Oval, long
Caspar	main	White, cylindrical
Ghostbuster	main	White, oval
Rosita	main	Lavender, long, cylindrical

## Fruiting Vegetables — Pepper

Varieties	Season	Fruit Shape	Color <sup>1</sup>	DisTol/Res <sup>2</sup>	Comments
Alliance	mid-early	blocky, 3-4 lobes	G>R	BLS-1,2,3,4,5, CMV, PHY, PMV, PVY,	Large peppers
Aristotle X3R	main	Blocky	G>R	BLS-1,2,3	Very consistent
Brigadier	mid-early	deep blocky, 3-4 lobes	G>R	BLS-1,2,3,PVY	
Crusader	main	blocky	G>R	BLS-1,2,3, TMV, PVY, PMV, Stip	Dark green
King Arthur	early	3-4 lobes, blocky	G>R	BLS-2	
Lafayette	main	blocky	G>Y	BLS-1,2,3, PVY	Not for sandy soils
Paladin	early-main	long blocky	G>R	PHY	
Revolution	main	blocky	G>R	BLS-1,2,3,5, CMV, PHY	Large peppers, not recommended for Iowa
Sentry	mid-early	blocky	G>R	BLS-1,2,3	Dark green
Socrates	early	blocky	G>R	BLS-1,2,3, PVY	
Red Knight X3R	early	blocky	G>R	BLS-1,2,3	Very good red

<sup>1</sup>Immature to ripe fruit color: G=green, R=red, Y=yellow

<sup>2</sup>Disease resistance or tolerance as reported by seed company. BLS-1,2,3=bacterial spot strains 1,2, and 3; CMV=cucumber mosaic virus; PHY=Phytophthora; PMV=pepper mottle virus; PVY=potato virus Y; TMV=tobacco mosaic virus.

Colored Bells for trial	Gold Finch (yellow), Orange Grande, Oriole (orange), Sweet Chocolate, Blackbird (brown to black), Blue Jay (lilac), Islander (lavender), Tequila (green to purple to red), Blushing Beauty (ivory to red)
Banana peppers/cubanelles	Sweet Banana (turns red at maturity), Key Largo (cubanelle, orange-red at maturity)
Sweet peppers	Aruba, Corno Verde, Giant Marconi
Hot Peppers	Hungarian Hot Wax: Stoked. Jalapeno: Tula, Grande, Ixtapa, Mitla, Pecos Long Thick Red: Ring of Fire, Copacabana (yellow) Anaheim: Big Chile, Anaheim TMR23

## Tomato — Fresh Market Varieties

Varieties	Season	Crack Resistance	Firmness	Vine Type <sup>1</sup>
Sunshine	first early	good	firm	D
Jet Star	early	good	fair	I
Celebrity	early-main	fair	fair	D
Fabulous	early-main	good	firm	D
Florida 91	early-main	excellent	firm	D
Mountain Spring	early-main	excellent	very firm	D
Red Sun	early-main	good	firm	D
Sun Brite	early-main	good		D
Sunsation	early-main		firm	D
Amelia	main	good	firm	D
BHN 589	main	excellent	firm	D
Big Beef	main	good	fair	I
Biltmore	main	good	firm	D
Crista	main	good	very firm	D
Florida 47	main	good	firm	D
Mountain Fresh	main	good	firm	D
Sun Leaper	main-late		firm	D
For trial: Applause (early), Linda				
Yellow: Carolina Gold, Lemon Boy				
Cherry types: Mountain Belle				
Grape types: Santa (indeterminate), Sweet Olive (determinate), Jolly Elf (determinate, for trial), Golden Sweet (yellow)				
Roma types: BHN 411, Plum Dandy, LaRossa				
<sup>1</sup> Vine Type: I=indeterminate (long vine); D=determinate (short vine).				

### Transplants

Eggplant, peppers, and tomatoes are typically started as transplants in greenhouses or artificially lit growing rooms — refer to the Transplant Production section (pages 8-10).

For rapid seed germination, maintain the temperature of potting mix at 85°F. Grow eggplant seedlings between 70°F and 80°F during the day and 65°F and 70°F at night, and tomatoes and peppers between 65°F and 75°F during the day and 60°F and 65°F at night.

Pepper and eggplant seedlings should be ready for the field in six to eight weeks and tomatoes in five to seven weeks.

Before transplanting, harden seedlings by exposing them for a few days to higher light and temperatures between 60°F and 65°F. Set tomatoes in the field after the danger of frost has passed. For peppers and eggplant, wait until soil has warmed and average daily temperature reach 65°F.

### Production Systems for Fresh Market

Fresh market eggplant, peppers, and tomatoes are often grown on raised beds covered with plastic mulch to promote earliness — refer to the Plastic Mulch section (page 13). Drip irrigation beneath the mulch provides a uniform water supply and can deliver fertilizer during the growing season. Typical beds are 30 inches across, 4 to 6 inches high, and centered 5 to 6 feet apart.

**Tomatoes and eggplant:** Space 1.5 to 2.5 feet apart in the row.

**Peppers:** Space 1 to 1.5 feet apart. Or, plant a double row of peppers with 1.5 feet between rows and 1 foot between plants.

**Bare ground culture:** Space rows 2.5 to 5 feet apart. *Tomatoes and eggplants:* space 1.5 to 3 feet apart in the row. *Peppers:* space 1 to 1.5 feet apart in the row.

**Tomatoes** may be left to grow over the ground or may be supported by cages, stakes, strings, or a trellis-weave system. Supported tomatoes produce higher quality fruit than unsupported plants and marketable yield is usually

much greater. Tomatoes supported by stakes or trellises are sometimes pruned, which involves removing several or all of the branches up to the branch just below the first flower cluster when the branches are a few inches long. For tomatoes supported by vertical string, only one or two stems are allowed to grow and so pruning continues throughout the season to remove branches that develop above the first flower cluster. Pruned plants produce larger fruit than unpruned plants, but the quantity of fruit is reduced.

**Peppers and eggplant** may benefit from staking if plants tend to break, lean, or lodge. If peppers are in a double row on a bed, a row of short stakes strung with twine along the outside of each row will support the plants. Peppers and eggplant may also be supported using a trellis-weave system.

## **Production Systems for Processing Tomatoes**

Select row spacing and bed formation that will work with available harvesting equipment. Double rows 16 to 20 inches apart on 5 to 6 feet centers are common, with plants 1 to 2 feet apart in the row.

Ethephon applications accelerate and concentrate fruit ripening, thus facilitating once-over machine harvesting of processing tomatoes.

**For Machine Harvest:** Apply 3.25 pts. Ethrel® or Cepha® in 5 to 70 gallons of water per acre as a spray over the entire plant when 10 to 30 percent of fruits are ripe. Harvest 15 to 21 days after treatment for optimum ripe fruit accumulation.

## **Fertilizing**

**Lime:** To maintain a soil pH of 6.0 to 6.8.



**Fresh Market Eggplant, Peppers, and Tomatoes:** Before planting, apply 30 pounds N per acre, 0 to 240 pounds per acre  $P_2O_5$ , and 0 to 300 pounds  $K_2O$  per acre based on soil test results and recommendations from your state. At transplanting, apply a starter solution


containing N and P — see Fertilizing, Liming, and Soil Sampling (page 7). If the transplant flat received a heavy fertilizer feeding just prior to setting, eliminate the starter solution. Three to four weeks after transplanting, and then six to eight weeks after transplanting, apply 30 to 40 pounds N per acre as a sidedressing. Sidedressing may be replaced by supplying N through the drip irrigation system at about 1 pound N per acre per day. Reduce the amount of fertilizer N applied by the value of N credits from green manures, legume crops grown in the previous year, compost and animal manures, and soils with more than 3 percent organic matter. The total amount of N from fertilizer (including starter) and other credits should be 100 to 120 pounds per acre.  $K_2O$  may also be supplied through drip irrigation at a rate of 1 to 1.5 pounds per acre per day for peppers and eggplant, and 1.5 to 2.5 pounds per acre per day for tomatoes. Reduce the amount of  $K_2O$  applied before planting by the amount that will be supplied through drip irrigation.


**Processing Tomatoes:** Before planting, apply 40 pounds N per acre, and  $P_2O_5$  and  $K_2O$  based on soil test results and recommendations from your state. At transplanting, apply a starter solution containing N and P — see Fertilizing, Liming, and Soil Sampling (page 7) Four to five weeks after transplanting or after first fruit, set sidedress with 40 to 50 pounds N per acre. Reduce the amount of fertilizer N applied by the amount of N credits from green manures, legume crops grown in the previous year, compost and animal manures, and soils with more than 3 percent organic matter. The total amount of N from fertilizer (including starter) and other credits should be 80 to 100 pounds per acre.


**Calcium:** Tomatoes and peppers are susceptible to calcium deficiency even when adequate calcium levels are present in the soil. Deficiency results in a disorder called “blossom end rot.” It often occurs under conditions of inadequate or excessive watering and/or excessive N fertilization with an ammonium source. Where the soil pH has been adjusted to 6.0 or higher, additional soil-applied calcium does not correct the disorder.

## Disease Control


Diseases Controlled	Treatment	Comments
Anthracnose (pepper and tomato only)	Use disease-free seed and/or transplants. Practice a 3-4 year crop rotation.	
	Amistar 80WP® at 2-5 oz. per acre.	Do not apply Amistar® more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
	Cabrio EG® at 8-12 oz. per acre.	Do not make more than 1 sequential application before alternating to a fungicide with a different mode of action. See label to avoid practices that could result in crop injury. 0-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, and Equus®) are available at various rates.	Fungicides and application schedules effective against early blight and Septoria leaf spot will protect against anthracnose infection. Note that higher rates may be required for anthracnose protection. 0-day PHI.
	Several formulations of mancozeb (e.g., Dithane®, Manzate®, Penncozeb®) or maneb (e.g., Maneb®, Manex®) are labeled at various rates. <b>Do not use mancozeb products on pepper.</b>	5-day PHI.
	Maneb 75DF® or 80WP® at 1.5-3.0 lbs. per acre, or Manex® at 1.2-2.4 qt. per acre.	7-day PHI.
	Quadris Flowable® at 6.0-15.5 oz. per acre.	Do not apply Quadris® more than twice before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris Opti® at 1.6 pts. per acre.	See comments for Quadris Opti® under anthracnose. 0-day PHI.
	Revus Top 2.08SC® at 5.5-7 fl. oz. per acre.	Adjuvant recommended. 1-day PHI.
	Tanos® at 8-10 oz. per acre.	Do not apply Tanos® more than once before alternating with a fungicide with another mode of action. 3-day PHI.
Bacterial Spot/Speck (bacterial spot on pepper and tomato only; bacterial speck on tomato only)	Resistant varieties available for bacterial spot of pepper. Note that several races of bacterial spot exist that can affect pepper.	Use disease-free seed and/or transplants.
	Actigard® at 0.3-0.75 oz. per acre. Use low rate early in season and increase with time. See label. <b>Tomato only.</b>	Use up to 8 weekly applications. May be effective when used with other labeled pesticides. 14-day PHI.
	Agri-mycin 17® at 200 ppm.	Begin applications at the 2-leaf stage on a 4-5 day schedule until transplanted in the field.
	 For greenhouse use, several formulations of copper products (e.g., Kocide®, Champ®, Cuprofix®) are labeled at tablespoon (TBSP) per 1,000 square feet rates.	Repeat according to label directions. Carefully note re-entry and personal protection warnings.
	 In the field, use copper sprays to reduce the rate of bacterial spread.	Avoid consecutive seasons with peppers or tomatoes in the same field. Avoid working in fields when plants are wet.
Blossom-End Rot	Avoid drastic moisture fluctuations. Mulching plants may help. Avoid excessive nitrogen or potassium fertilization, rapid plant growth, and root pruning during cultivation. Maintain soil pH and calcium levels in desired range. Choose less susceptible varieties.	Blossom-end rot is caused by a calcium deficiency in the fruit, although calcium levels in the soil may be sufficient. Wide fluctuations in soil water levels can trigger the disorder.


 May be acceptable for use in certified organic production. Check with your certifier before use.

<b>Diseases Controlled</b>	<b>Treatment</b>	<b>Comments</b>
Bacterial Canker (tomato only)	Some seed treatments show promise for reducing bacterial canker incidence. Use disease-free seed and transplants. Transplant facility treatments listed under bacterial spot and speck will help reduce the severity of bacterial canker. However, copper sprays in the field are generally ineffective for controlling canker.	Fields with a history of canker should be planted to crops other than tomatoes, potatoes, peppers, or eggplant for at least 3 years. Sanitize machinery, seedlings, and plant production materials (wooden flats, plastic trays, greenhouse benches, and wooden stakes) with a disinfectant such as 10% chlorine bleach solution or another appropriate solution. Avoid working in wet canker fields.
Botrytis Gray Mold (tomato only)	Keep greenhouse temperatures 70°F or higher, and keep relative humidities lower than 90%.	Use ventilation or forced air.
	Lime soils and keep fertility levels up.	A calcium to phosphorus ratio of 2 or higher in leaf petiole tissues aids in control.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are available at various rates.	Field use only. 0-day PHI.
	 Many copper formulations used for managing bacterial disease are labeled for greenhouse use for gray mold.	
	Endura® at 9-12.5 oz. per acre.	Field use only. Do not make more than 2 sequential applications of Endura® before alternating to a fungicide with a different mode of action. 0-day PHI.
	Scala® at 7 fl. oz. per acre.	Scala® may be used in greenhouses (see label for restrictions). Use only in tank mixture. 1-day PHI.
Buckeye Rot (tomato only)	Rotate away from tomatoes or other related crops for 3 years. Avoid low areas of fields. Plastic mulch may reduce splash infection.	
	Amistar® at 1.6-2.0 oz. per acre.	See comments for Amistar® under anthracnose. 0-day PHI.
	Gavel 75DF® at 1.5-2 lbs. per acre.	Start applications when seedlings emerge or transplants are set, and repeat at 7-10 day intervals. Adding a surfactant may improve performance. 5-day PHI.
	Quadris 2.08EC® at 5.0-6.0 fl. oz. per acre.	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris Opti at 1.6 pts. per acre.	See comments for Quadris Opti® under anthracnose. 0-day PHI.
Early Blight, Septoria Leaf Blight (tomato only)	Plant resistant varieties.	Use wilt resistant “VF” cultivars, and avoid fields with a wilt history. Tomatoes weakened by wilt disease may be more prone to leaf blights.
	3-4-year rotation with unrelated crops.	Rotate out of fields with a history of early blight or Septoria leaf spot.
	Amistar® at 1.6-2.0 oz. per acre.	See comments for Amistar® under anthracnose. 0-day PHI.
	Cabrio EG® at 8-12 oz. per acre.	Begin application prior to disease development and continue on a 7-14-day schedule. Do not apply more than once before alternating to a fungicide with a different mode of action. See label to avoid practices that could result in crop injury. 0-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are available at various rates.	0-day PHI.

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**Fruiting Vegetables (continued)**  
Disease Control (continued)


Diseases Controlled	Treatment	Comments
Early Blight, Septoria Leaf Blight (tomato only) (continued)	Endura 70WG® at 2.5-3.5 oz. per acre. <b>Early blight only.</b>	Do not make more than 2 sequential applications before alternating to a fungicide with a different mode of action. 0-day PHI.
	Gavel 75DF® at 1.5-2 lbs. per acre.	Start applications when seedlings emerge or transplants are set, and repeat at 7-10 day intervals. Adding a surfactant may improve performance. 5-day PHI.
	Several formulations of mancozeb (e.g., Dithane®, Mancozeb®, Penncozeb®), or maneb (e.g., Maneb®, Manex®) are labeled at various rates.	5-day PHI.
	Quadris 2.08EC® at 5.0-6.0 fl. oz. per acre.	Apply at 7- to 14-day intervals. Quadris® provides best control of foliar disease when applied between initial flower formation and color break of fruit. Do not make more than 1 sequential application of Quadris® before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris Opti® at 1.6 pts. per acre.	See comments for Quadris Opti® under anthracnose. 0-day PHI.
	Reason® at 5.5-8.2 fl. oz. per acre. <b>Septoria suppression only. See label for plant back restrictions.</b>	Do not make more than 1 application of Reason® before alternating to a fungicide with a different mode of action. 14-day PHI.
	Revus Top 2.08SC® at 5.5-7 fl. oz. per acre.	Adjuvant recommended. 1-day PHI.
	Scala® at 7 fl. oz. per acre. <b>Early blight only.</b>	May be used in greenhouses (see label for restrictions). Use only in tank mixture. 1-day PHI.
	Tanos® at the following rates: <b>Early blight:</b> 6-8 oz. per acre. <b>Septoria:</b> 8 oz. per acre.	See comments under anthracnose.
	Ziram 76DF® at 3-4.0 lbs. per acre. <b>Not for cherry tomatoes.</b>	Use with effective spreader sticker. 7-day PHI.
Fusarium Crown and Root Rot (tomato only)	Use long crop rotations.	Steam or fumigate soil in the greenhouse prior to transplanting.
Fusarium Wilt (tomato only)	Plant resistant varieties.	Avoid fields with a history of root knot nematode.
Leaf Mold (tomato only)	Practice good sanitation and crop rotation. Provide good aeration between plants.	This disease is most often observed in greenhouse situations.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are available at various rates. <b>Field use only.</b>	0-day PHI.
	 Some copper formulations are labeled and may be organically certified.	Some formulations may be labeled for the greenhouse.
	Several formulations of mancozeb (e.g., Dithane®, Manzate®, Penncozeb®) are labeled at various rates.	5-day PHI.
	Revus Top 2.08SC® at 5.5-7 fl. oz. per acre.	Adjuvant recommended. 1-day PHI.
	Tanos® at 8 oz. per acre.	3-day PHI.
Late Blight (tomato only)	Agri-Fos 50WP® at 1.5-2 qts. per acre.	0-day PHI
	Amistar® at 2.0 oz. per acre.	See comments for Amistar® under anthracnose. 0-day PHI.


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Diseases Controlled	Treatment	Comments
Late Blight (tomato only) (continued)	Cabrio EG® at 8-16 oz. per acre.	Begin application prior to disease development and continue on a 7-14 day schedule. Do not apply more than once before alternating to a fungicide with a different mode of action. See label to avoid practices that could result in crop injury. 0-day PHI.
	Chlorothalonil and mancozeb products may be used.	Higher rates may be required for late blight control. 0-day PHI for chlorothalonil. 5-day PHI for mancozeb.
	Curzate® at 3.2-5 oz. per acre.	Apply Curzate® plus a contact (protectant) fungicide. Use the 5 oz. rate if late blight is present. 3-day PHI.
	Gavel 75DF® at 1.5-2 lbs. per acre.	Start applications of Gavel® when seedlings emerge or transplants are set, and repeat at 7-10 day intervals. Adding a surfactant may improve performance. 5-day PHI.
	Previcur Flex® at 0.7-1.5 pts. per acre.	Increase the rate with increasing disease pressure (see label). Always tank mix with a protectant (contact) fungicide. 5-day PHI.
	Prophyt 54.5F® at 4 pts. per acre.	0-day PHI.
	Quadris 2.08EC® at 6 fl. oz. per acre.	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. Do not exceed 6 applications per year. 0-day PHI.
	Quadris Opti® at 1.6 pts. per acre.	Do not apply Quadris Opti® for 21 days after transplanting or 35 days after seeding. Do not apply more than once before alternating to a non-group 11 fungicide. 0-day PHI.
	Ranman 400SC® at 2.1-2.75 fl. oz. per acre.	0-day PHI.
	Reason® at 5.5-8.2 fl. oz. per acre. <b>See label for plant back restrictions.</b>	Do not apply Reason® more than once before alternating to a fungicide with a different mode of action. 14-day PHI.
	Several formulations of Ridomil® are labeled for late blight control. Consult label for rates and other important restrictions.	PHI varies widely by formulation.
Tanos 50WP® at 8 oz. per acre.	Should be tank mixed with a contact fungicide with a different mode of action. 3-day PHI.	
Powdery Mildew (pepper and tomato only)	Amistar® at the following rates: <b>Tomato:</b> 1.6-2.0 oz. per acre. <b>Pepper:</b> 2-5 oz. per acre.	See comments for Amistar® under anthracnose. 0-day PHI.
	Cabrio® at 8-16 oz. per acre.	Do not apply more than twice before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris 2.08EC® at the following rates: <b>Tomato:</b> 5.0-6.2 fl. oz. per acre. <b>Pepper:</b> 6-15.5 fl. oz. per acre.	Apply at 7-14 day intervals Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris Opti® at 1.6 pts. per acre. <b>Tomato only.</b>	Do not apply Quadris Opti® within 21 days after transplanting or 35 days after seeding. Do not apply more than once before alternating to a non-group 11 fungicide. 0-day PHI.
	Rally 40WSP® at 2.5-4.0 oz.	Do not exceed 21 days between applications. 0-day PHI.
	Revus Top 2.08SC® at 5.5-7 fl. oz. per acre.	Adjuvant recommended. 1-day PHI.

**Fruiting Vegetables** (continued)  
Disease Control (continued)

Diseases Controlled	Treatment	Comments
<b>Phytophthora Blight</b>  <b>Timing Critical</b> Fungicides applied for Phytophthora blight are most effective if applied when disease threatens, but before symptoms become severe.	Avoid waterlogged root zones throughout the season.	Peppers are very susceptible. Use well-drained fields. Planting on raised beds will increase soil drainage. Rotate infested fields with non-host crops for several years.
	Use resistant varieties if available for commercial production. See Table 22.	Water management is of primary importance for Phytophthora control.
	Agri-Fos 400® at 1.5-2.0 qt. per acre.	0-day PHI.
	Phostrol® at 1-2 qt per acre.	0-day PHI.
	Ridomil Gold SL® treat soil at 1 pt. per acre (broadcast; use less for band application) before transplanting. Subsequent directed sprays may be needed. <b>Phytophthora crown rot only.</b>	Fungicides will not be effective if peppers are planted in poorly drained fields with a history of the disease. 7-day PHI.
Root Knot Nematode	Methyl bromide, or sodium methyl dithiocarbamate, or Vydate L®.	Sample fields during growing season for plant parasitic nematodes before planting. Avoid fields with high numbers of root knot nematodes. Methyl bromide and sodium methyl dithiocarbamate give best results when nematode populations are moderate to high. Vydate® gives adequate control when nematode populations are low to moderate. <b>Vydate® and Methyl bromide formulations are RUPs.</b>
Verticillium Wilt (eggplant and tomato only)	Avoid fields with a history of Verticillium wilt. Rotate with small grains where possible.	Use of long rotations out of solanaceous crops will prevent rapid increase of pathogen populations. Tomato varieties with resistance are available.
	Fumigate with Vapam® at 37.5-75 gals. per acre under plastic mulch.	Allow at least 21 days between application of fumigant and transplanting. Observe the 48-hour REI. See label for important application instructions.
Virus Diseases	Grow resistant varieties. Plant disease-free transplants. Eliminate broadleaf weeds within 150 feet of field before crops are established.	Some broadleaf weeds may be reservoirs for pepper viruses. Aphids may spread virus diseases from weeds to peppers and from diseased peppers to healthy peppers. Oil sprays timed with aphid flight periods may prevent virus transmission by aphids but have short-term residual effectiveness. Light-colored and reflective mulches may deter aphids from landing on plants and transmitting the virus.
White mold (timber rot)	Avoid fields with history of the problem. Pathogen has large host range.	Avoid tomato after tomato rotations.
	 Contans WG® at 1-4 lbs. per acre.	Contans® is applied with conventional spray equipment directly to the soil surface at planting. See label for additional treatment information.

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## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals (emerged) — treatment applied before transplanting or as a directed spray	Gramoxone Inteon 2L <sup>®</sup> at 2-4 pts. per acre.	Use 1 qt. of COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Broadcast before transplanting, or use lowest rate as a directed spray between rows after crop establishment. 30-day PHI for tomatoes. <b>RUP.</b>
Annuals and Perennials (emerged) — treatment applied before transplanting or as a directed spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs. potassium salt/gal.) at 0.66-3.3 qts. per acre.	Broadcast before transplanting, or apply between crop rows with hooded or shielded sprayers or wiper applicators. Wait at least 3 days before transplanting eggplant or peppers. Remove herbicide residue from plastic mulch prior to transplanting. <b>Do not use row-middle applications for tomatoes grown on sandy soils because crop injury may occur.</b> Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. 14-day PHI.
Broadleaves (emerged) — crop not present or protected from spray	Aim EC <sup>®</sup> at 0.5-2 fl. oz. per acre.	Apply prior to transplanting tomatoes or peppers, or apply between crop rows with hooded sprayer for all crops in this section. Do not apply before direct seeding. Do not allow spray to contact crop. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not exceed 6.1 fl. oz. per acre per season.
Broadleaves and Grasses (not emerged)	Command 3ME <sup>®</sup> at 0.67-2.67 pts. per acre. <b>Pepper only. Not for banana peppers.</b>	Use lower rate on coarse soils, and higher rate on fine soils. Apply before transplanting. May cause temporary bleaching of crop leaves.
	Devrinol 50DF <sup>®</sup> at 2-4 lbs. per acre.	Use lower rate on coarse soil. Apply and incorporate before seeding or transplanting. After harvest or prior to planting succeeding crops, deep moldboard or disk plow. Do not seed alfalfa, small grains, sorghum, corn, or lettuce for 12 months after application.
	Dual Magnum <sup>®</sup> at 1-2 pts. per acre. <b>Tomato only.</b>	Use lower rate on coarse soils. Apply prior to transplanting, or as a directed spray after transplanting. Crop injury may occur under unfavorable growing conditions. Not recommended for fresh market tomatoes. 90-day PHI.
	Prowl H <sub>2</sub> O <sup>®</sup> at 1-3 pts. per acre. <b>Pepper and tomato only.</b>	Not for use under plastic mulch. Apply and incorporate before planting, apply before planting without incorporation, or apply to established transplants as a directed spray. Avoid any contact with leaves or stems of crop. 70-day PHI.
	Trifluralin <sup>®</sup> products at 0.5-1 lb. a.i. per acre. Apply 4EC formulations at 1-2 pts. per acre.	Use low rate on soils with less than 2% organic matter. Broadcast and incorporate before transplanting, or apply directed spray between rows after transplanting and incorporate. Not effective on muck or high organic matter soils. May cause early stunting if growing conditions are unfavorable, especially on eggplant. To minimize injury, dip transplant roots in carbon slurry (2 lbs. per gal.) prior to planting, or include 2 oz. of carbon per gallon of transplant water.
Grasses (not emerged)	Dacthal W-75 <sup>®</sup> at 6-14 lbs. per acre, or Dacthal Flowable <sup>®</sup> at 6-14 pts. per acre.	Apply 4-6 weeks after transplanting when growing conditions favor good plant growth. May be applied over the top of transplants.
	Prefar 4E <sup>®</sup> at 5-6 qts. per acre. <b>Pepper only.</b>	Use low rate on soils with less than 1% organic matter. Apply and incorporate before planting.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and Grasses (not emerged and newly emerged)	Matrix 25DF® at 1-2 oz. per acre. <b>Tomato only.</b>	Use 0.5 pt. of nonionic surfactant per 25 gallons of spray solution if emerged weeds are present. Apply when weeds are less than 1 in. tall. Soil activity requires rainfall within 5 days of application. If crop is stressed, chlorosis may occur. Do not exceed 4 oz. per acre per year. 45-day PHI.
Broadleaves (not emerged and newly emerged)	Sencor® products at the following rates: <b>Broadcast and incorporated before transplanting, or broadcast after transplants are established:</b> Sencor 4F® at 0.5-1 pt. per acre, or Sencor 75DF® at 0.33-0.66 lb. per acre. <b>In a directed spray between crop rows after transplants are established:</b> Sencor 4F® at up to 2 pts. per acre, or Sencor 75DF® at 1.33 lbs. per acre. <b>Tomato only.</b>	May be applied preplant incorporated with trifluralin products for improved weed control. Crop injury may occur if applied over the top of plants within 3 days of cool, wet, or cloudy weather. Wait at least 14 days between applications. Do not exceed 2 pts. of Sencor 4F®, or 1.33 lbs. of Sencor 75DF® per acre per season. 7-day PHI.
Broadleaves and Nutsedge (not emerged or emerged)	Sandea® at 0.5-1 oz. per acre.	Use lower rates on coarse soils with low organic matter. Use 0.5-1 pt. of nonionic surfactant per 25 gallons of spray solution if emerged weeds are present. <b>Pre-transplant for tomatoes:</b> apply to soil surface after final soil preparation or bed shaping and just before applying plastic mulch. Wait 7 days after application and lay mulch before transplanting. <b>Post-transplant on bare ground for tomatoes:</b> apply over the top of well-established, actively growing plants no sooner than 14 days after transplanting and before first bloom. <b>Row-middle application for all crops in this section:</b> apply between rows of crop, avoiding contact with crop. Not recommended for use under cool temperatures due to potential for crop injury. Avoid contact with surface of plastic mulch if present. Do not exceed 2 applications and 2 oz. per acre per crop-cycle per year. 30-day PHI.
Grasses (emerged)	Poast 1.5E® at 1-1.5 pts. per acre.	Use 1 qt. COC per acre. Spray on actively growing grass. Use high rate on quackgrass. Do not exceed 4.5 pts. per acre per season. 20-day PHI.
	Select Max® at 12-32 fl. oz. per acre, or Select 2EC® at 6-16 fl. oz. per acre.	Use 1 qt. COC per 25 gallons of spray solution (1% v/v). Spray on actively growing grass. Wait at least 14 days between applications. Do not exceed 64 fl. oz. Select Max®, or 32 fl. oz. Select 2EC® per acre per season. 20-day PHI.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects Controlled	Treatment	Comments
Aphids	Conserve natural enemies.	Limiting the use of some insecticides will conserve predators and parasites that help control aphid populations.
	Actara® at 2-3 oz. per acre.	Do not exceed 11 oz. per acre per season. 0-day PHI.
	Admire PRO® at the following rates: <b>Pepper:</b> 7-14 fl. oz per acre. <b>Other labeled crops:</b> 7.0-10.5 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. of per acre per season. 21-day PHI.

Insects Controlled	Treatment	Comments
Aphids (continued)	Assail 70 WP® at 0.8-1.7 oz. per acre.	Do not exceed 4 applications acre per season. 7-day PHI.
	Diazinon 50W® at 0.5 lb. per acre. <b>Tomato only.</b>	Do not exceed 5 applications per season. 1-day PHI.
	Dimethoate 4E® at 0.5-1 pts. per acre. <b>Pepper and tomato only.</b>	7-day PHI for tomato. 2-day PHI for pepper.
	Endosulfan 3EC® at 0.66-1.33 qts. per acre.	Do not exceed 2 lb. a.i. per acre per season. <b>Eggplant and pepper:</b> Do not exceed 2 applications per season. 1-day PHI for eggplant. 4-day PHI for pepper. <b>Tomato:</b> Do not exceed 4 applications per season. 2-day PHI.
	Fulfill® at 2.75 oz. per acre.	Do not exceed 5.5 oz. per acre per season. 0-day PHI.
	Lannate SP® at 0.25-1 lb. per acre.	<b>Tomatillo, pepper, and eggplant:</b> Do not exceed 4.5 lbs. a.i. per acre per crop. 3-day PHI for pepper. 5-day PHI for eggplant. <b>Other labeled crops:</b> Do not exceed 6.3 lb. a.i. per acre per season. 1-day PHI for tomato. <b>RUP.</b>
	Malathion 5EC® at 1-3.5 pt per acre.	1-day PHI for tomato. 3-day PHI for pepper and eggplant.
	Movento® at 4-5 fl. oz. per acre.	1-day PHI.
	M-Pede® at 1-2% by volume.	Must contact aphids to be effective. 0-day PHI.
	Orthene 97® at 0.5-1 lb. per acre. <b>Pepper only.</b>	Do not exceed 2 lbs. a.i. per acre per season. 7-day PHI.
	Platinum® at 5-11 fl. oz. per acre.	30-day PHI.
	Colorado Potato Beetles (tomato and eggplant only)	Crop rotation.
Scouting.		Regular (weekly) scouting will allow you to determine the need for insecticides and to improve application timing.
Admire PRO® at 7-10.5 fl. oz. per acre.		Do not exceed 0.38 lb. a.i. per acre per season. 21-day PHI.
Agri-Mek 0.15EC® at 8-16 fl. oz. per acre.		Allow at least 7 days between applications. Do not exceed 48 fl. oz. per acre per season. Make no more than 2 successive applications. 7-day PHI.
Asana XL® at 5.8-9.6 fl. oz. per acre.		Do not apply more than 0.35 lb. a.i. per acre per season. 1-day PHI for tomato. 7-day PHI for eggplant. <b>RUP.</b>
Assail 70WP® at 0.6-1.1 oz. per acre.		Do not exceed 0.3 lb. a.i. per acre per season. 7-day PHI.
Baythroid® at 1.6-2.8 fl. oz. per acre.		Do not exceed 16.8 fl. oz. or per acre per season. Allow 7 days between applications. 0-day PHI for tomato. 7-day PHI for eggplant. <b>RUP.</b>
Brigade 2EC® at 2.1-6.4 fl. oz. per acre, or Brigade WSB® at 5.3-16 oz. per acre.		<b>Eggplant:</b> Do not exceed 0.2 lb. a.i. per acre per season. <b>Tomato:</b> Do not exceed 4 applications per season. 7-day PHI. <b>RUP.</b>

**Fruiting Vegetables** (continued)

Insect Control (continued)

Insects Controlled	Treatment	Comments
Colorado Potato Beetles (tomato and eggplant only) (continued)	Endosulfan 3EC® at 0.66-1.33 qts. per acre.	Do not exceed 1 lb. a.i. per acre per season. 1-day PHI for eggplant. 2-day PHI for tomato.
	Entrust® at 1-2 oz. per acre.	Do not exceed 9 oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
	Kryocide® at 8-16 lbs. per acre.	Do not exceed 64 lbs. per acre per season. 14-day PHI.
	Mustang MAX® at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. Allow 7 days between applications. 1-day PHI. <b>RUP.</b>
	Platinum® at 5-8 fl. oz. per acre.	Do not exceed 8.0 fl. oz. per acre per season. 30-day PHI.
	Pounce 25WP® at 3.2-12.8 oz. per acre.	<b>Tomato:</b> Do not exceed 1.2 lbs. a.i. per acre per season. 0-day PHI. <b>Eggplant:</b> Do not exceed 2.0 lbs. a.i. per acre per season. 3-day PHI.
	Prokil Cyolite 50D® at 15-30.5 lbs. per acre.	Do not exceed 112 lbs. per acre per season. 14-day PHI.
	Provado 1.6F® at 3.8 fl. oz. per acre.	Do not exceed 18.8 fl. oz. per acre per season. Allow 5 days between applications. 0-day PHI.
	SpinTor 2SC® at 3-6 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
	Vydate L® at 2-4 pts. per acre.	Do not exceed 32 pts. per acre per season. 3-day PHI.
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. 5-day PHI.
Flea Beetles	Actara® at 2-3 oz. per acre.	Do not exceed 11 oz. per acre per season. 0-day PHI
	Admire PRO® at the following rates: <b>Pepper:</b> 7.0-14 fl. oz. per acre. <b>Eggplant and tomato:</b> 7.0-10.5 fl. oz. per acre.	<b>Pepper:</b> Do not exceed 14 fl. oz. per acre per season. <b>Eggplant and tomato:</b> Do not exceed 10.5 fl. oz. per acre per season. 21-day PHI.
	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not apply more than 0.35 lb. a.i. per acre per season. 1-day PHI for tomato. 7-day PHI for eggplant. <b>RUP.</b>
	Baythroid® at 2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 0-day PHI for tomato. 7-day PHI for pepper and eggplant. <b>RUP.</b>
	Brigade 2EC® at 2.1-6.4 fl. oz. per acre, or Brigade WSB® at 5.3-16 oz. per acre.	<b>Eggplant:</b> Do not exceed 0.2 lb. a.i. per acre per season. <b>Tomato:</b> Do not exceed 4 applications per season. 7-day PHI. <b>RUP.</b>
	Endosulfan 3EC® at 0.66-1.33 qts. per acre.	Do not exceed 2 lb. a.i. per acre per season. <b>Eggplant and pepper:</b> Do not exceed 2 applications per season. 1-day PHI for eggplant. 4-day PHI for pepper. <b>Tomato:</b> Do not exceed 4 applications per season. 2-day PHI.
	Mustang MAX® at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. Allow 7 days between applications. 1-day PHI. <b>RUP.</b>

Insects Controlled	Treatment	Comments
Flea Beetle (continued)	Platinum® at 5-11 fl. oz. per acre.	30-day PHI.
	Pounce 25WP® at 6.4-12.8 oz. per acre.	Do not exceed 2 lbs. a.i. per acre per season. 3-day PHI. <b>RUP.</b>
	Sevin XLR PLUS® at 0.5-1 qt. per acre.	Do not exceed 8 qts. per crop. 3-day PHI.
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. 5-day PHI.
Mites, Spider Mites, and Russet Mites	Acramite 50WS® at 0.75-1 lb. per acre. <b>Spider mites only.</b>	Do not exceed 1 application per season. 3-day PHI.
	Agri-mek 0.15EC® at 8-16 fl. oz. per acre.	Do not exceed 48 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>
	Epi-mek 0.15EC® at 8-16 fl. oz. per acre.	
	Oberon 2SC® at 7-8.5 fl. oz. per acre. <b>Spider mites only.</b>	Do not exceed 25.5 fl. oz. per acre per season. 7-day PHI.
	Wetttable sulfur (84-95%) at 10 lbs. per acre.	Sulfur dusts also are effective. Thorough coverage is required. Do not apply when temperatures are above 95°F or during a heavy dew.
Cutworms, Hornworms, Fruitworms, and European Corn Borers	Asana XL® at the following rates: <b>Cutworms and fruitworms:</b> 5.8-9.6 fl. oz. per acre. <b>Hornworms:</b> 2.9-5.8 fl. oz. per acre. <b>Not for European corn borers.</b>	Do not apply more than 0.35 lb. a.i. per acre per season. 1-day PHI for tomato. 7-day PHI for eggplant. <b>RUP.</b>
	Avaunt 30WDG® at 2.5-3.5 oz. per acre. <b>Not for cutworms.</b>	Use higher rate for fruitworms. Can provide European corn borer control in bell peppers only. Do not exceed 14 oz. per acre per season. 3-day PHI.
	Various <i>Bacillus thuringiensis</i> products (Agree®, Biobit®, Dipel®, Javelin®, Lepinox®, Xentari®). Follow label directions. <b>Not for cutworms.</b>	0-day PHI.
	Baythroid® at the following rates: <b>Cutworms:</b> 2.1-2.8 fl. oz. per acre <b>Hornworms and fruitworms:</b> 1.6-2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 0-day PHI for tomato. 7-day PHI for pepper and eggplant. <b>RUP.</b>
	Brigade 2EC® at 2.1-5.2 fl. oz. per acre, or Brigade WSB® at 5.3-12.8 oz. per acre.	<b>Eggplant:</b> Do not exceed 0.2 lb. a.i. per acre per season. 1-day PHI. <b>Tomato:</b> Do not exceed 4 applications per season. 7-day PHI. <b>RUP.</b>
	Coragen® at 3.5-5.0 fl. oz. per acre.	Coragen® can be applied as either a foliar application or via drip chemigation. Chemigation will provide up to 30 days control. Do not exceed 15.4 fl. oz. per acre per season. 1-day PHI.
	Danitol 2.4EC® at 10.67 fl. oz. per acre. <b>Tomato only.</b> <b>Not for cutworms or European corn borers.</b>	Do not exceed 42.67 fl. oz. per acre per season. 3-day PHI.
	Diazinon 50W® at 4-8 lbs. per acre. <b>Cutworms on tomato only.</b>	Do not exceed 5 applications per season. Apply before planting.
	Endosulfan 3EC® at 0.66-1.33 qts. per acre. <b>Not for cutworms or European corn borers.</b>	Use higher rate for fruitworms. Do not exceed 2 lb. a.i. per acre per season. <b>Eggplant and pepper:</b> Do not exceed 2 applications per season. 1-day PHI for eggplant. 4-day PHI for pepper. <b>Tomato:</b> Do not exceed 4 applications per season. 2-day PHI.
	Entrust® at 1-2 fl. oz. per acre. <b>Not for cutworms.</b>	Do not exceed 9 oz. per acre per season. Observe resistance management restrictions. 1-day PHI.

**Fruiting Vegetables (continued)**

Insect Control (continued)

Insects Controlled	Treatment	Comments
Cutworms, Hornworms, Fruitworms, and European Corn Borers <b>(continued)</b>	Intrepid 2F® at the following rates: <b>Early season on hornworms:</b> 4-8 fl. oz. per acre. <b>Mid- to late season on hornworms:</b> 8-16 fl. oz. per acre. <b>Fruitworms:</b> 10-16 fl. oz. per acre. <b>Not for cutworms.</b>	Do not exceed 64 fl. oz. per acre per season. 1-day PHI.
	Lannate SP® at the following rates: <b>Cutworms:</b> 0.5 lb. per acre. <b>Hornworms and fruitworms:</b> 0.5-1.0 lb. per acre.	<b>Tomatillo, pepper, and eggplant:</b> Do not exceed 4.5 lbs. a.i. per acre per crop. 1-day PHI for tomato. 3-day PHI for pepper. 5-day PHI for eggplant. <b>Other labeled crops:</b> Do not exceed 6.3 lb. a.i. per acre preseason. <b>RUP.</b>
	Mustang MAX® at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. Allow 7 days between applications. 1-day PHI.
	Pounce 25WP® at 6.4-12.8 oz. per acre.	Do not exceed 2 lbs. a.i. per acre per season. 3-day PHI. <b>RUP.</b>
	Sevin XLR PLUS® at 1-2 qts. pre acre.	Do not exceed 8 qts. per acre per season. 3-day PHI.
	SpinTor 2SC® at 3-6 fl. oz. per acre. <b>Not for cutworms.</b>	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
	Warrior® at the following rates: <b>Cutworms and hornworms:</b> 1.92-3.20 fl. oz. per acre. <b>Fruitworms:</b> 2.56-3.84 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. 5-day PHI.
Stink Bugs	Baythroid® at 1.6-2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. Allow 7 days between applications. 0-day PHI for tomato. 7-day PHI for pepper and eggplant. <b>RUP.</b>
	Brigade 2EC® at 2.1-5.2 fl. oz. per acre, or Brigade WSB® at 5.3-12.8 oz. per acre.	<b>Eggplant:</b> Do not exceed 0.2 lb. a.i. per acre per season. <b>Tomato:</b> Do not exceed 4 applications per season. 7-day PHI. <b>RUP.</b>
	Danitol 2.4EC® at 10.67 fl. oz. per acre. <b>Tomato only.</b>	Do not exceed 42.67 fl. oz. per acre per season. 3-day PHI.
	Endosulfan 3EC® at 1-1.33 qts. per acre.	<b>Eggplant and pepper:</b> Do not exceed 2 applications per season. 1-day PHI for eggplant. 4-day PHI for pepper. <b>Tomato:</b> Do not exceed 4 applications per season. 2-day PHI.
	Mustang MAX® at 3.2-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. Allow 7 days between applications. 1-day PHI.
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 2.88 pts. per acre per season. 5-day PHI.
Whiteflies	Actara at 3.0-5.5 oz. per acre.	Do not exceed 11.0 oz per acre per season. 0-day PHI.
	Admire PRO® at the following rates: <b>Pepper:</b> 7.0-14 fl. oz. per acre . <b>Eggplant and tomato:</b> 7.0-10.5 fl. oz. per acre.	<b>Pepper:</b> Do not exceed 14 fl. oz. per acre per season. <b>Eggplant and tomato:</b> Do not exceed 10.5 fl. oz. per acre per season. 21-day PHI for soil application.
	Align® according to label directions.	0-day PHI.
	Asana XL® at 5.8-9.6 fl. oz. per acre. <b>Not for eggplant</b>	Do not apply more than 0.35 lb. a.i. per acre per season. 1-day PHI for tomato. 7-day PHI for pepper. <b>RUP.</b>



Insects Controlled	Treatment	Comments
Whiteflies (continued)	Assail 70WP® at 1.1-1.7 oz. per acre.	Do not exceed 4 applications per season. 7-day PHI.
	Brigade 2EC® at 2.1-5.2 fl. oz. per acre, or Brigade WSB® at 5.3-12.8 oz. per acre.	<b>Eggplant:</b> Do not exceed 0.2 lb. a.i. per acre per season. <b>Tomato:</b> Do not make more than 4 applications per season. 7-day PHI. <b>RUP.</b>
	Danitol 2.4EC® at 7-10.67 fl. oz. per acre. <b>Tomato only.</b>	Do not exceed 42.67 fl. oz. per acre per season. 3-day PHI.
	Endosulfan 3EC® at 0.66 qts. per acre.	<b>Eggplant and pepper:</b> Do not exceed 2 applications per season. 1-day PHI for eggplant. 4-day PHI for pepper. <b>Tomato:</b> Do not exceed 4 applications per season. 2-day PHI.
	Fulfill® at 2.75 oz. per acre.	Do not exceed 5.5 oz. per acre per season. 0-day PHI.
	Knack® at 8-10 fl. oz. per acre.	Do not exceed 2 applications per acre per season. 14-day PHI.
	Movento® at 4-5 fl. oz. per acre.	1-day PHI.
	M-Pede® at 1-2% by volume.	Must contact whiteflies to be effective. 0-day PHI.
	Neemix® according to label directions.	0-day PHI.
	Oberon 2SC® at 7-8.5 fl. oz. per acre. <b>Spider mites only.</b>	Do not exceed 25.5 fl. oz. per acre per season. 7-day PHI.
	Phaser 3EC® at 0.66 qts. per acre.	<b>Eggplant and pepper:</b> Do not exceed 2 applications per season. 1-day PHI for eggplant. 4-day PHI for pepper. <b>Tomato:</b> Do not exceed 4 applications per season. 2-day PHI.
	Platinum® at 5-11 fl. oz. per acre.	No more than 1 application per season. 30-day PHI.
	Provado 1.6F® at 3.8-6.2 fl. oz. per acre.	Do not exceed 18.8 fl. oz. per acre per season. Allow at least 5 days between applications. 0-day PHI.
Fruit Flies and Vinegar Flies ( <i>Drosophila</i> spp.)	For additional cultural practices, see Fruit Fly and Vinegar Fly Management below.	
	Starting 2 weeks before harvest, place bait fruits in fields in late afternoon, and examine next morning. If half of the baits show eggs, spray fields immediately at 4-6 day intervals with:	
	Diazinon 50W® at 0.5-1.5 lbs. per acre.	Do not exceed 5 applications per season. 1-day PHI.
	Dust fruit and hampers as soon as filled with a dust containing 0.1% stabilized pyrethrins plus 1.0% piperonyl butoxide, and move hampers to processing plant as soon as possible.	

## Fruit Fly and Vinegar Fly Management

To prevent contamination of tomato products by fruit fly and vinegar fly eggs and maggots, follow these cultural practices:

1. Provide unplanted driveways through fields to prevent fruit damage, and avoid crushing fruit with trucks or spray equipment
2. Pick fruit carefully to avoid bruising
3. Fill hampers, boxes, and trucks so fruits will not be damaged during transit
4. Do not leave filled hampers in the field overnight
5. Process tomatoes the day they are picked and as rapidly as possible
6. Keep hampers and trucks clean

# Leafy Vegetables

## Endive, Herbs, Lettuce, Parsley, and Spinach

Varieties		
Salad Greens	Endive	Full Heart Batavian, Green Curled Ruffoc
	Leaf Lettuce	Tiara, Glossy Green, Green Wave, New Red Fire, Sierra, Vulcan, Tango (oakleaf), Lolla Rossa
	Butterhead	Buttercrunch, Esmeralda, Ermosa (for trial)
	Head Lettuce	Ithaca, Maverick (for trial), Montello (for trial)
	Spinach	Bloomsdale Long Standing (spring), Early Hybrid No. 7 (fall), Early Hybrid No. 10 (fall), Old Dominion (fall), Virginia Savoy (fall), Tyee, Melody, Decatur, Unipak 151 (semi-savoy)
Herbs	Cilantro	Long Standing. Cilantro is a type of coriander grown for its aromatic leaves. Plant tends to bolt and must be planted early in the spring.
	Fennel	Marketed for its foliage as anise and for its edible leaf base as Florence or finocchio fennel. Plant has a strong licorice flavor and aroma.
	Parsley	Curly leaf: Moss Curled, Dark Moss Curled, Perfection Flat leaf: Plain Hamburg enlarged edible root marketed as a fresh product
	Sweet Basil	Green foliage: Sweet basil, Mammoth, Italian Small Leaf: Piccolo Purple Foliage: Dark Opal, Opal, Rubin. May partially revert to green foliage due to by genetic instability. Lemon-Scented: Lemon Basil, Sweet Dani Lemon Basil

### Spacing

These crops can have a common between-row spacing for convenience in cultivating. Raised beds are recommended for the culinary herbs.

**Fennel:** Rows 12 to 18 inches apart. Plants 6 to 8 inches apart in row. Transplant to the field early in the spring.

**Spinach:** Rows 12 to 18 inches apart. Plants 4 to 6 per foot of row. Seed 12 to 20 pounds per acre.

**Lettuce and Endive:** Rows 12 to 15 inches apart. Plants 10 to 16 inches apart in row. Seed 1 to 2 pounds per acre.

**Sweet Basil:** Rows 15 to 36 inches apart. Plants 6 to 8 inches apart within rows.

**Parsley:** Rows 15 inches apart. Plants 4 to 8 inches apart in row. Seed 30 pounds per acre. Germination is enhanced by presoaking seeds in water for 24 hours, then allowing them to partially dry.

### Fertilizing

**Lime:** To maintain soil pH of 6.5 to 6.8. Spinach is particularly sensitive to soil acidity.

**Preplant:** N: 60 pounds per acre. P<sub>2</sub>O<sub>5</sub>: 0 to 150 pounds per acre. K<sub>2</sub>O: 0 to 200 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state.

**Sidedress N:** for soils with more than 3 percent organic matter and following soybeans, alfalfa, or a grass-legume hay crop, apply 30 pounds N per acre. For soils with less than 3 percent organic matter and the above rotation, apply 45 pounds N per acre. Following corn, rye, oats, wheat, or a vegetable crop, apply 60 pounds N per acre. Use a total of 90 to 120 pounds N per acre for culinary herbs. For herbs grown for seeds, such as coriander, fennel, and dill, use 60 to 90 pounds N acre.

### Herb Weed Control

Plastic or an organic mulch is recommended. Most herbs are weak competitors to weeds, and herbicides are not available.

## Disease Control

Diseases Controlled <sup>1</sup>	Treatment	Comments
Damping-Off	Conditions that favor rapid germination limit damping off severity.	Avoid excessive irrigation and poorly drained soils.
	Previcur Flex <sup>®</sup> for leaf lettuce before or after transplanting in greenhouse.	See label for rate information and application instructions. Note warning about possible phytotoxicity. 2-day PHI.
	Ridomil Gold SI <sup>®</sup> at 1-2 pts. per acre applied pre-plant, to control damping off.	Apply preplant to the soil surface and incorporate to a depth of 2 inches. 7-day PHI.
Downy Mildew, White Rust	Plant downy mildew resistant varieties.	
	Actigard <sup>®</sup> at 0.75 oz. per acre. <b>Spinach only.</b>	Do not make more than 3 consecutive applications per crop. Do not apply to crops stressed by heat, drought, etc. 7-day PHI.
	Agri-Fos 400 <sup>®</sup> at 2 qt. per acre.	0-day PHI.
	Aliette <sup>®</sup> at 3-5 lbs. per acre (alone), or at 2-3 lbs. per acre when tank mixed with another fungicide registered for use on greens.	Apply when conditions are favorable for disease and continue on a 7-21 day interval. Do not tank mix with copper fungicides. 3-day PHI.
	Amistar <sup>®</sup> at the following rates: <b>Downy mildew:</b> 4-5 oz. per acre. <b>White rust:</b> 2-5 oz. per acre.	See label for caution regarding possible phytotoxicity. Do not make more than 1 application before alternating to a fungicide with a different mode of action. 0-day PHI.
	Phostrol <sup>®</sup> at 2.5-5 pt. per acre.	0-day PHI.
	Presidio 4SC <sup>®</sup> at 3-4 fl. oz. per acre.	2-day PHI.
	Previcur Flex <sup>®</sup> at 2 pts. per acre. <b>Downy mildew on lettuce only.</b>	2-day PHI.
	Quadris <sup>®</sup> at the following rates: <b>Downy mildew:</b> 12.0-15.5 fl. oz. per acre. <b>White rust:</b> 6.0-15.5 fl. oz. per acre.	See label for caution regarding possible phytotoxicity. Do not make more than 1 application before alternating to a fungicide with a different mode of action. 0-day PHI.
	Reason <sup>®</sup> at 5.5-8.2 oz. per acre.	Do not make more than 1 application of Reason <sup>®</sup> before alternating to a fungicide with a different mode of action. 2-day PHI.
	Revus 2.09SC <sup>®</sup> at 8 fl. oz. per acre.	Do not make more than 2 consecutive applications before switching to another effective non-group 40 fungicide.
	Ridomil Gold EC <sup>®</sup> and Ridomil Gold Copper <sup>®</sup> may be applied preplant, by surface application and shanked. <b>Spinach only.</b>	Read label carefully for rates and application instructions. Do not apply Ridomil Gold <sup>®</sup> where white rust is already established. 21-day PHI.
Tanos 50WP <sup>®</sup> at 8 oz. per acre. <b>Downy mildew on lettuce only.</b>	Do not make more than 1 application of Tanos <sup>®</sup> before alternating to a fungicide with a different mode of action. 3-day PHI.	
Bottom Rot and Drop (lettuce)	Bottom rot is caused by <i>Rhizoctonia</i> . Lettuce drop is caused by <i>Sclerotinia</i> .	
	Avoid poorly drained fields with a history of the disease.	
	Amistar <sup>®</sup> at the following rates: <b>Downy mildew:</b> 4-5 oz. per acre. <b>White rust:</b> 2-5 oz. per acre.	See label for caution regarding possible phytotoxicity. Do not make more than 1 application before alternating to a fungicide with a different mode of action. 0-day PHI.
	Endura 70WG <sup>®</sup> at 8-11 oz. per acre. <b>Suppression of bottom rot in lettuce only.</b>	Do not make more than 2 sequential applications before rotating to a product with a different mode of action. 14-day PHI.

**Leafy Vegetables (continued)**

Disease Control (continued)

Diseases Controlled <sup>1</sup>	Treatment	Comments
Bottom Rot and Drop (lettuce)	Quadris® at the following rates: <b>Downy mildew:</b> 12.0-15.5 fl. oz. per acre. <b>White rust:</b> 6.0-15.5 fl. oz. per acre.	See label for caution regarding possible phytotoxicity. Do not make more than 1 application before alternating to a fungicide with a different mode of action. 0-day PHI.
	Rovral® at 1.5-2 pts. per acre for flowable (F) formulations. <b>Lettuce only.</b>	Do not cultivate after application. See label for details. 14-day PHI.
Powdery Mildew	Amistar® at 4-5 oz per acre.	See comment under downy mildew. 0-day PHI.
	Folicur 3.6F® at 3-4 fl. oz. per acre. <b>Not for Brussels sprouts, cabbage, or cauliflower.</b>	7-day PHI.
	Quadris® at 12.0-15.5 oz. per acre.	See comment under downy mildew. 0-day PHI.
	Quintec® at 4-6 fl. oz. per acre.	1-day PHI.

<sup>1</sup>The information in this table does not necessarily pertain to herbs since labeling for herbs varies widely.

**Weed Control**

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals (emerged) — treatment applied before crop emergence	Gramoxone Inteon 2L® at 2-4 pts. per acre, or Gramoxone Max 3L® at 1.3-2.7 pts. per acre. <b>Lettuce only.</b> <b>Not for spinach, parsley, chicory, endive, or herbs.</b>	Include 1 qt. of COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply before or after seeding but before crop emerges. <b>RUP.</b>
Annuals and Perennials (emerged) — crop not present or protected from spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs. potassium salt/gal.) at 0.66-3.3 qts. per acre. <b>Basil, chicory, endive, Florence fennel, lettuce, parsley, and spinach only.</b>	Broadcast before seeding, or apply between crop rows with wipers or hooded or shielded sprayers. Use low rate for annuals and higher rates for perennials. See label for suggested applications volume and adjuvants. 14-day PHI.
Broadleaves and Grasses (not emerged)	Balan 60DF® at 2-2.5 lbs. per acre. <b>Lettuce only.</b>	Apply and incorporate before seeding or transplanting.
	Kerb 50WP® at the following rates: <b>Endive only:</b> 2-3 lbs. per acre. <b>Lettuce only:</b> up to 4 lbs. per acre.	Use lower rate on coarse soils. Apply before or after seeding but before crop emerges. May also be applied postemergence to endive and head lettuce. Mechanical incorporation or rainfall required for effectiveness. Do not exceed 1 application per crop per year. 55-day PHI. <b>RUP.</b>
	Lorox 50DF® at 1.5-3 lbs. per acre. <b>Only for parsley grown east of the Mississippi River.</b>	Do not use on sand, loamy sand, or soils with less than 1% organic matter. Apply after seeding before crop emerges. On muck soils, may be applied at 1 lb. per acre to control small emerged weeds after parsley has 3 true leaves. Do not exceed 3 lbs. per acre per season. 30-day PHI.
	Trifluralin products at 0.5-0.75 lb. a.i. per acre. Apply 4EC formulations at 1-1.5 pts. per acre. <b>Chicory and endive only.</b> <b>Not for Florence fennel, lettuce, spinach, or parsley.</b>	Use lowest rate on coarse soils. Apply and incorporate before planting. Not effective on soils with high organic matter.
Grasses (not emerged)	Prefar 4E® at 5-6 qts. per acre. <b>Lettuce, endive, and Florence fennel only.</b> <b>Not for chicory or spinach.</b>	Use low rate on soils with less than 1% organic matter. Apply and incorporate before planting, or apply after seeding before crop emerges and irrigate within 24 hours.
Broadleaves (emerged)	Aim EC® at 0.5-2 fl. oz. per acre.	Apply with hooded sprayers as a directed application between crop rows. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not allow spray to contact crop. Do not exceed 6.1 fl. oz. per acre per season.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves (emerged) (continued)	Spin-Aid 1.3E® at 3-6 pts. per acre in 11-22 gals. of water. <b>For spinach grown for processing or seed only.</b>	Apply to spinach with 4 true leaves to avoid injury. Do not apply if spinach is stressed. Does not control pigweed. 40-day PHI.
Broadleaves (emerged) — primarily composites and nightshade	Stinger 3L® at 4-8 fl. oz. per acre. <b>Spinach only.</b>	Maximum 8 oz. per acre per year. 21-day PHI.
Grasses (emerged)	Fusilade DX® at 10-12 fl. oz. per acre. <b>Endive only.</b>	Use with 1-2 pts. COC or 0.5-1 pt. of nonionic surfactant per 25 gallons of spray solution. Spray on actively growing grass. Do not exceed 3 pts. per acre. 28-day PHI.
	Poast 1.5E® at the following rates: <b>Endive, dill, Florence fennel, lettuce, parsley, and spinach:</b> 1-1.5 pts. per acre. <b>Dill:</b> up to 2.5 pts. per acre. <b>Not for chicory or herbs other than dill.</b>	Use with 1 qt. of COC per acre. Spray on actively growing grass. Do not exceed 3 pts. per acre per season; for dill, do not exceed 5 pts. per acre per season. 14-day PHI for dill. 15-day PHI for leaf lettuce, spinach, endive, and parsley. 30-day PHI for fennel and head lettuce.
	Select Max® at 12-16 fl. oz. per acre, or Select 2EC® at 6-8 fl. oz. per acre. <b>Leaf lettuce, Florence fennel, and spinach only.</b> <b>Not for chicory, endive, head lettuce, parsley, or herbs.</b>	Use with 1 qt. of COC per 25 gallons of spray solution. Apply to actively growing grass. Wait at least 14 days between applications. Maximum 64 fl. oz. Select Max® or 32 fl. oz. Select 2EC® per acre per season. 14-day PHI for lettuce and spinach. 30-day PHI for fennel.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

Herbicides For Use on Leafy Vegetables													
	Aim® <sup>5</sup>	trifluralin	Kerb®	Balan®	Prefar®	Poast®	Fusilade®	Spin-Aid®	glyphosate	paraquat	Lorox®	Select®	Stinger®
Chicory	X	X							X				
Endive	X	X	X		X	X	X		X				
Lettuce	X		X	X	X	X			X	X		X	
Spinach	X					X		X	X			X	X
Parsley	X				X	X			X		X		
Florence Fennel	X				X	X			X			X	

## Insect Control

Insects Controlled	Treatment	Comments
Aphids, Leafminers, Mites	Actara® at 1.5-3 oz. per acre. <b>Aphids only.</b>	Do not exceed 11 oz. per acre per season. 7-day PHI.
<b>Aphid Thresholds</b> Seedlings: 2 per plant Established plants: 7 per plant	Admire PRO® at 4.4-10.5 fl. oz. per acre. <b>Aphids only.</b>	Do not exceed 0.38 lb. a.i. per acre per season. 21-day PHI.
<b>Leafminer Thresholds</b> Seedlings: 50% of plants infested Near Harvest: 5% of leaves infested	Agri-Mek 0.15EC® at 8-16 fl. oz. per acre. <b>Leafminers and mites only.</b>	Do not exceed 2 applications or 48 fl. oz. per acre per season. Use non-ionic surfactant. 7-day PHI. <b>RUP.</b>

**Leafy Vegetables (continued)**

Insect Control (continued)

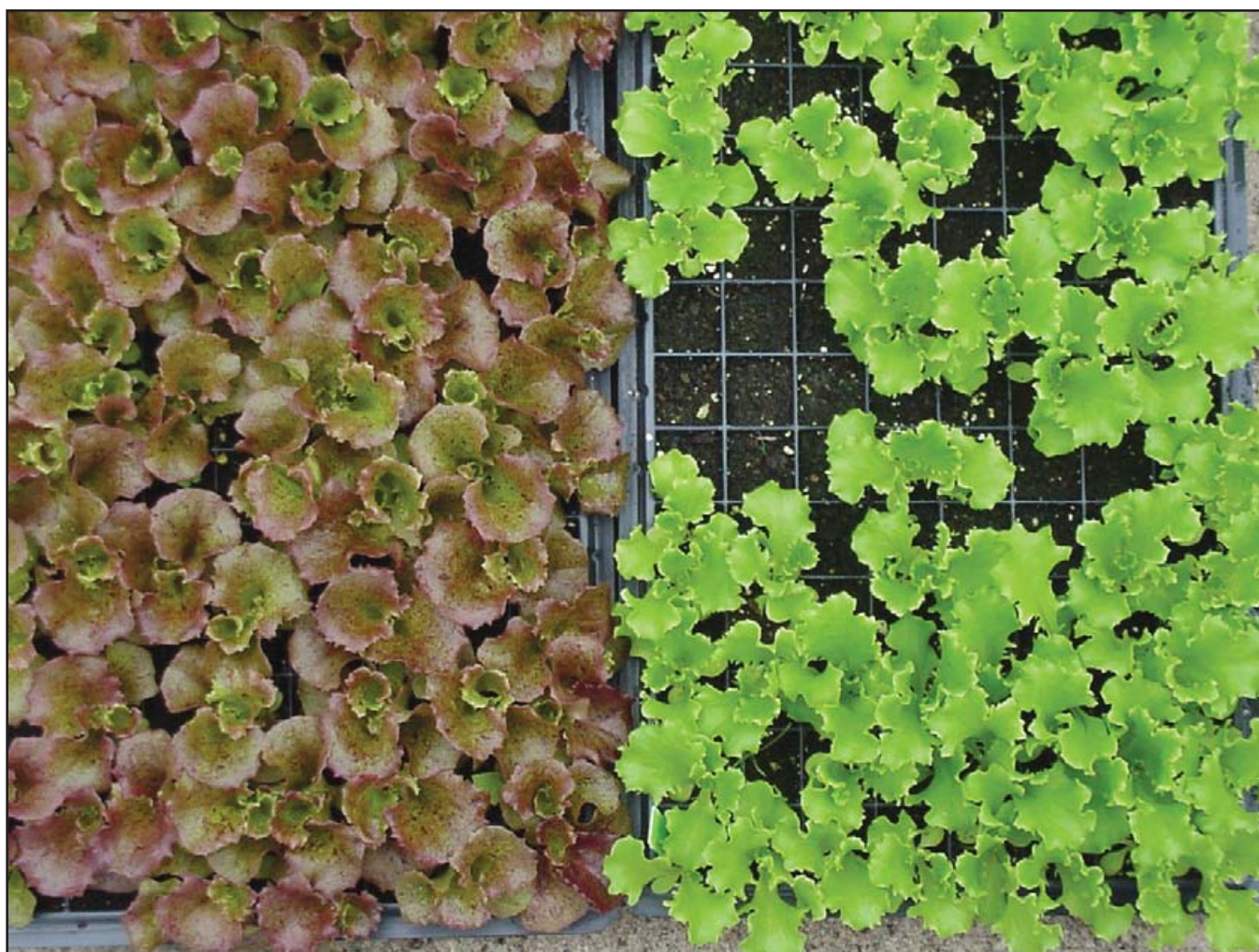
Insects Controlled	Treatment	Comments
Aphids, Leafminers, Mites (continued)	Align® according to label directions. <b>Aphids and leafminers only.</b>	0-day PHI.
	Ambush 25W® at 6.4-12.8 oz. per acre. <b>Leafminers only.</b>	<b>Spinach:</b> Do not exceed 1 lb. a.i. per acre per season. <b>Other labeled crops:</b> Do not exceed 2 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
<b>Aphid Thresholds</b> <b>Seedlings:</b> 2 per plant <b>Established plants:</b> 7 per plant  <b>Leafminer Thresholds</b> <b>Seedlings:</b> 50% of plants infested <b>Near Harvest:</b> 5% of leaves infested	Assail 30SG® at 2-4 oz. per acre, or Assail 70WP® at 0.8-1.7 oz per acre. <b>Aphids only.</b>	Do not exceed 0.375 lbs a.i. per acre per season. 7-day PHI.
	Diazinon AG500® at 0.5-1 pt. per acre, or Diazinon 50W® at 0.5-1 pt. per acre.	Do not exceed 5 applications per acre per season. 14-day PHI. <b>RUP.</b>
	Dimethoate 4E® or Dimethoate 400® at 0.5 pt. per acre, or Dimethoate 2.67EC® at 0.75 pt. per acre. <b>Not for parsley, spinach, celery or head lettuce.</b>	14-day PHI for endive, swiss chard, and leaf lettuce.
	Endosulfan® at 1-1.33 qts. per acre. <b>Lettuce and spinach only.</b>	Do not exceed 2 applications per season. 14-day PHI.
	Entrust® at 2-3 oz. per acre. <b>Leafminers only.</b>	Do not exceed 9 oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
	Epi-mek® 0.15EC® at 8-16 fl. oz. per acre. <b>Leafminers and mites only.</b>	Do not exceed 2 applications or 48 fl. oz. per acre per season. Use non-ionic surfactant. 7-day PHI. <b>RUP.</b>
	Fulfill® at 2.75 oz. per acre.	Do not exceed 5.5 oz. per acre per season. 7-day PHI.
	Malathion 5EC® or at 2 pts. per acre.	14-day PHI for leaf lettuce. 7-day PHI for head lettuce, endive, and spinach.
	Movento® at 4-5 fl. oz. per acre.	3-day PHI.
	M-Pede® at 1-2% by volume. <b>Aphids only.</b>	Must contact aphids to be effective. 0-day PHI.
	Neemix® according to label directions. <b>Aphids and leafminers only.</b>	0-day PHI.
	Orthene 97® at 0.5-1 lb. per acre. <b>Aphids on head lettuce only.</b>	Do not exceed 2 1/8 lbs. a.i. per acre per season. 21-day PHI.
	Platinum® at 5-11 fl. oz. per acre. <b>Aphids only.</b>	30-day PHI.
	Pounce 25WP® at 6.4-12.8 oz. per acre. <b>Leafminers only.</b>	<b>Spinach:</b> Do not exceed 1 lb. a.i. per acre per season. <b>Other labeled crops:</b> Do not exceed 2 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Provado 1.6F® at 3.8 fl. oz. per acre. <b>Aphids only.</b>	Do not exceed 0.23 lb. a.i. per acre per season. Allow 5 days between applications. 7 day-PHI.
	SpinTor 2SC® at 6-10 fl. oz. per acre. <b>Leafminers only.</b>	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
Trigard® at 2.66 oz. per acre.	Do not exceed 6 applications per acre per season. 7-day PHI.	
Caterpillars, Loopers  <b>Caterpillar/Looper Threshold</b> 5% of plants infested	Ambush 25W® at 3.2-12.8 oz. per acre.	<b>Spinach:</b> Do not exceed 1 lb. a.i. per acre per season. <b>Other labeled crops:</b> Do not exceed 2 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Avaunt 30WDG® at 2.5-6.0 oz. per acre. <b>Not for spinach.</b>	Do not exceed 24 oz. per acre per season. 3-day PHI.

Insects Controlled	Treatment	Comments
Caterpillars, Loopers (continued)	Various <i>Bacillus thuringiensis</i> products (Agree <sup>®</sup> , Biobit <sup>®</sup> , Dipel <sup>®</sup> , Javelin <sup>®</sup> , Lepinox <sup>®</sup> , Xentari <sup>®</sup> ) are available in various formulations.	Follow label instructions for rates and use. 0-day PHI.
Caterpillar/Looper Threshold 5% of plants infested	Baythroid <sup>®</sup> at the following rates: <b>Cabbageworm and loopers:</b> 1.6-2.4 fl. oz. per acre. <b>Armyworms, corn earworms, and European corn borers:</b> 2.4-3.2 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. Allow 7 days between applications. 0-day PHI. <b>RUP.</b>
	Brigade 2EC <sup>®</sup> at 2.1-6.4 fl. oz. per acre, or Brigade WSB <sup>®</sup> at 5.3-16 oz. per acre. <b>Head lettuce and spinach only.</b>	<b>Head lettuce:</b> Do not exceed 0.5 lb. a.i. per acre per season. 7-day PHI. <b>Spinach:</b> Do not exceed 0.4 lb. a.i. per acre per season. 40-day PHI. <b>RUP.</b>
	Entrust <sup>®</sup> at 1-2.0 oz. per acre.	Do not exceed 9 oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
	Intrepid 2F <sup>®</sup> at the following rates: <b>Early season applications:</b> 4-8 fl. oz. per acre. <b>Mid- to late-season applications:</b> 8-10 fl. oz. per acre.	Do not exceed 64 fl. oz. per acre per season. 1-day PHI.
	Lannate SP <sup>®</sup> at 0.5-1 lb. per acre.	Maximum application amounts and PHIs vary among vegetables. Read and follow label directions. <b>RUP.</b>
	Larvin 3.2 <sup>®</sup> at 16-30 fl. oz. per acre.	Do not exceed 60 fl. oz. per acre per season. 14-day PHI. <b>RUP.</b>
	Mustang MAX <sup>®</sup> at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Orthene 97 <sup>®</sup> at 1 lb. per acre. <b>Head lettuce only.</b>	Do not exceed 2 1/8 lbs. a.i. per acre per season. 21-day PHI.
	Pounce 25WP <sup>®</sup> at 3.2-12.8 oz. per acre.	<b>Spinach:</b> Do not exceed 1 lb. a.i. per acre per season. <b>Other labeled crops:</b> Do not exceed 2 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Proclaim <sup>®</sup> at 2.4-4.8 oz. per acre.	Do not exceed 28.8 oz. per acre per season. Allow 7 days between applications. 7-day PHI. <b>RUP.</b>
	SpinTor 2SC <sup>®</sup> at 3-6 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
	Warrior <sup>®</sup> at 1.92-3.20 fl. oz. per acre. <b>Lettuce only.</b>	Do not exceed 2.4 pts. per acre per season. 1-day PHI. <b>RUP.</b>
Flea Beetles, Leafhoppers	Admire PRO <sup>®</sup> at 4.4-10.5 fl. oz. per acre. <b>Leafhoppers only.</b>	Do not exceed 0.38 lb. a.i. per acre per season. 21-day PHI.
Flea Beetle Threshold Seedling plants: >50% plants infested and defoliation > 30%	Align <sup>®</sup> according to label directions.	0-day PHI.
	Ambush 25W <sup>®</sup> at 6.4-12.8 oz. per acre. <b>Leafhoppers only.</b>	<b>Spinach:</b> Do not exceed 1 lb. a.i. per acre per season. <b>Other labeled crops:</b> Do not exceed 2 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Ammo 2.5EC <sup>®</sup> at 2.5-5.0 fl. oz. per acre. <b>Head lettuce only.</b>	Do not exceed 0.6 lb. a.i. per acre per season. 5-day PHI. <b>RUP.</b>
	Baythroid <sup>®</sup> at the following rates: <b>Flea beetles:</b> 2.4-3.2 fl. oz. per acre. <b>Potato leafhopper:</b> 0.8-1.6 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. Allow 7 days between applications. 0-day PHI. <b>RUP.</b>
	Brigade 2EC <sup>®</sup> at 2.1-6.4 fl. oz. per acre, or Brigade WSB <sup>®</sup> at 5.3-16 oz. per acre. <b>Head lettuce and spinach only.</b>	7-day PHI for head lettuce. 40-day PHI for spinach. <b>RUP.</b>

**Leafy Vegetables (continued)**

Insect Control (continued)

Insects Controlled	Treatment	Comments
Flea Beetles, Leafhoppers (continued)	Dimethoate 4E® or Dimethoate 400® at 0.5 pt. per acre, or Dimethoate 2.67EC® at 0.75 pt. per acre. <b>Leafhoppers only.</b> <b>Not for parsley, spinach, celery or head lettuce.</b>	14-day PHI for endive, swiss chard, and leaf lettuce.
	Mustang MAX® at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 5-day PHI. <b>RUP.</b>
	Neemix® according to label directions.	0-day PHI.
	Platinum® at 5-11 fl. oz. per acre.	30-day PHI.
	Pounce 25WP® at 6.4-12.8 oz. per acre. <b>Leafhoppers only.</b>	<b>Spinach:</b> Do not exceed 1 lb. a.i. per acre per season. <b>Other labeled crops:</b> Do not exceed 2 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Provado 1.6F® at 3.8 fl. oz. per acre. <b>Leafhoppers only.</b>	Do not exceed 0.23 lb. a.i. per acre per season. Allow 5 days between applications. 7-day PHI.
	Sevin XLR PLUS® at 0.5-1 qt. per acre.	Do not exceed 6 qts. per acre per season. 14-day PHI.
	Warrior® at 2.56-3.84 fl. oz. per acre. <b>Lettuce only.</b>	Do not exceed 2.4 pts. per acre per season. 1-day PHI. <b>RUP.</b>



*Starting lettuce from transplants can help the crop get a head start on weeds.*



# Legumes — Snap Bean, Dry Bean, Lima Bean

Snap Bean Varieties	Use	Pod Color	Seed Color	Comments
<b>Bush Snap Bean Varieties-Green Pod</b>				
Benchmark	market	medium-dark green	white	excellent quality
Bronco	market	dark green	white	excellent quality, mechanical harvest
Daytona	market	medium green	white	
Envy	processing			
Evergreen	processing			
Flo	processing			
Hialeah	market	green	white	excellent quality
Hystyle	market, processing	dark green	white	mechanical harvest
Labrador	market, processing	dark green	white	
Opus	market	medium-light green	white	rust tolerant
Rushmore	market	medium green	brown	early
Strike	market	medium-light green	white	mechanical harvest
Tema	market	medium-dark green	brown	
Venture	market, processing	dark green	white	early
<b>Yellow Pod</b>				
Eureka	market	yellow	white	
Gold Mine	market	yellow	white	susceptible to brown spot
Gold Rush	market, processing	yellow	white	susceptible to brown spot
Kinghorn Wax	market	yellow	white	excellent quality
Klondyke	market	yellow	white	mechanical harvest
Nugget	market, processing	yellow	white	

Lima Bean Varieties	Use	Seed Color	Comments
Bridgeton	processing	greenish	Bush, late, medium size
Fordhook 242	market & home	white	Bush, midseason, medium size, variable yield
Henderson Bush	market & home	white	Bush, very early, small seed, high yield
King of the Garden	home garden	greenish-white	Pole, midseason to late, large seed

# Legumes — Pea and Cowpea

“Pea” has been commonly used to describe two distinctly different legume crops. English and Snow peas, both *Pisum sativum*, are cool-season crops grown for their immature edible seeds or pods. Snap peas are a type of English pea with tender, edible pods. Southern peas, or cowpeas, are *Vigna unguiculata* and include black-eyed peas, cream peas and crowder peas. These heat-loving crops are more commonly grown in southern states, although they can be grown in the north. They are grown for their immature shelled seeds and are well-accepted in markets where customers are familiar with them.

Pea Varieties	Season	Comments
<b>English Shell Peas</b>		
Spring	early	
Knight	early	Short vines
Bolero	mid	
Green Arrow	mid-late	Long holding in field
Lincoln	mid-late	Very sweet, home garden variety

## Legumes (continued)

Pea Varieties	Season	Comments
<b>Snap peas (edible-podded)</b>		
Sugar Bon	early	Short vines
Sugar Ann	early	Short vines
Cascadia	main	
Supersnappy	main	Large pods
<b>Snow peas (edible-podded)</b>		
Oregon Giant	mid-late	Large pods
Snowflake	late	Dark green
Super Sugar Pod	late	Long vines
<b>Southern Peas or Cowpeas</b>		
Brown Crowder		
Mississippi Silver (crowder)		
Purple Crowder		
Texas Cream Cowpea		
Zipper Cream Cowpea		

## Spacing

**Beans:** Rows 18 to 36 inches apart, 5 to 7 seeds per foot of row. Larger inter-row spacing helps limit white mold development. Seed 70 to 100 pounds per acre.

**Peas and Cowpeas:** Rows 32 to 36 inches apart, 6 to 8 seeds per foot of row. Seed 100 to 150 pounds per acre.

## Fertilizing

**Lime:** To maintain a soil pH of 6.0 to 6.8.

**Preplant N:** for soils with more than 3 percent organic matter and following soybeans, alfalfa or a grass-legume hay crop no N is needed. For soils with less than 3 percent organic matter and the above rotation apply 20 pounds N per acre for peas, and 30 pounds N per acre for beans. Following corn, rye, oats, wheat, or a vegetable


crop apply 40 pounds N per acre for peas, and 40 to 60 pounds N per acre for beans.  $P_2O_5$ : 0 to 100 pounds per acre.  $K_2O$ : 0 to 100 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. Micronutrients: beans are prone to zinc deficiency. If the soil test shows zinc below 0.7 ppm, then prior to planting broadcast and incorporate 5 pounds of zinc per acre, or include 1 pound zinc per acre in the fertilizer band at planting.


**At Planting:** Apply 12 pounds N and 48 pounds  $P_2O_5$  per acre in bands at least 2 inches below and 2 inches to the side of the row. Potassium (K) is not recommended in the band because peas and beans are sensitive to injury from fertilizer salts.


**Sidedress N:** None needed.


## Disease Control

Diseases Controlled	Treatment	Comments
Ascochyta Blight (pea only)	Use pathogen-free seed. 3-year rotation.	
	Amistar® at 2-5 oz. per acre.	Do not apply Amistar® more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris 2.08SC® at 6.0-15.5 fl. oz. per acre.	Do not apply more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
Rust, Anthracnose (dry beans)	Follow 2-3 year rotation schedules.	
	Rust resistant varieties are available.	

Diseases Controlled	Treatment	Comments
Rust, Anthracnose (dry beans) (continued)	Amistar® at the following rates: <b>Anthracnose:</b> 2.0-5.0 oz. per acre. <b>Rust:</b> 2.0 oz. per acre.	Do not make more than 1 application before alternating to a fungicide with a different mode of action. 0-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates.	Begin applications during early bloom or when disease threatens. 14-day PHI.
	Folicur 3.6F® at 4-6 fl. oz. per acre.	14-day PHI.
	Headline® at 6.9 oz. per acre.	Start applications at the beginning of flowering. Do not make more than 2 applications of Headline® or other group 11 fungicides per year. 21-day PHI.
	Manex® at 1.2-1.6 qts. per acre, or Maneb 75DF® or Maneb 80WP® 1.5-2.0 lbs. per acre.	30-day PHI.
	Quadris® at the following rates: <b>Anthracnose:</b> 15.5 fl. oz. per acre. <b>Rust:</b> 6 fl. oz. per acre.	Do not make more than 2 applications before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris Opti® at 1.6-2.4 pts. per acre.	Do not make more than 2 applications of Quadris Opti® before alternating to a non-group 11 fungicide. 14-day PHI.
	Topsin 70W®, or Topsin 4.5L®. See labels for rates. <b>Anthracnose only.</b>	The rate of Topsin® depends on timing, number of applications to be made, and percentage of plants in bloom. See product labels for details. 28-day PHI.
Rust (snap beans)	Follow 2-3 year rotation schedules.	Rotate with non-host crops.
	Rust-resistant varieties are available. Planting date may be adjusted to minimize exposure to long dew periods.	Note that several races of rust are known.
	Amistar® at 2.0 oz. per acre.	Do not make more than 1 application before alternating to a fungicide with a different mode of action. 0-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates.	7-day PHI.
	Folicur 3.6F® at 4-6 fl. oz. per acre.	7-day PHI.
	Headline® at 6-9 oz. per acre.	Start applications at the beginning of flowering. Do not make more than 2 applications of Headline® or other group 11 fungicides per year. 7-day PHI.
	Quadris® at 6 fl. oz. per acre.	Do not make more than 2 applications before alternating to a fungicide with a different mode of action. 0-day PHI.
	Rally 40WSP® at 4-5 oz. per acre.	0-day PHI.
Asian Soybean Rust	Headline® at 6-9 fl. oz. per acre mixed with an adjuvant and a non-group 11 fungicide.	Vegetable legumes do not appear to be very susceptible to Asian soybean rust, however, growers should monitor the epidemic and scout their fields. 21-day PHI.
Bacterial Blights, Brown Spot, Halo Blight, Common Blight	Follow 2-3 year crop rotation schedules.	
	 Field applications of fixed copper fungicides. Application rates vary widely with product and formulation. <b>Do not use copper on fresh market lima bean.</b>	Repeat at 7-10 day intervals. Copper sprays will slow the spread of bacterial blights in the field.
Fusarium Wilt	Use resistant cultivars.	Rotate away from legumes for several years to avoid build up of the Fusarium fungus.
Seed Rot and Damping Off	Use pathogen-free seed. Treat seeds with Captan® or Thiram®.	Apply seed treatment just before planting. Follow label directions.

 May be acceptable for use in certified organic production. Check with your certifier before use.

Diseases Controlled	Treatment	Comments
White Mold and Gray Mold	Avoid fields with a history of white mold or with poor drainage.	
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates. <b>Gray mold on snap bean only.</b>	Apply at weekly intervals as needed. 7-day PHI.
	 Contans WG® at 1-4 lbs. per acre for white mold on snap beans.	Contans® is applied with conventional spray equipment directly to the soil surface at planting. See label for additional treatment information.
	Endura 70 WG® at 8-11 oz. per acre.	7-day PHI for snap bean. 21-day PHI for dry beans.
	Rovral 75WG® at 1.5-2 pts. per acre for flowable formulations.	Apply at first bloom, when 10% of the plants have one open bloom, and again at peak bloom. Observe restrictions on feeding of forage. Do not treat after full bloom. 0-day PHI.
	Switch® at 11-14 oz. per acre.	Do not make more than 2 applications before applying a fungicide with a different mode of action. 7-Day PHI.
	Topsin 70W®, or Topsin 4.5L®. See labels for rates.	The rate of Topsin® depends on timing, number of applications to be made, and percentage of plants in bloom. See product labels for details. 14-day PHI for snap beans. 28-day PHI for dry and lima beans.
Seedling Diseases and Root Rots	Plant only western-grown certified seed in warm, well-drained seedbeds.	
	Ridomil Gold SL® at 0.5-1 pt. per acre, or Ridomil Gold PGGR® at 0.75 lb. per 1,000 ft. of row. <b>Apply at planting.</b>	Fungicides containing mefenoxam (Ridomil Gold®) may help control early season seedling diseases caused by pythium. Ridomil PC® GR or PCNB may be used to help control rhizoctonia. Applications may be made preplant incorporated, or as a soil surface spray after planting.
Soybean Cyst Nematode (SCN)	Rotate at least 2-3 years with corn, small grains, alfalfa, or other non-host crops.	Do not include soybeans in the rotation.
Mosaic Virus Diseases	Plant varieties with resistance when available.	Controlling aphids may lessen the impact of some virus diseases.

 May be acceptable for use in certified organic production. Check with your certifier before use.

## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals and Perennials (emerged) — crop not present or protected from spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gals. (5 lbs. potassium salt/gal.) at 0.66-3.3 qts. per acre.	Broadcast before seeding or apply between crop rows with wipers or hooded or shielded sprayers. Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. 14-day PHI.
Annuals (emerged) — treatment applied before crop emergence	Gramoxone Inteon 2L® at 2-4 pts per acre. <b>Lima beans, snap beans, and peas only.</b>	Use 1 qt. of COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply before seeding or after seeding but before crop emergence. <b>RUP.</b>
Broadleaves (emerged) — crop not present or protected from spray	Aim EC® at 0.5-2 fl. oz. per acre.	Apply prior to or within 24 hours after seeding, or apply between crop rows with hooded sprayer. Do not allow spray to contact crop. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not exceed 6.1 fl. oz. per acre per season.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and Grasses (not emerged)	Command 3ME <sup>®</sup> at the following rates: <b>Peas and cowpeas:</b> 1.3 pts. per acre. <b>Succulent lima beans and snap beans:</b> 0.4-0.67 pt. per acre.	Broadcast before planting, or after planting before crop emerges. Not effective on muck soil. 45-day PHI for succulent and snap beans.
	Dual Magnum <sup>®</sup> , or Dual II Magnum <sup>®</sup> at 1-2 pts. per acre.	Use lower rates on coarse soils. <b>Peas:</b> apply prior to planting. Do not incorporate in English peas. <b>Beans:</b> apply and incorporate before planting, or apply after seeding but before crop emerges. Can be tank-mixed preplant incorporated with Eptam <sup>®</sup> or trifluralin. Do not use on muck soils.
	Eptam 7E <sup>®</sup> at 3.5 pts. per acre, or Eptam 20G <sup>®</sup> at 15 lbs. per acre. <b>Dry beans and snap beans only.</b>	Apply before planting and incorporate immediately, and/or apply as a directed spray at last cultivation. Check label for sensitive varieties. <b>Snap beans and navy beans on coarse soils:</b> do not exceed 3.5 pts. per acre. <b>All other labeled crops:</b> do not exceed 9.75 pts. per acre.
	Frontier <sup>®</sup> at 1.25-2 pts. per acre. <b>Dry beans only.</b>	Use lower rate on coarse soils that low in organic matter. Apply before planting and incorporate, apply after planting before emergence, or apply after planting when beans have 1-3 trifoliolate leaves. Do not exceed 20 fl. oz. on coarse soils prior to emergence. 70-day PHI.
	Lasso 4E <sup>®</sup> at 2.5-3 qts. per acre. <b>Lima beans in Indiana only.</b>	Apply before planting and incorporate. <b>RUP.</b>
	MicroTech <sup>®</sup> at the following rates: <b>Lima beans:</b> 2.5-3 qts. per acre. <b>Red kidney types of dry bean in Illinois only:</b> 2.5-3 qts. per acre.	Apply before planting and incorporate. <b>RUP.</b>
	Outlook <sup>®</sup> at 10-21 fl. oz. per acre. <b>Dry beans only.</b>	Use lower rate on coarse soils that low in organic matter. Apply before planting and incorporate, apply after planting before emergence, or apply after planting when beans have 1-3 trifoliolate leaves. Do not exceed 12 fl. oz. on coarse soils prior to emergence. 70-day PHI.
	Pendimethalin products. Use 3.3EC formulations at 1.2-3.6 pts. per acre, or Prowl H <sub>2</sub> O <sup>®</sup> at 1.5-3 pts. per acre.	Use low rates on coarse soils. Broadcast and incorporate before planting. Not effective on soils with high organic matter.
	Pursuit Plus <sup>®</sup> at 20-30 fl. oz. per acre. <b>Dry beans, lima beans, and peas in Illinois, Iowa, and Minnesota only.</b> In Minnesota, use only 20 fl. oz. per acre on sandy loams and soils with less than 2% organic matter.	Apply and incorporate before planting. Apply before June 30. See label for specific bean types. 60-day PHI for dry beans. 30-day PHI for lima beans and peas.
	Sonalan <sup>®</sup> at 1.5-4.5 pts. per acre. <b>Dry beans only.</b>	Apply and incorporate before planting. Use higher rates to suppress eastern black nightshade. Not for muck soils.
Trifluralin products at 0.5-0.75 lb. a.i. per acre. Use 4EC formulations at 1-1.5 pts. per acre.	Use lowest rate on coarse soils. Apply and incorporate before planting. Not effective on soils with high organic matter.	
Grasses (not emerged)	Dacthal W-75 <sup>®</sup> at 6-14 lbs. per acre, or Dacthal Flowable <sup>®</sup> at 6-14 pts. per acre. <b>Cowpeas, dry beans, and snap beans only.</b>	Apply at seeding. May be incorporated.

**Legumes (continued)**  
Weed Control (continued)

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves (not emerged or emerged)	Permit <sup>®</sup> at 0.5-0.66 oz. per acre. <b>Dry beans only.</b>	Use 0.5-1 pt. of nonionic surfactant per 25 gallons of spray solution if emerged weeds are present. Apply after planting but prior to soil cracking. Row-middle applications with no crop contact may be used after crop emergence. Do not exceed 1 oz. per acre per crop cycle, or 2 oz. per acre per 12-month period.
	Pursuit <sup>®</sup> products at the following rates: <b>Cowpeas:</b> Pursuit 2L <sup>®</sup> at 4 fl. oz. per acre, or Pursuit DG <sup>®</sup> at 1.44 oz. per acre. <b>Dry beans, lima beans, and peas:</b> Pursuit 2L <sup>®</sup> at 3 fl. oz. per acre, or Pursuit DG <sup>®</sup> at 1.08 oz. per acre. <b>Snap beans in Illinois and Minnesota:</b> Pursuit 2L <sup>®</sup> at 1.5 fl. oz. per acre. <b>All labeled crops in Minnesota north of Highway 210:</b> use only 2 fl. oz. of Pursuit 2L <sup>®</sup> , or 0.72 oz. of Pursuit DG <sup>®</sup> .	Use 8 oz. of nonionic surfactant per 25 gallons of spray solution if emerged weeds are present. <b>Snap beans in Illinois and Minnesota:</b> Apply and incorporate within 1 week of planting, or apply within 1 day after planting. Apply before July 31. <b>All other labeled crops:</b> Apply and incorporate within 1 week of planting, or apply within 3 days after planting before crop emerges, or apply after beans have 1 fully expanded trifoliolate leaf. Do not apply to fields treated with trifluralin or injury may occur. If N fertilizer is added to postemergence application, Basagran <sup>®</sup> also must be added to minimize crop injury. Refer to Basagran <sup>®</sup> label for rates. 30-day PHI for succulent peas and snap beans. 60-day PHI for all others.
	Sanda <sup>®</sup> at the following rates: <b>Dry beans:</b> 0.5-0.67 oz. per acre. <b>Snap beans and lima beans preemergence:</b> up to 1 oz. per acre.	Use 0.5-1 pt. of nonionic surfactant per 25 gallons of spray solution if emerged weeds are present. Use lower rates on coarse soils with low organic matter. Apply after planting but prior to cracking. Or, apply to snap beans or lima beans after the crop has 2-4 trifoliolate leaves (directed spray recommended). Not recommended when temperatures are cool due to potential for crop injury. Row-middle applications with no crop contact may be used after crop emergence. Do not exceed 0.67 oz. per acre per crop-cycle for dry beans, or 1 oz. per acre per crop-cycle for snap beans. Do not exceed 2 oz. per acre per 12-month period. 30-day PHI.
Broadleaves (emerged)	Basagran 4L <sup>®</sup> at 1.5-2 pts. per acre.	Apply when weeds are small and after peas have 3 pairs of leaves or first trifoliolate leaf of beans is fully expanded. Do not add COC for peas. Do not exceed 4 pts. per acre per season. 30-day PHI.
	Reflex <sup>®</sup> at the following rates: <b>Extreme southeast Missouri:</b> 1.5 pts. per acre per year. <b>Indiana and Illinois south of I-70:</b> 1.5 pts. per acre in alternate years. <b>Indiana, Illinois north of I-70, and rest of Missouri:</b> 1.25 pts. per acre in alternate years. <b>Kansas east of U.S. highway 281 and Minnesota south of I-94:</b> 1 pt. per acre in alternate years. <b>Minnesota south of Highway 2 and north of I-94:</b> 0.75 pt. per acre in alternate years. See label for map. <b>Dry beans and snap beans only.</b> <b>Not for lima beans.</b>	If dry beans have at least 4 fully expanded trifoliolate leaves, or snap beans have at least 1 fully expanded trifoliolate leaf, use nonionic surfactant, COC, or other additive following label instructions. Do not use liquid nitrogen as an additive. 30-day PHI for snap beans. 45-day PHI for dry beans.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and Grasses (emerged)	Raptor® at the following rates: <b>Succulent peas in Illinois and Minnesota only:</b> 3 fl. oz. per acre. <b>Dry peas in Illinois and Minnesota only:</b> 4 fl. oz. per acre. <b>Snap beans in Illinois, Indiana, Iowa, and Minnesota only:</b> 4 fl. oz. per acre.	Use 1-2 qts. of COC or 8-16 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply to peas after they are 3 in. tall but before they have 5 nodes or begin to flower. Apply to beans after first trifoliolate is fully expanded. Do not apply to snap beans that are flowering. To minimize crop injury, Basagran® must be added if COC or N fertilizer is used. Refer to Basagran® label for rates. Using Raptor® on fields treated with trifluralin may increase the risk of injury. Do not exceed 1 application per year.
Grasses (emerged)	Assure II® at 5-12 fl. oz. per acre. <b>Dry beans, snap beans, and peas only.</b>	Use 1 qt. of COC per acre. Apply to actively growing grass. Do not exceed 14 fl. oz. per acre. 30-day PHI for succulent peas, dry beans, and succulent peas. 15-day PHI for snap beans. 60-day PHI for dry peas.
	Poast 1.5E® at 1-2.5 pts. per acre.	Use 1 qt. of COC per acre. Spray on actively growing grass. Use high rate on quackgrass. Do not exceed 4 pts. per acre per season. 15-day PHI for succulent beans and peas. 30-day PHI for dry beans and dry peas.
	Select Max® at 12-16 fl. oz. per acre, or Select 2EC® at 6-8 fl. oz. per acre for annual grasses. Use high rate for perennial grasses. <b>Dry beans only.</b>	Use 1 qt. COC per 25 gals. spray solution. Apply to actively growing grass. Do not exceed 64 fl. oz. Select Max® or 32 fl. oz. Select 2EC® per acre per season. 30-day PHI.
	Targa® at 5-12 fl. oz. per acre. <b>Dry beans, snap beans, and peas only.</b>	Use 1 qt. of COC per acre. Apply to actively growing grass. Do not exceed 14 fl. oz. per acre. 30-day PHI for succulent peas, dry beans, and succulent peas. 15-day PHI for snap beans. 60-day PHI for dry peas.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects Controlled	Treatment	Comments
Seed Corn Maggots	Plant seed that has been treated with a product containing diazinon, a lindane-diazinon combination, or Cruiser®.	Flies are attracted to rotting organic material and freshly plowed soil. Plow winter cover crop under early in the spring and thoroughly cover. Handle seeds carefully to prevent cracking.
	Cruiser 5FS® or Cruiser Maxx®. Rates vary by seeding rate and spacing. See labels.	Cruiser® provides against early season injury by pests.
Wireworms	Cruiser 5FS® or Cruiser Maxx®. Rates vary by seeding rate and spacing. See labels.	Cruiser® provides against early season injury by pests.
Aphids and Leafhoppers	Admire 2F® at 16-24 fl. oz. per acre, or Admire PRO® at 7-10.5 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. or 1 application per season. 21-day PHI.
<b>Potato Leafhopper Threshold</b> <b>Seedlings:</b> 0.5 per sweep, or 2 per row foot <b>3rd trifoliolate:</b> 1 per sweep, or 5 per row foot <b>Bud stage:</b> 5 per row foot	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not exceed 0.2 lb. a.i. per acre per season. Do not feed or graze livestock on treated vines. 3-day PHI for succulent legumes. 21-day PHI for dry legumes. <b>RUP.</b>
	Assail 70WP® at 1.0-2.3 oz. per acre.	Do not exceed 3 applications per season. 7-day PHI.
	Brigade 2EC® at 1.6-6.4 fl. oz. per acre, or Brigade WSB® at 4-16 oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 3-day PHI for succulent legumes. 14-day PHI for dry legumes. <b>RUP.</b>

**Legumes (continued)**  
**Insect Control (continued)**

Insects Controlled	Treatment	Comments
Aphids and Leafhoppers (continued)	Cruiser 5FS® or Cruiser Maxx®. Rates vary by seeding rate and spacing. See labels.	Cruiser® provides against early season injury by pests.
<b>Potato Leafhopper Threshold</b> <b>Seedlings:</b> 0.5 per sweep, or 2 per row foot <b>3rd trifoliolate:</b> 1 per sweep, or 5 per row foot <b>Bud stage:</b> 5 per row foot	Dimethoate 4E® or Dimethoate 400® at 0.5-1 pt. per acre, or Dimethoate 2.67EC® at 0.75-1.5 pts. per acre.	Do not feed treated plants to livestock. Do not apply during bloom. 0-day PHI for Diamethoate 400® (mechanical harvest only). 2-day PHI for Dimethoate 4E®.
	Di-Syston 8E® at 0.9-1.9 fl. oz. per 1,000 linear ft. of row for any row spacing, or at 1-2 pts. per acre. <b>Succulent legumes only.</b>	Do not use treated vines for feed. Do not exceed 1 application per season. 60-day PHI. <b>RUP.</b>
	Endosulfan 3EC® at 0.66-1.33 qts. per acre. <b>Not for succulent beans.</b>	Do not exceed 2 lbs. a.i. or 2 applications per season. Do not feed treated threshings to livestock or allow livestock to graze in treated fields. 3-day PHI.
	Lannate SP® at the following rates: <b>Aphids:</b> 0.5-1 lb. per acre. <b>Leafhoppers:</b> 0.25-1 lb. per acre.	Do not feed hay to livestock for 7 days. 1-day PHI for succulent beans at 0.75-1.5 pts. 3-day PHI for succulent beans at high rate. 14-day PHI for dry beans. <b>RUP.</b>
	M-Pede® at 1-2% by volume. <b>Aphids only.</b>	Must contact aphids to be effective. 0-day PHI.
	Mustang MAX® at the following rates: <b>Aphids:</b> 3.2-4.0 oz. per acre. <b>Leafhoppers:</b> 2.72-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 1-day PHI for succulent beans. 21-day PHI for dry beans.
	Orthene 97® at 0.5-1 lb. per acre.	Do not feed treated vines to livestock. 14-day PHI for snap beans and dry beans. 1-day PHI for lima beans.
	PennCap-M® at 2 pts. per acre. <b>Dry beans only.</b>	Do not exceed 12 pts. per acre per season. 15-day PHI. <b>RUP.</b>
	Provado 1.6F® at 3.5 fl. oz. per acre.	Do not exceed 10.5 fl. oz. per acre per season. 7-day PHI.
	Sevin XLR PLUS® at 0.5-1 qt. per acre. <b>Not for aphids.</b>	Do not exceed 6 qts. per acre per season. 3-day PHI for succulent legumes. 14-day PHI for forage. 21-day PHI for dry legumes.
Thimet 20G® at 4.5-7.0 oz. per 1,000 linear feet of row at any spacing.	Drill granules to the side of the seed. Do not place granules in direct contact with seed. Do not feed bean foliage to livestock. 60-day PHI. <b>RUP.</b>	
Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 0.96 pt. per acre per season for succulent and dried shelled peas and beans. 7-day PHI for succulent legumes. 21-day PHI for dry legumes. <b>RUP.</b>	
Mexican Bean Beetles, Bean Leaf Beetles	Asana XL® at 2.9-5.8 fl. oz. per acre. <b>Mexican bean beetle only. Not for bean leaf beetles.</b>	Do not exceed 0.2 lb. a.i. per acre per season. Do not feed or graze livestock on treated vines. 3-day PHI for succulent legumes. 21-day PHI for dry legumes. <b>RUP.</b>
<b>Bean Leaf Beetle Threshold</b> 1 beetle per foot of row	Baythroid® at 2.4-3.2 fl. oz. per acre. <b>Dry beans and peas only.</b>	Do not exceed 6.4 fl. oz. or 4 applications per acre per season. Allow 14 days between applications. 3-day PHI for southern peas. 7-day PHI for dry beans. <b>RUP.</b>
<b>Mexican Bean Beetle Threshold</b> 0.5 beetles per plant	Brigade 2EC® at 1.6-6.4 fl. oz. per acre, or Brigade WSB® at 4-16 oz. per acre. <b>Not for Mexican bean beetles.</b>	Do not exceed 12.8 fl. oz. per acre per season. 3-day PHI for succulent legumes. 14-day PHI for dry legumes. <b>RUP.</b>
	Cruiser 5FS® or Cruiser Maxx®. Rates vary by seeding rate and spacing. See labels.	Cruiser® provides against early season injury by pests.
	Dimethoate 4E® or Dimethoate 400® at 0.5-1 pt. per acre, or Dimethoate 2.67EC® at 0.75-1.5 pts. per acre.	Do not feed to livestock. Do not apply during bloom. 0-day PHI for Diamethoate 400® (mechanical harvest only). 2-day PHI for Dimethoate 4E®.



Insects Controlled	Treatment	Comments
Mexican Bean Beetles, Bean Leaf Beetles (continued)	Di-Syston 8E® at 0.9-1.9 fl. oz. per 1,000 linear ft. of row for any row spacing, or 1-2 pts. per acre. <b>Not for bean leaf beetles.</b>	Do not use treated vines for feed. Do not exceed 1 application per season. 60-day PHI. <b>RUP.</b>
	Endosulfan 3EC® at 0.66-1.33 qts. per acre. <b>Not for succulent beans.</b>	Do not exceed 2 lbs. a.i. or 2 applications per season. Do not feed treated threshings to livestock or allow livestock to graze in treated fields. 3-day PHI.
<b>Bean Leaf Beetle Threshold</b> 1 beetle per foot of row	Lannate SP® at 0.25-1 lb. per acre. <b>Not for bean leaf beetles.</b>	Do not feed hay to livestock for 7 days. 1-day PHI for succulent beans at 0.75-1.5 pts. 3-day PHI for succulent beans at high rate. 14-day PHI for dry beans. <b>RUP.</b>
<b>Mexican Bean Beetle Threshold</b> 0.5 beetles per plant	Mustang MAX® at 2.72-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 1-day PHI for succulent beans. 21-day PHI for dry beans.
	Orthene 97® at 0.5-1 lb. per acre.	Do not feed treated vines to livestock. 14-day PHI for snap beans and dry beans. 1-day PHI for lima beans.
	Pennacp-M® at 2 pts. per acre. <b>Dry beans only. Not for bean leaf beetles.</b>	Do not exceed 12 pts. per acre per season. 15-day PHI. <b>RUP.</b>
	Sevin XLR PLUS® at 0.5-1 qt. per acre.	Do not exceed 6 qts. per acre per season. 3-day PHI for succulent legumes. 14-day PHI for forage. 21-day PHI for dry legumes.
	Thimet 20G® at 4.5-7.0 oz. per 1,000 linear feet of row at any spacing .	Drill granules to the side of the seed. Do not place granules in direct contact with seed. Do not feed bean foliage to livestock. 60-day PHI. <b>RUP.</b>
	Warrior® at the following rates: <b>Mexican bean beetles:</b> 1.92-3.20 fl. oz. per acre. <b>Bean leaf beetles:</b> 2.56-3.84 fl. oz. per acre.	Do not exceed 0.96 pt. per acre per season for succulent and dried shelled peas and beans. 21-day PHI for dry beans. <b>RUP.</b>
Caterpillars (Alfalfa Caterpillars, Armyworms, Corn Earworms, Cutworms, European Corn Borers, and Loopers)	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not exceed 0.1 lb. a.i. per acre per season. Do not feed treated vines to livestock. 3-day PHI for succulent legumes. 21-day PHI for dry legumes. <b>RUP.</b>
	Baythroid® at 2.4-3.2 fl. oz. per acre. <b>Dry beans and peas only.</b>	Do not exceed 6.4 fl. oz. per acre per season. Allow 14 days between applications. 3-day PHI for southern peas. 7-day PHI for dry beans. <b>RUP.</b>
	Brigade 2EC® at 1.6-6.4 fl. oz. per acre, or Brigade WSB® at 4-16 oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 3-day PHI for succulent legumes. 14-day PHI for dry legumes. <b>RUP.</b>
	Lannate SP® at 0.5-1 lb. per acre.	Do not exceed 2.7 lbs. a.i. per are per crop. 1-day PHI for peas. 5-day PHI for forage. 14-day PHI for hay. <b>RUP.</b>
	Mustang MAX® at 1.28-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 1-day PHI for succulent legumes. 21-day PHI for dry legumes. <b>RUP.</b>
	Orthene 97® at 0.75-1 lb. per acre.	Do not feed treated vines to livestock. 14-day PHI for snap beans and dry beans. 1-day PHI for lima beans.
	Pennacp-M® at 2-4 pts. per acre. <b>European corn borer in dry beans only.</b>	Do not exceed 12 pts. per acre per season. 15-day PHI. <b>RUP.</b>
	Sevin XLR PLUS® at 1-1.5 qts. per acre.	Do not exceed 6 qts. per acre per season. 3-day PHI for fresh beans. 14-day PHI for forage. 21-day PHI for dry beans.
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 0.96 pt. per acre per season for succulent and dried shelled peas and beans. 7-day PHI for succulent legumes. 21-day PHI for dry legumes. <b>RUP.</b>

**Legumes (continued)**  
**Insect Control (continued)**

Insects Controlled	Treatment	Comments
Cowpea Curculios, Pea Weevils (cowpeas)	Asana XL® at 4.8-9.6 fl. oz. per acre. <b>Dry legumes only.</b>	Do not exceed 0.2 lb. a.i. per acre per season. Do not feed treated vines to livestock. 21-day PHI. <b>RUP.</b>
	Baythroid® at the following rates: <b>Cowpea curculios:</b> 1.6-2.4 fl. oz. per acre. <b>Pea weevils:</b> 2.4-3.2 fl. oz. per acre. <b>Dry beans and peas only.</b>	Do not exceed 6.4 fl. oz. or 4 applications per acre per season. Allow 14 days between applications. 3-day PHI for southern peas. 7-day PHI for dry beans. <b>RUP.</b>
	Brigade 2EC® at 2.1-6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 3-day PHI. <b>RUP.</b>
	Endosulfan 3EC® at 1-2 qts. per acre.	Do not exceed 2 applications per season. 3-day PHI.
	Mustang MAX® at 2.72-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 1-day PHI for succulent legumes. 21-day PHI for dried. <b>RUP.</b>
	Sevin XLR PLUS® at 1.5 qts. per acre.	Do not exceed 6 qts. per acre per season. 3-day PHI for succulent legumes. 21-day PHI for dry legumes.
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 0.96 pts. per acre per season. 7-day PHI for succulent legumes. 21-day PHI for dry legumes. <b>RUP.</b>
Seed Corn Maggots	Plant seed that has been treated with diazinon or a lindane-diazinon combination.	Adult flies are attracted to rotting organic matter or freshly plowed soil.
Stink Bugs	Baythroid® at 2.4-3.2 fl. oz. per acre. <b>Dry beans and peas only.</b>	Do not exceed 6.4 fl. oz. or 4 applications per acre per season. Allow 14 days between applications. 3-day PHI for southern peas. 7-day PHI for dry beans. <b>RUP.</b>
	Brigade 2EC® at 2.1-6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 3-day PHI. <b>RUP.</b>
	Mustang MAX® at 3.2-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 1-day PHI for succulent legumes. 21-day PHI for dry legumes.
	Sevin XLR PLUS® at 1.5 qts. per acre.	Do not exceed 6 qts. per acre per season. 3-day PHI for succulent legumes. 21-day PHI for dried. <b>RUP.</b>
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 0.96 pts. per acre per season. 7-day PHI for succulent legumes. 21-day PHI for dry legumes.
Thrips (cowpeas)	Admire 2F® at 16-24 fl. oz. per acre, or Admire PRO® at 7-10.5 fl. oz per acre.	1 application per season. 21-day PHI.
	Brigade 2EC® at 2.1-6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 3-day PHI. <b>RUP.</b>
	Mustang MAX® at 3.2-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 1-day PHI for succulent legumes. 21-day PHI for dry legumes. <b>RUP.</b>
	Sevin XLR PLUS® at 1 qt. per acre.	Do not exceed 6 qts. per acre per season. 3-day PHI for succulent legumes. 21-day PHI for dried.
	SpinTor 2SC® at 4.5-6.0 fl. oz. per acre.	<b>Succulent legumes:</b> Do not exceed 29 fl. oz. per acre per season. 3-day PHI. <b>Dry legumes:</b> Do not exceed 12 fl. oz. per acre per season. 28-day PHI.
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 0.96 pts. per acre per season. 7-day PHI for succulent legumes. 21-day PHI for dry legumes. <b>RUP.</b>

# Mint

## Peppermint and Spearmint

### Varieties

**Peppermint:** Black Mitcham, Robert’s Mitcham, Todd’s Mitcham, and Murray Mitcham. The latter three varieties are more resistant to verticillium wilt.

**Spearmint:** Scotch Spearmint and Native Spearmint. These two spearmints have distinctly different oils.

### Planting and Rotation

Mints are grown from dormant runners (stolons) dug from existing fields in the late fall or spring. Because verticillium wilt disease is an important problem (even with the more resistant varieties), growers should always use disease-free planting stock. Certified and disease-free stocks are available. Also, careful fall plowing of established stands is important for both winter protection

and for reducing the incidence of mint rust and other foliar diseases. “Squirrely” mint, which occurs primarily on peppermint, is caused by the mint bud mite, *Tarsonemus pipermenthae*.

Although mints are perennials, stands should not be maintained longer than 3 or 4 years in a rotation program. Older stands may show serious build-ups of disease, insect, and weed problems.

Irrigation significantly increases oil yields both on muck and mineral soils, even in seasons with normal rainfall.

### Fertilizing

For established mint, apply 120 to 150 pounds N per acre in split application (before emergence and before canopy closure). Potash and phosphorous should be maintained at 400 pounds K<sub>2</sub>O per acre and 50 pounds P<sub>2</sub>O<sub>5</sub> per acre.

### Disease Control

Diseases Controlled	Treatment	Comments
Spearmint Rust, Septoria Leafspot	Several chlorothalonil formulations (e.g., Bravo <sup>®</sup> , Echo <sup>®</sup> , Equus <sup>®</sup> ) are labeled for use at various rates. <b>Indiana only.</b>	Repeat spray at 7-10 day intervals for a total of 3 sprays. 80-day PHI.
	Rally 40WSP <sup>®</sup> at 4-5 oz. per acre. <b>Rust only.</b>	30-day PHI.
Verticillium Wilt	Use wilt-resistant varieties of peppermint. Native spearmint is resistant.	Rotate plantings after no more than 3 or 4 years.

### Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals (emerged) — treatment applied before crop emergence	Gramoxone Inteon 2L <sup>®</sup> at 2-3 pts. per acre, or Gramoxone Max 3L <sup>®</sup> at 1.3-2.0 pts. per acre.	Use 1 qt. of COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply before crop begins to grow in spring. Do not exceed 3 pts. of Gramoxone Inteon 2L <sup>®</sup> or 2 pts. of Gramoxone Max 3L <sup>®</sup> per acre per season. <b>RUP.</b>
	Chateau WDG <sup>®</sup> at 2-3 oz per acre, or Chateau SW <sup>®</sup> at 4 oz per acre.	Use nonionic surfactant according to label instructions. Apply when mint is dormant. Tank mix with paraquat (see paraquat label for rates). Adding a nitrogen source will increase activity. Do not apply to frozen ground. Do not exceed 4 oz. per acre in a single application or more than 8 oz. per acre in a single growing season. Make no more than 1 sequential application of Chateau <sup>®</sup> within 60 days of first application. Applying to nondormant mint may result in unacceptable injury. 80-day PHI.
Broadleaves and Grasses (not emerged or newly emerged)	Sinbar 80WP <sup>®</sup> at 1-2 lbs. per acre, or 0.25-0.5 lb. per acre plus surfactant or crop oil postemergence to the crop and small weeds.	Apply before mint emerges. Do not exceed 2 lbs. per acre per season. 60-day PHI.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and Grasses (not emerged)	Chateau WDG® at 2-3 oz per acre, or Chateau SW® at 4 oz per acre.	Apply prior to weed and crop emergence. Crop must be dormant. See notes above for Annuals (emerged). 80-day PHI.
	Command 3ME® at 1.3 pts. per acre.	Apply in spring before mint starts to grow. Do not apply to emerged mint. Do not exceed 1 application per season. Some whitening of tissue may occur as mint emerges. 84-day PHI.
	Prowl H <sub>2</sub> O® at 1.5-4 pts. per acre. <b>Established mint only.</b>	Use low rate on coarse soils. Apply to dormant mint before mint and weeds start to grow. 90-day PHI.
	Trifluralin products at 0.5-0.75 lb. a.i. per acre. Use 4EC formulations at 1-1.5 pts. per acre, or 10G formulations at 5-7.5 lbs. per acre.	Use low rate on coarse soils. Apply late winter or early spring, or in the fall after harvest when mint is dormant or semi-dormant. Incorporate or irrigate with 0.5 in. water.
Broadleaves (not emerged)	Spartan 75DF® at 3-6.7 oz. per acre.	Apply to established mint when it is dormant — in the fall after post harvest cultivation, and/or in the spring after cultivation. For new mint, use 2.25-5 oz. per acre and apply before mint emerges. Rainfall or irrigation is required to move herbicide into the soil. Application may injure crop as mint emerges. Application to emerged mint will result in severe injury. Do not exceed 8 oz. per 12-month period.
Broadleaves (not emerged or newly emerged)	Goal 2XL® at 2-3 qts. per acre in 20-40 gals. of water per acre. <b>Indiana only.</b>	Use 8 fl. oz. of nonionic surfactant per 25 gallons of spray solution if emerged weeds are present. Apply to dormant spearmint and peppermint on muck soil (greater than 20% organic matter) before weeds are 4 in. tall. Not for use on mineral or black sand soils. Application to emerged mint will result in severe injury.
Broadleaves and Nutsedge (emerged)	Bentazon products at 0.5-1 lb. a.i. per acre. Use 4L formulations at 1-2 pts. per acre.	Apply after mint and weeds have emerged. To control yellow nutsedge and Canada thistle, repeat application 7-10 days later. Crop oil will enhance activity. Do not exceed 4 pts. per acre per season.
Broadleaves (emerged)	Buctril 2E® at 1-1.5 pts. per acre in at least 10 gals. water per acre, or Buctril 4EC® at 8-12 fl. oz. per acre in at least 10 gals. water per acre.	Apply before weeds have more than 4-6 leaves, and only on established mint that has been harvested at least one year prior to application. Buctril® may cause temporary stunting and chlorosis of mint. Do not apply to mint growing under stressful conditions. when air temperatures are, or are expected to be, more than 70°F within 5 days of application. 70-day PHI.
Broadleaves (emerged) — primarily composites and nightshade	Stinger 3EC® at 0.33-1 pt. per acre	Use 4 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply up to 0.5 pt. in spring or up to 1 pt. in fall. To control Canada thistle in spring, apply before bud stage. Do not use mint straw, hay, or spent hay for compost or mulch and do not dispose of on land to be rotated to broadleaf crops. Do not exceed 1 pt. per acre per growing season. 45-day PHI.
Grasses (emerged)	Assure II® at 8-12 oz. per acre.	Use 1 qt. of COC per acre. Apply to actively growing grass. Do not exceed 2 applications or 30 fl. oz. per acre per season. 30-day PHI.
	Poast 1.5E® at 1-1.5 pts. per acre.	Use 1 qt. of COC per acre. Spray on actively growing grass. Do not exceed 2 applications per season. 20-day PHI.
	Select Max® at 12-32 fl. oz. per acre, or Select 2EC® at 6-16 fl. oz. per acre	Use 1 qt. of COC per 25 gallons of spray solution (1%v/v). Spray on actively growing grass. Use at least 16 fl. oz. Select Max®, or 8 fl. oz. of Select 2EC® on established mint. Wait at least 14 days between applications. 21-day PHI.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects Controlled	Treatment	Comments
Cutworms, Loopers	Various <i>Bacillus thuringiensis</i> formulations (Agree <sup>®</sup> , Biobit <sup>®</sup> , Dipel <sup>®</sup> , Javelin <sup>®</sup> , Lepinox <sup>®</sup> , etc.) are available. Follow label rates.	0-day PHI.
	Lannate SP <sup>®</sup> at 1 lb. per acre.	Do not exceed 1.8 lbs. a.i. per acre per crop. 14-day PHI. <b>RUP.</b>
	Lorsban 4E <sup>®</sup> at 2-4 pts. per acre, or Lorsban 75WG <sup>®</sup> at 1.33-2.67 lb per acre.	Use lower rate when cutworm larvae are less than 0.75 inch long. Only 1 application per growing season. 90-day PHI.
	Orthene 97 <sup>®</sup> at 1 lb. per acre.	Do not exceed 2 1/8 lbs. a.i. per acre per season. 14-day PHI.
Flea Beetles	Actara at 1.5-3.0 oz. per acre.	Do not exceed 12 oz. per acre per season. 7-day PHI.
	Lannate SP <sup>®</sup> at 0.75-1 lb. per acre.	For best results, apply immediately after harvest on stubble. Do not exceed 1.8 lbs. a.i. per acre per crop. 14-day PHI. <b>RUP.</b>
	Malathion 5EC <sup>®</sup> at 1 pt. per acre.	For best results, apply immediately after harvest on stubble. 7-day PHI.
Mites	Acramite 50WS <sup>®</sup> at 0.75-1.5 lbs. per acre.	Do not exceed 1 application per season. 7-day PHI.
	Agri-mek 0.15EC <sup>®</sup> at 8-12 fl. oz. per acre.	Do not exceed 36 fl. oz. per acre per season. 28-day PHI. <b>RUP.</b>
	Epi-mek 0.15EC <sup>®</sup> at 8-12 fl. oz. per acre.	
	Kelthane MF <sup>®</sup> at 1.75-2.5 pts. per acre.	Do not exceed 1 application per season. 30-day PHI.



*Good weed control before row closure boosts mint production.*

# Okra

Varieties	Days to Maturity
Annie Oakley II (F1 Hybrid)	52
Clemson Spineless, (Open pollinated)	55
Burgundy (red)	60

## Planting and Spacing

Seed 12 to 18 inches apart in rows 36 inches apart. Seed only after the soil has warmed to 65°F to 70°F for several days. Black plastic mulch with drip irrigation will increase yields. Transplants can be used for early production.

## Fertilizing

**Lime:** To maintain a soil pH of 6.0 to 6.5. Okra is very sensitive to low pH soils.

**Preplant:** N: 40 pounds N per acre preplant broadcast and disked in prior to seeding. P<sub>2</sub>O<sub>5</sub>: 0 to 200 pounds per

acre. K<sub>2</sub>O: 0 to 300 pounds per acre. Adjust according to soil type, previous management, and soil test results.

**Sidedress N:** Apply 40 pounds N as a sidedress after the first harvest.

## Harvest

Okra should be harvested every 2 to 3 days to maintain optimal market size (2- to 4-inch long pods). Frequent harvesting increases overall yield since the plant will reset pods faster. Okra will yield 8,000 to 10,000 pounds per acre. Okra can be stored at 45°F to 55°F and 90 percent to 95 percent relative humidity for 7 to 10 days.

## Disease Control

Diseases Controlled	Treatment	Comments
Fusarium Wilt	Avoid fields with a history of Fusarium wilt.	Rotations of several years may reduce Fusarium wilt severity.

## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals and Perennials (emerged) — crop not present or protected from spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs. potassium salt/gal.) at 0.66-3.3 qts. per acre.	Broadcast at least 3 days before transplanting or apply between crop rows with hooded or shielded sprayers. Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. Remove herbicide residue from plastic mulch prior to transplanting. 14-day PHI.
Broadleaves (emerged) — crop not present or protected from spray	Aim EC <sup>®</sup> at 0.5-2 fl. oz. per acre.	Apply prior to transplanting or apply between crop rows with hooded sprayer. Do not apply before direct seeding. Do not allow spray to contact crop. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not exceed 6.1 fl. oz. per acre per season.
Broadleaves and Grasses (not emerged)	Trifluralin products at 0.5-1 lb. a.i. per acre. Use 4EC formulations at 1-2 pts. per acre.	Use low rate on soils with less than 2% organic matter. Broadcast and incorporate before transplanting. Not effective on muck or high organic matter soils.
Grasses (emerged)	Poast 1.5E <sup>®</sup> at 1-1.5 pts. per acre.	Use 1 qt. of COC per acre. Spray on actively growing grass. Use high rate on quackgrass. Do not exceed 5.5 pts. per acre per season. 14-day PHI.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects controlled	Treatment	Comments
Aphids	Admire PRO® at 7-14 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. per acre per season. 21-day PHI.
	Malathion 5EC® at 1.5 pts. per acre.	1-day PHI.
	Provado 1.6F® at 3.8 fl. oz. per acre.	Do not exceed 0.24 lb. a.i. per acre per season. 0-day PHI.
Colorado Potato Beetles	Admire PRO® at 7-14 fl. oz. per acre, or Provado 1.6F® at 3.8 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. per acre per season. 21-day PHI.
	Entrust® at 1-2 oz. per acre.	Do not exceed 9 oz. per acre per season. 1-day PHI.
	Provado 1.6F® at 3.8 fl. oz. per acre.	Do not exceed 0.24 lb. a.i. per acre per season. 0-day PHI.
	SpinTor 2SC® at 3-6 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. 1-day PHI.
Corn Earworms	Brigade 2EC® at 2.1-6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 7-day PHI.
	Entrust® at 1-2 oz. per acre.	Also controls European corn borers, hornworms, armyworms, and loopers. Do not exceed 9 oz. per acre per season. 1-day PHI.
	Sevin XLR PLUS® at 1-1.5 qts. per acre.	Do not exceed 6 qts. per acre per season. 3-day PHI.
	SpinTor 2SC® at 3-6 fl. oz. per acre.	Also controls European corn borers, hornworms, armyworms, and loopers. Do not exceed 29 fl. oz. per acre per season. 1-day PHI.
Mites	Acramite 50WS® at 0.75-1.5 lbs. per acre.	Do not exceed 1 application per season. 3-day PHI.
Potato Leafhoppers	Admire PRO® at 7-14 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. per acre per season. 21-day PHI.
	Provado 1.6F® at 3.8 fl. oz. per acre.	Do not exceed 0.24 lb. a.i. per acre per season. 0-day PHI.
Thrips	Admire PRO® at 7-14 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. per acre per season. 21-day PHI.
	Brigade 2EC® at 2.1-6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 7-day PHI.
	Entrust® at 1.25-2.5 oz. per acre.	Do not exceed 9 oz. of Entrust® per acre per season. 1-day PHI.
	SpinTor 2SC® at 4-8 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. 1-day PHI.



*Okra plants respond well to the higher soil temperatures that can be maintained by using opaque plastic mulch.*

# Dry Bulb and Green Bunching Onion, Garlic, and Leek

ONION Varieties		
Bulbs	Early	Candy, Cavalier, Comanche, Norstar
	Main	Burgos, Copra, Lakota, Nitro, Spirit
	Late	Crusader, Daytona, Celtic, Sweet Sandwich, Spartan Banner 80, Walla Walla Sweet
Green		Beltsville Bunching

GARLIC Varieties	
Hardneck, Porcelain group	Georgian Crystal, Music
Hardneck, Rocamboles group	Capathian, Spanish Roja
Hardneck, Purple Stripe group	Metechi, Persian Star
Softneck, Artichoke group	Inchelium Red
Softneck, Silverskin group	Idaho Silverskin

LEEK Varieties	
Arkansas, Lancelot	

## Spacing

**Onion:** Raised beds with two double rows or wide rows spaced 14 inches apart on top of the bed with 12 seeds per foot within the wide (2 inches) row. Seed: 4 pounds per acre. Or transplant 4 inches apart in rows.

**Garlic:** Rows 12 to 36 inches apart with cloves 3 to 6 inches apart in the row. Plant bulbs 3 to 4 inches deep, with top of clove twice the depth of the clove height. For mechanical cultivation, plant flat side of clove perpendicular to the length of the row; for hand cultivation in dense plantings, plant angled side of clove parallel to the length of the row. Plant in fall 6 to 8 weeks before ground freezes.

**Leek:** Rows 14 to 18 inches apart with transplants 3 to 4 inches apart in the row.

## Fertilizing

### Onion, Garlic and Leek

**Lime:** Mineral soils: to maintain a soil pH of 6.0 to 6.8. Organic soils: lime if pH is less than 5.2.

## Harvesting

**Green onion:** Harvest by pulling from soil after bulb base is thicker than a pencil but before bulbing. Optional undercutting can be used to make pulling easier. Remove dirty outer layer from bulb area. Trip roots. Trim tops as needed if allowed by state regulations. Green onions are usually sold in bunches. Harvest knob onions by pulling from soil when bulb has reached desired stage of development. Follow practices for green onions.

**Dry bulb onion:** Harvest dry bulb onions after tops have naturally fallen over. If a sprout inhibitor is used on storage onions, time application according to label

instructions. Undercutting several days before harvest can improve keeping quality of storage onions. Dig from soil and dry in field or indoors at 75°F to 80°F and 70 percent to 80 percent relative humidity. Cut tops about 1 inch from bulb at harvest or after drying, or braid tops and hang onions to dry. Clean dry onions by gently brushing.

**Leek:** Harvest when stalk is 1 inch or more in diameter. Undercut plants, pull from soil, trim, and bunch.

**Garlic:** Harvest when tops have fallen over and partially dried. Lift from soil and dry protected from sun and rain. After drying, trim roots and remove tops, or leave tops on for braiding.

## Onion and Leek

**Preplant:** N: for mineral soils, 70 pounds N per acre broadcast or applied to bed before planting for transplanted crops, or half broadcast preplant and half applied as a band 2 inches below the seed for direct seeded crops; for organic soils, 100 pounds N per acre broadcast and disked in. P<sub>2</sub>O<sub>5</sub>: 25 to 250 pounds per acre. K<sub>2</sub>O: 0 to 250 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. At seeding, spray directly on the seed a solution of 2-6-0 at 1 pint per 100 feet of linear row. A 2-6-0 solution is equivalent to a 1:5 dilution of 10-34-0 liquid fertilizer with water. On muck soils with a pH greater than 6.0, add 1 pound of MnSO<sub>4</sub> per 1,000 feet of row at seeding, or use foliar Mn at the rate of 0.3 pound/100 gallons. Apply 2 to 3 times during the season starting 3 weeks after emergence.

**Sidedress N:** Mineral soils: 60 pounds N per acre to either side of the row at the 4- to 5-week stage of growth or by June 1. Muck soils: No sidedress N needed unless heavy rain occurs.



## Garlic

N: 70 to 125 pounds N per acre total. Adjust according to soil organic matter content and cropping history. Broadcast and incorporate 0 to 20 pounds N per acre before planting in the fall. Apply half the remainder when

garlic begins to grow in the spring, and the rest in 1 to 2 sidedressings at 3-week intervals, ending 4 to 6 weeks before harvest. P<sub>2</sub>O<sub>5</sub>, 25 to 250 pounds per acre. K<sub>2</sub>O: 0 to 250 pounds per acre. Adjust according to soil type, previous management and soil test results for your state. Broadcast and incorporate before planting in the fall.

## Disease Control

Diseases Controlled	Treatment	Comments
Alternaria Purple Blotch and Botrytis Leaf Blight (all onion types)	3-4 year crop rotation.	Rotation out of onions or related vegetables reduces the threat of these diseases in future onion crops.
	Amistar 80WP® at the following rates: <b>Purple blotch:</b> 2-4 oz. per acre. <b>Botrytis:</b> 3-5 oz. per acre.	Do not make more than 1 application before alternating to a fungicide with a different mode of action. 0-day PHI.
	Cabrio EG20® at the following rates: <b>Purple blotch:</b> 8-12 oz. per acre. <b>Botrytis:</b> 12 fl. oz. per acre (suppression only).	Do not apply Cabrio® more than once before alternating to a fungicide with a different mode of action. 7-day PHI.
	Endura 70WG® at 6.8 oz. per acre.	Do not make more than two applications of Endura® before alternating to a fungicide with a different mode of action. 7-day PHI.
	Maneb 75 DF® or 80 WP® at 2-3 lbs. per acre, or Manex® at 1.6-2.4 qts. per acre.	7-day PHI.
	Pristine 38WG® at the following rates: <b>Botrytis leaf blight:</b> 14.5-18.5 oz. per acre. <b>Purple blotch:</b> 10.5-18.5 oz. per acre.	Do not make more than 2 applications of Pristine® before alternating to a fungicide with a different mode of action. If application intervals are shorter than every 14 days, rotate to another fungicide with a different mode of action. 7-day PHI.
	Quadris 2.08SC® at the following rates: <b>Purple blotch:</b> 6.0-12.0 fl. oz. per acre. <b>Botrytis leaf blotch:</b> 9.0-15.5 fl. oz. per acre.	Do not make more than 1 application of Quadris® before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris Opti® at 1.6-3.2 pts. per acre.	Do not apply Quadris Opti® more than once before alternating to a fungicide with a different mode of action. 14-day PHI for green onion. 7-day PHI for dry bulb.
	Reason® at 5.5 fl. oz. per acre. <b>Not for Botrytis leaf blight.</b>	Do not apply more than once before alternating to a fungicide with a different mode of action. 7-day PHI.
	Scala® at 18 fl. oz. per acre (9 oz. per acre in tank mixes).	Use the lower rate only in tank mix. 7-day PHI.
Switch 62.5WG® at 11-14 oz. per acre.	Use 7-10 day interval. May be effective when used in rotation with other pesticides labeled for purple blotch or botrytis leaf blight. 7-day PHI.	
Alternaria Purple Blotch and Botrytis Leaf Blight (dry bulb, garlic only)	Aliette® at 2-3 lbs. per acre. <b>Purple blotch only.</b>	If disease is present, use the 3-lb. rate. 7-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates.	Minimum re-treatment interval is 7 days. 7-day PHI.
	Folicur 3.6F® at 4-6 fl. oz. per acre.	7-day PHI.
	Several formulations of mancozeb (e.g., Dithane®, Manzate®, Manex II® Penncozeb®) or maneb (e.g., Manex®, Maneb®) are labeled at various formulations.	7-day PHI.
	Rovral 4F® at 1.0-1.5 pts. per acre.	Use low rate when tank mixed with another product registered for use on onion. 7-day PHI.

**Dry Bulb and Green Bunching Onion, Garlic, and Leek (continued)**

Disease Control (continued)

Diseases Controlled	Treatment	Comments
Downy Mildew (all types)	Acrobat 50WP® at 6.4 oz. per acre.	Do not apply Acrobat 50WP® more than twice before alternating to a fungicide with a different mode of action. Apply Acrobat 50WP® as a tank mix with another fungicide with another mode of action. 0-day PHI.
	Agri-Fos® at 1.25 qts. per acre.	7-day PHI.
	Aliette® at 2-3 lbs. per acre. <b>Dry bulb only.</b>	7-day PHI.
	Amistar 80WP® at 3-5 oz. per acre.	Do not make more than one application before alternating to a fungicide with a different mode of action. 0-day PHI.
	Cabrio EG20® at 12 oz. per acre.	Do not apply Cabrio® more than once before alternating to a fungicide with a different mode of action. 7-day PHI.
	Several formulations of chlorothalonil (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates. <b>Suppression only.</b>	14-day PHI for green onion. 7-day PHI for dry bulb.
	Several formulations of mancozeb (e.g., Dithane®, Manzate®, Manex II® Penncozeb®) are labeled for dry bulb.	7-day PHI.
	Maneb 75DF® or Maneb 80WP® at 2-3 lbs. per acre, or Manex® at 1.6-2.4 qts. per acre.	7-day PHI.
	Phostrol® at 2.5-3.75 pts. per acre.	0-day PHI
	Quadris 2.08SC® flowable at 9.0-15.5 fl. oz. per acre. Note rate differences between diseases.	Do not make more than 1 application of Quadris® before alternating to fungicides with a different mode of action. 0-day PHI.
	Quadris Opti® at 2.4-3.6 pts. per acre.	Do not apply Quadris Opti® more than once before alternating to a fungicide in group 11. 14-day PHI for green onion. 7-day PHI for dry bulb.
	Reason® at 5.5 fl. oz. per acre.	Do not apply more than once before alternating to a fungicide with a different mode of action. 7-day PHI.
	Revus 2.09SC® at 8 fl. oz. per acre.	Make no more than 2 consecutive applications before switching to another non-group 40 fungicide.
	Ridomil Gold Bravo® at 2 lbs. per acre.	7-day PHI for dry bulb. 21-day PHI for green onion.
Fusarium Basal Rot	Use Fusarium-resistant varieties such as Elba Globe, Spartan Banner, and Harvestmore.	Consult seed catalogues for varietal characteristics.
Botrytis Neck Rot (all types)	Windrow plants until neck tissues are dry before topping and storage. Cure rapidly and properly.	Artificial drying may be necessary (forced heated air at 93-95°F for 5 days).
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates. <b>Suppression only.</b>	7-day PHI.
	Maneb 75 DF® or Maneb 80WP® at 2-3 lbs. per acre, or Manex® at 1.6-2.4 qts. per acre.	7-day PHI.

## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals (emerged) — treatment applied before planting or crop emergence	Gramoxone Inteon 2L <sup>®</sup> at 2.5-4 pts. per acre, or Gramoxone Max 3L <sup>®</sup> at 1.3-2.7 pts. per acre. <b>Garlic and direct-seeded onions only.</b> <b>Not for leeks or transplanted onions.</b>	Use 1 qt. of COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply before planting or after planting but before crop emergence. Do not exceed 4 pts. of Gramoxone Inteon 2L <sup>®</sup> or 2 pts. of Gramoxone Max 3L <sup>®</sup> per acre. <b>RUP.</b>
Annuals (emerged) and Perennials — crop not present or protected from spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs. potassium salt/gal) at 0.66-3.3 qts. per acre.	Broadcast before planting, after planting but before crop emergence, or apply between crop rows with hooded or shielded sprayers. Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. 14-day PHI.
Broadleaves and Grasses (not emerged)	Nortron SC <sup>®</sup> at the following rates: <b>Preemergence:</b> 16-32 fl. oz. per acre. <b>Postemergence:</b> 16 fl. oz. per acre. <b>Garlic and dry bulb onions only.</b> <b>Not for leeks or green onions.</b>	Apply preemergence or soon after seeding before weeds germinate. Apply postemergence up to 4 times, ending 30 days before harvest. May cause temporary leaf fusion. May injure stressed plants. Use on mineral soils only. Do not exceed 48 fl. oz. per acre per season on coarse soils and 96 fl. oz. per acre per season on medium and fine soils.
	Outlook <sup>®</sup> at 12-21 fl. oz. per acre.	Apply after crop plants have 2 true leaves. For transplants, apply after transplanting when soil has settled around plants. May be tank-mixed with other herbicides, see label. 30-day PHI.
	Pendimethalin products. Use 3.3EC formulations at 1.2-3.6 pts. per acre, or Prowl H <sub>2</sub> O <sup>®</sup> at 1.5-3 pts. per acre. <b>Garlic and dry bulb onions only.</b> <b>Not for leeks or green onions.</b>	<b>Garlic:</b> apply after planting before crop and weeds emerge, and/or apply when garlic has 1-5 true leaves. <b>Dry bulb onions:</b> apply when onions have 2-9 true leaves. <b>Onions on muck soils only:</b> apply up to 4.8 pts. 3.3EC formulations, or 4 pts. Prowl H <sub>2</sub> O <sup>®</sup> after seeding and before crop emerges, after onions have 2 leaves, and if needed at 6-9 leaves. Do not exceed 14.4 pts. per acre of 3.3EC formulations or 12.5 pts. per acre of Prowl H <sub>2</sub> O <sup>®</sup> on muck soils. Use low rates on coarse soils. 45-day PHI.
	Trifluralin products at 0.375-0.625 lb. a.i. per acre. Use 4EC formulations at 0.75-1.25 pts. per acre. <b>Dry bulb onions only.</b> <b>Not for use on garlic, leeks, or green onions.</b>	Use the lowest rate on coarse soils. Apply at layby as directed spray between onion rows and incorporate. Mineral soils only. 60-day PHI.
Broadleaves (not emerged)	Chateau WDG <sup>®</sup> at the following rates: <b>Dry bulb onions:</b> 2 oz. per acre. <b>Garlic:</b> 6 oz. per acre.	<b>Dry bulb onions:</b> Apply to transplanted onions between the 2- and 6- leaf stage or to direct-seeded onions between the 3- and 6-leaf stage. Will not control emerged weeds. Wait at least 14 days between applications. Do not exceed 2 oz. per acre per application, or 3 oz. per acre per growing season. 45-day PHI for dry bulb onions. <b>Garlic:</b> Apply within 3 days after planting and before garlic emerges. Do not exceed 6 oz. per acre per growing season.
Grasses (not emerged)	Dacthal W-75 <sup>®</sup> at 6-14 lbs. per acre, or Dacthal Flowable <sup>®</sup> at 6-14 pts. per acre. <b>Garlic and onions only.</b>	Apply at seeding, transplanting, and/or layby. Preplant incorporation not recommended. May be sprayed over transplants.

**Dry Bulb and Green Bunching Onion, Garlic, and Leek (continued)**

Weed Control (continued)

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Grasses (not emerged) <b>(continued)</b>	Prefar 4E® at 5-6 qts. per acre. <b>Garlic and dry bulb onions only.</b> <b>Not for leeks or green onions.</b>	Use low rate on soils with less than 1% organic matter. Apply and incorporate before planting. Or apply after seeding, before crop emerges and irrigate within 24 hours. Mineral soils only.
Broadleaves (emerged)	Aim EC® at 0.5-2 fl. oz. per acre.	Apply with hooded sprayers as a directed application between crop rows. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not allow spray to contact crop. Do not exceed 6.1 fl. oz. per acre per season.
	Buctril® products at the following rates: <b>Garlic:</b> Buctril 2EC® at 1.5-2 pts. per acre, or Buctril 4EC® at 0.75-1 pt. per acre <b>Onions:</b> Buctril 2EC® at 1-1.5 pts. per acre, or Buctril 4EC® 0.5-0.75 pt. per acre for onions. <b>Not for leeks.</b>	Apply after garlic emerges and before it is 12 in. tall. Apply when onions have 2-5 true leaves, using 50-70 gallons of water per acre, or on muck soils east of the Mississippi River only, apply 3-4 days before onions emerge. To minimize onion injury apply after 2 days of sunny weather when onion leaves are dry and temperatures are 70-80°F. 112-day PHI for garlic.
	Goal 2XL® at the following rates: <b>Seeded crops:</b> 0.5 pt. per acre. <b>Transplanted crops:</b> 1-2 pts. per acre. <b>Garlic and dry bulb onions only.</b> <b>Not for use on leeks, green garlic, or green onions.</b>	Use lower rate on coarse soils. Apply after direct-seeded crop has 2 true leaves, or prior to transplanting onions, or within 2 days after transplanting. Do not exceed 2 pts. per acre. 45-day PHI for onions. 60-day PHI for garlic.
Broadleaves and Grasses (emerged)	Nortron SC® at 16 fl. oz. per acre postemergence. <b>Garlic and dry bulb onions only.</b> <b>Not for leeks or green onions.</b>	Apply postemergence up to 4 times, ending 30 days before harvest. May cause temporary leaf fusion. May injure stressed plants. Use on mineral soils only. Do not exceed 48 fl. oz. per acre per season on coarse soils and 96 fl. oz. per acre per season on medium and fine soils.
Grasses (emerged)	Fusilade DX 2E® at 10-12 fl. oz. <b>Garlic and dry bulb onions only.</b> <b>Not for leeks or green onions.</b>	Use 1-2 pts. of COC or 0.5-1 pt. of nonionic surfactant per 25 gallons of spray solution. Apply to small actively growing grass. Do not exceed 48 fl. oz. per acre. 45-day PHI.
	Poast 1.5E® at 1-1.5 pts. per acre.	Use 1 qt. of COC per acre. Spray on actively growing grass. Use high rate on quackgrass. Do not exceed 4.5 pts. per acre per season. 30-day PHI.
	Select® products at the following rates: <b>Garlic:</b> Select Max® at 12-16 fl. oz per acre, or Select 2EC® at 6-8 fl. oz. per acre. <b>Dry bulb onions:</b> Select Max® at 12-32 fl. oz. per acre, or Select 2EC® at 6-16 fl. oz. per acre. <b>Not for use on leeks or green onions.</b>	Use 1 qt. of COC per 25 gallons of spray solution (1% v/v). Spray on actively growing grass. Wait at least 14 days between applications. Do not exceed 2 applications per season for garlic or shallots. 45-day PHI.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

**Insect Control**

Insects Controlled	Treatment	Comments
Onion Maggots (dry bulb)	Lorsban 4E® at 1.1 fl. oz. per 1,000 linear ft. of row, or Lorsban 75WG® at 0.73 oz. per 1,000 linear ft. of row as an in-furrow drench. <b>For furrow treatment at planting.</b>	Use a minimum of 40 gals. of total drench per acre. One application per year.
Onion maggots (dry bulb and green bunching)	Ambush 25W® at 6.4-19.2 fl. oz. per acre. <b>Adult control.</b>	Do not exceed 2.0 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Diazinon AG500® at 2-4 qts. per acre, or Diazinon 50W® at 4-8 lbs. per acre.	Broadcast just before planting and mix into the top 3-4 inches of soil. Apply in sufficient water to drench seed furrow planting. Do not exceed 3 foliar applications per season. 14-day PHI. <b>RUP.</b>

<b>Insects Controlled</b>	<b>Treatment</b>	<b>Comments</b>
Onion maggots (dry bulb and green bunching) <b>(continued)</b>	Mustang MAX® at 2.24-4.0 fl. oz. per acre. <b>Adult control.</b>	Do not exceed 0.125 lb. a.i. per acre per season. Add COC at 16 fl. oz. per acre. 7-day PHI. <b>RUP.</b>
	Pounce 25WP® at 6.4-19.2 fl. oz. per acre. <b>Adult control.</b>	Do not exceed 2.0 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Warrior® at 1.92-3.2 fl. oz. per acre. <b>Adult control.</b>	Do not exceed 1.92 pts. per acre per season. 14-day PHI. <b>RUP.</b>
Onion Thrips (dry bulb, green bunching, garlic, and leeks)	Field site selection.	Onion thrips build to high levels in small grains and move to onions when small grains dry down or are harvested. Avoid planting next to small grains.
	Plant resistant/tolerant varieties.	Tolerant varieties include White Keeper, El Charro, Snow White, Vega, X201, and Zapotec.
	Assail 70WP® at 2.1-3.4 oz. per acre.	Do not exceed 4 applications per season. 7-day PHI.
	Mustang MAX® at 2.88-4.0 fl. oz. per acre.	Do not exceed 0.125 lb. a.i. per acre per season. Add COC at 16 fl. oz. per acre. 7-day PHI. <b>RUP.</b>
	PennCap-M® at 2 pts. per acre.	Do not exceed 8 pts. per acre per season. 15-day PHI. <b>RUP.</b>
Onion Thrips (dry bulb and garlic)	Ambush 25W® at 9.6-19.2 oz. per acre.	Use when thrips first appear. Not for rescue treatments. Do not exceed 2.0 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Pounce 25WP® at 9.6-19.2 oz. per acre.	
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 1.92 pts. per acre per season. 14-day PHI. <b>RUP.</b>
Onion Thrips (dry bulb and green bunching)	Diazinon AG500® at 1 pt. per acre, or Diazinon 50W® at 1 lb. per acre.	Use 100-200 gals. of water per acre for improved control. Do not exceed 3 foliar applications per season. 14-day PHI. <b>RUP.</b>
	Lannate SP® at 1 lb. per acre.	<b>Green onion:</b> Do not exceed 5.4 lbs. a.i. per acre. <b>Dry bulb:</b> Do not exceed 3.6 lbs. a.i. per acre. 7-day PHI. <b>RUP.</b>



*These onions are members of the green onion group. Pesticide label directions differ significantly for applications to green or dry onions. Always read product labels.*

# Potato

Varieties	Season	Use	Scab Resistance	Appearance and Comments
Dark Red Norland	very early	market, home	good	Dark, deep red; smooth skinned; shallow eyes medium in number
Red Norland	very early	market, home	good	Bright red, oblong, smooth skinned, shallow eyes medium in number
Superior	early	chips, market	very good	White, slight russet, oval, very popular
Russet Norkotah	early	market, home	fair	Very good appearance, good baking quality, fair specific gravity
Cascade	mid-season	market, home	good	White, round
Goldrush	mid-season	market, home	fair	Very good appearance, good baking quality, fair specific gravity.
Snowden	mid-season	chips, market	good	White, very high dry matter, ideal for baking and French fries; exceptional ability to produce white potato chips; tubers sometimes rough
Atlantic	late	chips, market	good	White, blocky-round, high yield; hollow heart, internal browning, high specific gravity
Katahdin	late	market, home	fair	White, smooth, round, shallow-eyed
Kennebec	late	market, home	fair	White, long, oval
Red Pontiac	late	home garden	fair	Red, round, very high yield, low specific gravity, good boiling, mashing type
Russet Burbank				
<b>For trial only</b>				
Conestoga	early			A white type with good shelf life, shape, and baking quality
Somerset	mid-season			Blocky, very good appearance, high specific gravity, chips well, white
Yukon Gold	early	local market, home		Yellow flesh, good size
Russian Banana	late	specialty markets	good	Long, narrow fingerling; pale yellow flesh
Carola	late	specialty markets	good	Yellow skin and flesh, oval

## Spacing

Rows 34 to 36 inches apart. Seed pieces 9 to 11 inches apart in row, depending on variety and intended use. Seed 16 to 18 100-pound bags per acre. Seed piece should be 1.5 to 2 ounces. Using B-size certified seed will save cutting labor and reduce tuber-borne diseases.

## Fertilizing

**Lime:** To control common scab, soil pH should be within 5.0 to 5.2. However, low soil pH reduces phosphorus availability and increases availability of toxic elements such as manganese and aluminum. If the field has a history of scab, using scab-resistant varieties is recommended. Then, the soil pH can be 6.5 where phosphorus is most available.

**Preplant:** N: none — only a small amount such as 24 to 30 pounds with the starter fertilizer.  $P_2O_5$ : none — apply 50 to 150 pounds as a starter depending on the soil test results.  $K_2O$ : 50 to 400 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. For the most efficient

phosphate application, apply the fertilizer at planting in a band 2 to 3 inches to the side and below each side of the tuber. Examples would be 500 pounds per acre of 6-24-24 or 8-16-16. Do not apply more than 200 pounds of  $K_2O$  per acre in the band at planting. On sandy soils, broadcast 30 pounds or band 15 pounds sulfur per acre.

**Sidedress N:** For irrigated sandy soils, two split N applications are recommended: half at emergence and half at hilling or tuber initiation. For the early maturing varieties, use 50 to 60 pounds of N per acre at each growth stage. The second application can be adjusted according to rainfall and a petiole nitrate-N analysis. For upland or finer textured soils, all of the required N can be applied preplant or shortly after emergence. For soils with more than 3 percent organic matter and following soybeans, alfalfa, or a grass-legume hay crop, apply 100 pounds N per acre. For soils with less than 3 percent organic matter and the above rotation, apply 135 pounds N per acre. For potatoes following corn, rye, oats, wheat, or a vegetable crop, apply 150 pounds N per acre. Refer to University of Minnesota recommendations for N rates adjusted for yield goal.

## Vine Killing

Vine Killing Product	Treatment	Comments
Defol 750®	3.2 qts. per acre in 10-20 gals. water by ground or 5-10 gals. by air.	Apply 10 days before harvest. Do not apply in extreme heat during middle of the day.
paraquat	0.8-1.5 pts. per acre of 2.5L or 0.6-1.0 pt. per acre of 3L in 50-100 gals. of water plus 1 gal. COC or 1-2 pts. nonionic surfactant per 100 gals. spray solution. <b>Not for use on potatoes to be stored or used for seed.</b>	Begin applications when leaves begin to turn yellow. Immature potato foliage and drought-stressed potato foliage are tolerant to this product. Maximum 3 pts. of 2.5L or 2 pts. of 3L per acre per season. For split applications, use lower rate and wait 5 days between applications. Read label for complete instructions. <b>3L formulation not for use in Iowa or Missouri.</b> 3-day PHI.
Reglone®	1-2 pts. in 20-100 gals. water plus 8-64 fl. oz. nonionic surfactant.	A second application can be made if necessary. Allow at least 5 days between applications. 7-day PHI.
Rely 200®	29 fl. oz. per acre.	Do not make more than 1 application. 9-day PHI.

## Chemical Sprout Control

Use maleic hydrazide (MH-30) according to label directions one week after blossoms fall. For varieties and conditions where flowering does not occur, apply four to six weeks before potatoes are mature and ready for harvest. Make only one application. Apply when no rain is expected for 24 hours. Potatoes treated with MH cannot be used for seed because sprouting will be inhibited. Follow label directions.

## Disease Control

Diseases Controlled	Treatment	Comments
Black Leg	Plant cut seed tubers that have been stored under conditions for rapid healing of cut surfaces and treated with a labeled potato seed treatment.	Plant whole seed tubers where possible.
Early Blight	Choose a cultivar with some resistance to early blight.	Avoid droughty, wet, or compacted soils, and other conditions (such as insufficient nitrogen) that might add undue stress to the crop and increase susceptibility to early blight. Rotate fields away from potato production for 2-3 years.
	Amistar 80WP® at 2-5oz. per acre.	Do not make more than 1 application before alternating to a fungicide with a different mode of action. For a 7-day application schedule, use the 2 oz. rate. If the interval is increased to 14 days, use the 4 oz. rate. 14-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates.	Begin applications at the low rate when vines are exposed to disease and leaf wetness occurs. Repeat applications at higher labeled rates at 5-10 day intervals when vines close between rows or crop reaches 300-P days. 7-day PHI.
	Endura 70WG® at 2.5-4.5 oz. per acre.	Do not make more than 2 applications before alternating to a fungicide with a different mode of action. The maximum is 4 applications per season. 10-day PHI.
	Gavel 75DF® at 1.5-2 lbs. per acre.	Use a 5-7 day schedule when disease pressure is high. When disease pressure is low use a 7-10 day schedule. 14-day PHI.
	Gem 500SC® at 2.9-3.8 fl. oz. per acre, or Gem 25WDG® at 6-8 oz. per acre.	Do not make more than 1 application before alternating to a fungicide with a different mode of action. 7-day PHI.
	Headline® at 6-9 oz. per acre.	Do not make more than 1 application before alternating to a fungicide with a different mode of action. 3-day PHI.

**Potato** (continued)  
Disease Control (continued)

Diseases Controlled	Treatment	Comments
Early Blight (continued)	Several mancozeb formulations (e.g., Dithane®, Manzate®, Penncozeb®) are labeled for use at various rates.	14-day PHI.
	Maneb® or Manex® at 0.8-1.6 qts. per acre for liquid formulations, or 1.5-2.0 lbs. per acre for dry formulations.	Begin when plants are 2-6 inches high. 14-day PHI.
	Quadris 2.08SC® at the following rates: <b>7-day spray intervals:</b> 6.0 fl. oz. per acre. <b>14-day spray intervals:</b> 12.4 oz. per acre.	Do not make more than 1 application of Quadris® before alternating to a fungicide with a different mode of action, such as Bravo®, Dithane®, Rovral® or Super Tin®. 14-day PHI.
	Quadris Opti® at 1.6 pts. per acre.	Do not make more than 1 application of Quadris Opti® before alternating to a fungicide not in group 11. 14-day PHI.
	Reason® at 5.5-8.2 oz. per acre.	Do not make more than 1 application of Reason® before alternating to a fungicide with a different mode of action. 14-day PHI.
	Revus Top 2.08SC® at 5.5-7 fl. oz. per acre.	Adjuvant recommended. 1-day PHI.
	Rovral® at 1-2 pts. per acre for flowable formulations.	14-day PHI.
	Scala® at 7 oz. per acre.	Use Scala® only in a tank mix with another effective early blight fungicide. 7-day PHI.
	Super Tin 80WP® at 2.5-3.75 oz. per acre, or Super Tin 4L® at 4-6 fl. oz per acre.	Lower Super Tin® rates may be used if combined with another fungicide labeled for early blight. 7-day PHI. <b>RUP.</b>
	Tanos 50WDG® at 6 oz. per acre.	Tanos® must be tank-mixed with another fungicide with a different mode of action. Do not make more than 1 application before alternating to a contact (protectant) fungicide. 14-day PHI.
Fusarium Dry Rot	Mertect 340-F® at 0.42 oz. per 2,000 lbs. of tubers. Treat potatoes as they go into storage.	This product should be applied uniformly as a fine mist. Avoid bruising at harvest. Cure potatoes in storage at 60°F before lowering temperature. Provide adequate ventilation.
Late Blight	Destroy all potato cull piles.	
	Acrobat 50WP® at 4-6.4 oz. per acre.	4-day PHI.
	Amistar 80WP® at 4 oz. per acre.	Apply Amistar® on a 7-day preventative schedule. If late blight symptoms develop or conditions favor disease, switch to a non-group 11 fungicide and use a 5-day schedule. 14-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates.	7-day PHI.
	Curzate 60DF® at 3.2 oz. per acre.	Use only in combination with a labeled contact fungicide. 14-day PHI.
	Forum 4.18SC® at 4-6 fl. oz. per acre.	4-day PHI.
	Gavel 75DF® at 1.5-2 lbs. per acre.	Use a 5-7-day schedule when disease pressure is high. When disease pressure is low use a 7-10-day schedule. 14-day PHI.
	Gem 500SC® at 3.8 oz. per acre, or Gem 25WDG® at 8 oz. per acre.	Tank mix Gem® with a contact fungicide (use 75% of contact fungicide rate). Do not make more than 1 application of Gem® before alternating to a fungicide with a different mode of action. 7-day PHI.
	Headline® at 6-12 oz. per acre.	Do not make more than 1 application of Headline® before alternating to a fungicide with a different mode of action. 3-day PHI.



Diseases Controlled	Treatment	Comments
Late Blight (continued)	Several mancozeb formulations (e.g., Dithane®, Manzate®, Penncozeb®) are labeled for use at various rates.	14-day PHI
	Maneb® or Manex® at 0.8-1.6 qts. per acre for liquid formulations, or at 1.5-2.0 lbs. per acre for dry formulations.	Begin when plants are 2-6 inches high. 14-day PHI
	Omega 500F® at 5.5 oz. per acre.	Start applications when plants are 6-8 inches tall. May be effective when used in rotation with other pesticides labeled for late blight. 14-day PHI.
	Quadris 2.08SC® at 12 fl. oz. per acre.	Use on a 7-day schedule prior to late blight development. If late blight develops, switch to a non-group 11 fungicide and a 5-day spray schedule. 14-day PHI.
	Quadris Opti® at 1.6 pts. per acre.	Do not make more than 1 application of Quadris Opti® before alternating to a fungicide not in group 11. 14-day PHI.
	Ranman 400SC® at 1.4-2.75 fl oz per acre.	7-day PHI.
	Reason® at 5.5-8.2 oz. per acre.	Do not make more than 1 application of Reason® before alternating to a fungicide with a different mode of action. 14-day PHI.
	Revus Top 2.08SC® at 5.5-7 fl. oz. per acre.	Adjuvant recommended. 1-day PHI.
	Ridomil Gold Bravo® at 2.5 pts. per acre, or Ridomil Gold MZ® at 2.5 lbs. per acre.	Do not apply more than once before alternating to a fungicide with a different mode of action. 14-day PHI.
	Super Tin 80WP® at 2.5-3.75 oz. per acre, or Super Tin 4L® at 4-6 fl. oz. per acre.	Lower Super Tin® rates may be used if combined with another fungicide labeled for early blight. 7-day PHI. <b>RUP.</b>
	Tanos 50 WDG® at 6-8 oz per acre.	14-day PHI.
Rhizoctonia Canker	Avoid heavily infested fields, and plant uncontaminated seed tubers.	
Scab	Plant resistant varieties.	Maintain high moisture levels (near field capacity) during tuber set and enlargement. Do not apply manure or other organic matter immediately before planting. Avoid excessive liming, and maintain acid soil pH.
	Follow 3-4 year rotation schedule.	
Verticillium Wilt	Employ at least a 2-year rotation with small grains to manage fungus populations in the soil.	Good weed control also is important in reducing pathogen populations.
Virus Diseases and Purple-Top Wilt (Aster Yellows)	Plant only certified seed tubers.	Practice clean cultivation. Rogue first infected plants, including tubers.
	Control aphids and leafhoppers with insecticides.	
Root Knot and Lesion Nematodes	Methyl bromide, sodium methyl dithiocarbamate, or Vydate L®.	Sample fields during growing season for parasitic nematodes before planting. Avoid fields with high numbers of root knot and/or lesion nematodes. Methyl bromide and sodium methyl dithiocarbamate give best results when nematode populations are moderate to high. Vydate® gives adequate control when nematode populations are low to moderate. <b>Vydate® and methyl bromide formulations are RUPs.</b>

## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals (emerged) — treatment applied before crop emergence or transplanting	Gramoxone Inteon 2L <sup>®</sup> at 1-2 pts. per acre, or Gramoxone Max 3L <sup>®</sup> at 0.7-1.3 pts. per acre.	Use 1 qt. of COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply before planting, or after planting but before ground cracks. <b>RUP.</b>
Annuals and Perennials (emerged) — crop not present or protected from spray	Glyphosate products at 0.75-2.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs. potassium salt/gal.) at 0.66-3.3 qts. per acre.	Broadcast before planting, after planting before ground cracks, or apply between crop rows with wipers or hooded or shielded sprayers. Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. 14-day PHI.
Broadleaves (emerged) — crop not present or protected from spray	Aim EC <sup>®</sup> at 0.5-2 fl. oz. per acre.	Apply prior to or within 24 hours of planting, or apply between crop rows with hooded sprayer. Do not allow spray to contact crop. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not exceed 6.1 fl. oz. per acre per season.
Some Broadleaf Weeds (not emerged)	Chateau 51WDG <sup>®</sup> at 1.5 oz. per acre to soil covered potato. <b>Minnesota only.</b>	Apply to potatoes after hilling. A minimum of 2 inches of soil must cover vegetative plant parts when applied to avoid injury. Provides suppression of lambsquarters, nightshades, pigweeds, wild mustard, and wild radish. Tank-mixes recommended to improve efficacy. No PHI listed.
Broadleaves and Grasses (not emerged)	Dual Magnum <sup>®</sup> or Dual II Magnum <sup>®</sup> at 1-2 pts. per acre.	Use lower rates on coarse soils. Apply and incorporate before planting, or apply after planting before weeds emerge. May also be applied at 1.67 pts. per acre after hilling. Dual <sup>®</sup> might delay maturity and/or reduce yield of Superior and other early maturing varieties if cold, wet soil conditions occur after treatment. Dual <sup>®</sup> can be tank-mixed with Lorox <sup>®</sup> , Sencor <sup>®</sup> , Prowl <sup>®</sup> or Eptam <sup>®</sup> . See labels. Do not exceed 3.6 pts. per acre. 60-day PHI if applied before drag-off. 40-day PHI if applied at lay-by.
	Eptam 7E <sup>®</sup> at 3.5-7 pts. per acre, or Eptam 20G <sup>®</sup> at 15-20 lbs. per acre.	Apply before planting, after drag-off, or as directed spray at lay-by. Incorporate immediately. On muck soils, supplement with Lorox <sup>®</sup> /Linex <sup>®</sup> or Sencor <sup>®</sup> applied before crop emerges and after drag-off. The Superior variety may be sensitive. Suppresses nutsedge. 45-day PHI.
	Outlook <sup>®</sup> at 12-21 fl. oz. per acre.	Apply after planting or drag-off and before weeds emerge. In cold and wet conditions potatoes may emerge slowly or be stunted. May be tank-mixed with a number of other potato herbicides. 40-day PHI.
	Pendimethalin products. Use 3.3EC formulations at 1.2-3.6 pts. per acre or Prowl H <sub>2</sub> O <sup>®</sup> at 1.5-3 pts. per acre.	Use low rates on coarse soils. Broadcast after planting but before emergence or drag-off, or after potatoes have fully emerged before potatoes are 6 in. tall. May be incorporated. Not effective on muck soils. Do not apply postemergence to stressed potatoes.
	Trifluralin products at 0.5-1 lb. a.i. per acre. Use 4EC formulations at 1-2 pts. per acre, or 60DF formulations at 0.8-1.7 lbs. per acre.	Use low rate on soils with less than 2% organic matter. Broadcast and incorporate after planting but before emergence, immediately after drag-off, or after potatoes have fully emerged. Not effective on muck or high organic matter soils.
Grasses (not emerged)	Dacthal W-75 <sup>®</sup> at 6-14 lbs. per acre, or Dacthal Flowable <sup>®</sup> at 6-14 pts. per acre.	Apply at planting, drag-off, or layby. Preplant incorporation not recommended.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and Grasses (not emerged and newly emerged)	Lorox 50DF <sup>®</sup> at 1.5-3 lbs. per acre, or Linex 4L <sup>®</sup> at 1.5-4 pts. per acre.	Do not use on sand, loamy sand, or soils with less than 1% organic matter. Apply after planting but before crop emergence, when weeds are less than 2 in. tall. Seed pieces must be planted at least 2 in. deep.
	Matrix 25DF <sup>®</sup> at 1-1.5 oz. per acre.	Use 0.5 pt. of nonionic surfactant per 25 gallons of spray solution if emerged weeds are present. Apply after planting before crop emerges, at hilling, drag-off, or reservoir tillage, to a clean, newly prepared seedbed. Apply post when weeds are less than 1 in. tall. Avoid using adjuvants when potatoes are under heat stress. Do not exceed 2.5 oz. per acre per year. 60-day PHI.
Broadleaves and Grasses (not emerged), and Broadleaves (newly emerged)	Sencor 4F <sup>®</sup> at 0.5-2 pts. per acre, or Sencor 75DF <sup>®</sup> at 0.33-1.32 lbs. per acre. <b>Not for early-maturing or red-skinned varieties.</b>	Apply after planting before crop emerges, or apply up to 1 pt. of Sencor 4F <sup>®</sup> (1.32 lbs. of Sencor 75DF <sup>®</sup> ) after emergence. Check label for sensitive varieties. Avoid spraying when potatoes are 12-15 in. tall. Do not apply within 3 days of cool, wet, or cloudy weather, or crop injury may occur. Do not apply within 1 day of other pesticide applications. Do not exceed 2 pts. of Sencor 4F <sup>®</sup> or 1.32 lbs. of Sencor 75DF <sup>®</sup> per acre per year. 60-day PHI.
Grasses (emerged)	Poast 1.5E <sup>®</sup> at 1-2.5 pts. per acre.	Use 1 qt. of COC per acre. Spray on actively growing grass. Use high rate on quackgrass. Do not exceed 5 pts. per acre per season. 30-day PHI.
	Prism 0.94EC <sup>®</sup> at 12.8-34 fl. oz. per acre.	Use 1 qt. of COC per 25 gallons of spray solution (1% v/v). Spray on actively growing grass. Wait at least 14 days between applications. 30-day PHI.
	Select Max <sup>®</sup> at 12-32 fl. oz. per acre, or Select 2EC <sup>®</sup> at 6-16 fl. oz. per acre.	

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insect Controlled	Treatment	Comments
Aphids (Green Peach Aphid, Melon Aphid, Potato Aphid, and others)	Conserve natural enemies.	Limiting insecticide use will conserve predators and parasites that help control aphid populations.
	<b>Seed applied or seed piece treatment materials</b>	
	Admire PRO <sup>®</sup> at 5.7-8.7 fl. oz. per acre.	Apply directly to seed piece or below seed piece at planting. Can expect 70-90 days of control. Do not exceed 0.31 lb. a.i. per acre per season.
	Cruiser 5FS <sup>®</sup> or Cruiser Maxx <sup>®</sup> . Rates vary according to seeding rate and row spacing. See labels.	For best results plant potatoes immediately after treatment.
	Platinum 2SC <sup>®</sup> at 5-8 fl. oz. per acre, or Platinum Ridomil Gold <sup>®</sup> at 2.2 fl. oz. per 1,000 linear ft. of row.	Apply directly to seed piece in sufficient water to cover entire seed piece. Do not exceed 8 fl. oz. of Platinum 2SC <sup>®</sup> , or 38 fl. oz. of Platinum Ridomil Gold <sup>®</sup> per acre per season. Can expect 90-100 days control.
	<b>Foliar applied materials</b>	
	Actara <sup>®</sup> at 3 oz. per acre.	Do not exceed 6 oz. per acre per season. 14-day PHI.
	Assail 70WP <sup>®</sup> at 1-1.7 oz. per acre.	Do not exceed 4 applications per year. 7-day PHI.
	Dimethoate 400 <sup>®</sup> or Dimethoate 4E <sup>®</sup> at 0.5-1 pt. per acre, or Dimethoate 2.67EC <sup>®</sup> at 0.75-1.5 pts per acre.	0-day PHI for Dimethoate 400 <sup>®</sup> and Dimethoate 2.67EC <sup>®</sup> . 2-day PHI for Dimethoate 4E <sup>®</sup> .
Endosulfan 3EC <sup>®</sup> at 0.66-1.33 qts. per acre.	Do not exceed 4 qts. per acre per season. 1-day PHI.	

Insect Controlled	Treatment	Comments
Aphids (Green Peach Aphid, Melon Aphid, Potato Aphid, and others) <b>(continued)</b>	Fulfill® at 2.75-5.5 oz. per acre.	Requires up to 7 days to see results. Best control achieved with more than 10 gallons of water per acre. Do not exceed 5.5 oz. per acre per season. 14-day PHI.
	Lannate SP® at 0.5-1 lb. per acre.	Do not exceed 4.5 lbs. a.i. per acre per season. 6-day PHI. <b>RUP.</b>
	Leverage 2.7SE® at 3-3.8 fl. oz. per acre.	Do not use if Admire® was used at planting. Do not exceed 15 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>
	M-Pede® at 1-2% by volume.	Must contact aphids to be effective. 0-day PHI.
	Monitor 4® at 1.5-2 pts. per acre. <b>Not for melon aphids.</b>	Do not exceed 8 pts. per acre per season. 14-day PHI. <b>RUP.</b>
	Provado 1.6F® at 3.8 fl. oz. per acre.	Do not use if Admire® was used at planting. Do not exceed 15 fl. oz. per acre per season. Allow 7 days between treatments. 7-day PHI.
	Thimet 20G® at the following rates: <b>Light or sandy soils:</b> 8.5-11.3 oz. per 1,000 linear ft. of row for any spacing (minimum 32 in. spacing). <b>Heavy or clay soils:</b> 13.0-17.3 oz. per 1,000 linear ft. of row.	Apply as a band application on each side of row and beneath the soil surface, or in the seed furrow. 90-day PHI. <b>RUP.</b>
	Vydate C-LV® at 17-33 fl. oz. per acre, or Vydate L® at 2-4 pts. per acre.	Do not exceed 198 fl. oz. of Vydate C-LV® or 24 pts. of Vydate L® per acre per season. 7-day PHI. <b>RUP.</b>
Colorado Potato Beetles	Crop rotation.	Planting fields as far as possible from last year's potato fields will reduce potato beetle damage.
<b>Allowable Defoliation From Colorado Potato Beetles</b> <b>Preflowering:</b> 20-30% <b>Flowering:</b> 5-10% <b>Tuber Formation:</b> 30%  <b>Manage Resistance</b> <i>See Colorado Potato Beetle Resistance Management on page 137.</i>	Scouting.	Regular (weekly) field scouting will allow you to determine the necessity for, and improve the timing of, insecticide treatments.
	<b>Soil applied or seed piece treatments</b>	
	Admire PRO® at 5.7-8.7 fl. oz. per acre.	Apply directly to seed piece or below seed piece at planting. Can expect good control of first generation potato beetle and 70-90 days of aphid control. Do not exceed 0.31 lb. a.i. per acre per season.
	Cruiser 5FS® or Cruiser Maxx®. Rates vary according to seeding rate and row spacing. See labels.	For best results plant potatoes immediately after treatment.
	Platinum® at 5-8 fl. oz per acre, or Platinum Ridomil Gold® at 2.2 fl. oz. per 1,000 linear ft. of row.	Apply directly to seed piece in sufficient water to cover entire seed piece. Provides seasonlong control of potato beetles and aphids at higher label rates. Do not exceed 8.0 fl. oz. of Platinum 2SC®, or 38 fl. oz. of Platinum Ridomil Gold® per acre per season.
	Provado 1.6F® at 3.8 fl. oz. per acre.	Do not use if Admire® was used at planting. Do not exceed 15 fl. oz. per acre per season. Allow 7 days between treatments. 7-day PHI.
	Thimet 20G® at the following rates: <b>Light or sandy soils:</b> 8.5-11.3 oz. per 1,000 linear ft. of row for any spacing (minimum 32 in. spacing). <b>Heavy or clay soils:</b> 13.0-17.3 oz. per 1,000 linear ft. of row.	Apply as a band application on each side of row and beneath the soil surface or in the seed furrow. 90-day PHI. <b>RUP.</b>
	Vydate C-LV® at 8.5-33 fl. oz. per acre, or Vydate L® at 1-4 pts. per acre.	Do not exceed 198 fl. oz. of Vydate C-LV® or 24 pts. of Vydate L® per acre per season. 7-day PHI. <b>RUP.</b>
	<b>Foliar applied products</b>	
	Actara® at 1.5-3 oz. per acre.	Do not exceed 6 oz. per acre per season. 14-day PHI.
Agri-Mek 0.15EC® at 8-16 fl. oz. per acre.	Do not exceed 32 fl. oz. per acre per season. 14-day PHI. <b>RUP.</b>	

Insect Controlled	Treatment	Comments
Colorado Potato Beetles (continued)	Ambush 25W® at 3.2-12.8 oz. per acre.	Do not exceed 1.6 lbs. a.i. per acre per season. 14-day PHI. <b>RUP.</b>
	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not exceed 0.35 lb. a.i. per acre per season. 7-day PHI. <b>RUP.</b>
<b>Allowable Defoliation From Colorado Potato Beetles</b> <b>Preflowering:</b> 20-30% <b>Flowering:</b> 5-10% <b>Tuber Formation:</b> 30%  <b>Manage Resistance</b> <i>See Colorado Potato Beetle Resistance Management on page 137.</i>	Assail 70WP® at 0.6-1.7 oz. per acre.	Do not exceed 4 applications per year. 7-day PHI.
	Avaunt 30WDG® at 3.5-6.0 oz. per acre.	Do not exceed 24 oz. per acre per season. 7-day PHI.
	Baythroid® at 1.6-2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Endosulfan 3EC® at 0.67-1.33 qts. per acre.	Do not exceed 4 applications or 2.66 qts. per acre per season. 1-day PHI.
	Entrust® at 1-2 oz. per acre.	Do not exceed 6.5 oz. per acre per season. Observe resistance management restrictions. 7-day PHI.
	Epi-mek 0.15EC® at 8-16 fl. oz. per acre.	Do not exceed 32 fl. oz. per acre per season. 14-day PHI. <b>RUP.</b>
	Furadan 4F® at 1-2 pts. per acre.	Do not exceed 2 applications or 2 pts. per acre per year. Do not apply to foliage if Furadan® was used at planting. 14-day PHI. <b>RUP.</b>
	Kryocide® at 10-12 lbs. per acre.	Apply by air in 5-15 gallons of water per acre, or by ground in 25-100 gallons of water per acre at a minimum of 7-day intervals. Do not exceed 96 lbs. per acre per season. 0-day PHI.
	Leverage 2.7SE® at 3-3.8 fl. oz. per acre.	Do not use if Admire® was used at planting. Do not exceed 15 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>
	Monitor 4® at 1.5-2 pts. per acre.	Do not exceed 8 pts. per acre per season. 14-day PHI. <b>RUP.</b>
Mustang Max® at 1.76-4 fl. oz. per acre.	Do not exceed 0.3 lb. a.i. per acre per season. 1-day PHI.	
Novodor® at 1-3 qts. per acre. <b>Small Colorado potato beetle larvae only.</b>	<i>Bacillus thuringiensis</i> based insecticide. 0-day PHI.	
Platinum 2SC® at 5-8 fl. oz. per acre, or Platinum Ridomil Gold® at 2.2 fl. oz. per 1,000 linear ft. of row.	Apply directly to seed piece in sufficient water to cover entire seed piece. Do not exceed 8 fl. oz. Platinum 2SC®, or 38 fl. oz. Platinum Ridomil Gold® per acre per season. Can expect 90-100 days control.	
Pounce 25WP® at 6.4-12.6 oz. per acre.	Do not exceed 1.6 lbs. a.i. per acre per season. 14-day PHI. <b>RUP.</b>	
Prokil Cryolite 96® at 10-12 lbs. per acre, or Prokil Cryolite 50D® at 19-23 lbs. per acre.	Apply by air in 5-15 gallons of water per acre, or by ground in 25-100 gallons of water per acre at a minimum of 7-day intervals. Do not exceed 96 lbs. of Prokil Cryolite 96® per acre per season. Do not exceed 184 lbs. Prokil Cryolite 50D® per acre per season. 0-day PHI.	
Provado 1.6F® at 3.8 fl. oz. per acre.	Do not use if Admire® was used. Do not exceed 15 fl. oz. per acre per season. Allow 7 days between applications. 7-day PHI.	
Rimon 0.83EC® at 9-12 fl. oz. per acre.	Do not exceed 24 fl. oz. per acre. 14-day PHI.	
Sevin XLR PLUS® at 1-2 qts. per acre.	Do not exceed 6 qts. per acre per crop. 7-day PHI.	
SpinTor 2SC® at 3-6 fl. oz. per acre.	Do not exceed 21 fl. oz. per acre per season. Observe resistance management restrictions. 7-day PHI.	
Warrior® at 2.56-3.85 fl. oz. per acre.	Do not exceed 15.36 fl. oz. per acre per season. 7-day PHI.	

Insect Controlled	Treatment	Comments	
Cutworms	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not exceed 0.35 lb. a.i. per acre per season. 7-day PHI.	
	Baythroid® at 0.8-1.6 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>	
	Lannate SP® at 0.5 lb. per acre.	Do not exceed 4.5 lbs. a.i. per acre per season. 6-day PHI. <b>RUP.</b>	
	Leverage 2.7SE® at 3-3.8 fl. oz. per acre.	Do not use if Admire® was used at planting. Do not exceed 15 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>	
	Monitor 4® at 1.5-2 pts. per acre.	Do not exceed 8 pts. per acre per season. 14-day PHI. <b>RUP.</b>	
	Sevin XLR PLUS® at 1-2 qts. per acre.	Do not exceed 6 qts. per acre per crop. 7-day PHI.	
	Warrior® at 1.92-3.20 fl. oz. per acre.	Do not exceed 15.36 fl. oz. per acre per season. 7-day PHI.	
European Corn Borers	Avaunt 30WDG® at 3.5-6.0 oz. per acre.	Do not exceed 24 oz. per acre per season. 7-day PHI.	
<b>European Corn Borer Threshold</b> 1 egg mass per 25 leaves	Baythroid® at 1.6-2.8 fl. oz. per acre.	Do not exceed 6 applications or 16.8 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>	
	Endosulfan 3EC® at 1.0-1.33 qts. per acre.	Do not exceed 4 applications or 2.66 qts. per acre per season. 1-day PHI.	
	Entrust® at 1-2 oz. per acre.	Do not exceed 9 oz. per acre per season. Observe resistance management restrictions. 7-day PHI.	
	Furadan 4F® at 1-2 pts. per acre.	Do not exceed 2 applications or 2 pts. per acre per season. Do not apply to foliage if Furadan® was used at planting. 14-day PHI. <b>RUP.</b>	
	Leverage 2.7SE® at 3.0-3.8 fl. oz. per acre.	Do not use if Admire® was used at planting. Do not exceed 15 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>	
	Monitor 4® at 1.5-2 pts. per acre.	Do not exceed 8 pts. per acre per season. 14-day PHI. <b>RUP.</b>	
	Pounce 25WP® at 6.4-12.8 per acre.	Do not exceed 1.6 lbs. a.i. per acre per season. 14-day PHI.	
	Rimon 0.83EC® at 9-12 fl. oz. per acre.	Do not exceed 24 fl. oz. per acre. 14-day PHI.	
	Sevin XLR PLUS® at 1-2 qts. per acre.	Do not exceed 6 qts. per acre per crop. 7-day PHI.	
	SpinTor 2SC® at 3-6 fl. oz. per acre.	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 7-day PHI.	
	Warrior® at 2.56-3.85 fl. oz. per acre.	Do not exceed 15.36 fl. oz. per acre per season. 7-day PHI.	
Flea Beetles	Actara®, Admire®, Asana®, Ambush®, Baythroid®, Endosulfan®, Furadan®, Kryocide®, Leverage, Monitor®, Platinum®, Pounce®, Provado, or Vydate® as described for Colorado potato beetles.	Be sure to check PHI on product labels.	
<b>Flea Beetle Threshold</b> 2 per sweep		Cruiser 5FS® or Cruiser Maxx®. Rates vary according to seeding rate and row spacing. See labels.	For best results, plant potatoes immediately after treatment.
		Lannate SP® at 0.5 lb. per acre.	Do not exceed 4.5 lbs. a.i. per acre per season. 6-day PHI. <b>RUP.</b>
		Sevin XLR PLUS® at 1-2 qts. per acre.	Do not exceed 6 qts. per acre per crop. 7-day PHI.

Insect Controlled	Treatment	Comments
Flea Beetles <b>(continued)</b>	Thimet 20G® at the following rates: <b>Light or sandy soils:</b> 8.5-11.3 oz. per 1,000 linear ft. of row for any spacing (minimum 32 in. spacing). <b>Heavy or clay soils:</b> 13.0-17.3 oz. per 1,000 linear ft. of row.	Apply as a band application on each side of row and beneath the soil surface or in the seed furrow. 90-day PHI. <b>RUP.</b>
<b>Flea Beetle Threshold</b> 2 per sweep		
	Warrior® at 2.56-3.85 fl. oz. per acre.	Do not exceed 15.36 fl. oz. per acre per season. 7-day PHI.
Potato Leafhoppers	<b>Soil applied or seed piece treatment materials</b>	
	Admire PRO® at 5.7-8.7 fl. oz. per acre.	Apply directly to seed piece or below seed piece at planting. Can expect 40-50 days of control. Do not exceed 0.31 lb. a.i. per acre per season.
	Cruiser 5FS® or Cruiser Maxx®. Rates vary according to seeding rate and row spacing. See labels.	For best results, plant potatoes immediately after treatment. <b>RUP.</b>
	Furadan 4F® at 1-2 pts. per acre.	Do not exceed 2 applications or 2 pts. per acre per year. 14-day PHI.
	Platinum 2SC® at 5-8 fl. oz. per acre, or Platinum Ridomil Gold® at 2.2 fl. oz. per 1,000 linear ft. of row.	Apply directly to seed piece in sufficient water to cover entire seed piece. Do not exceed 8 fl. oz. of Platinum 2SC®, or 38 fl. oz. of Platinum Ridomil Gold® per acre per season. Can expect 90-100 days control.
	Thimet 20G® at the following rates: <b>Light or sandy soils:</b> 8.5-11.3 oz. per 1,000 linear ft. of row for any spacing (minimum 32 in. spacing). <b>Heavy or clay soils:</b> 13.0-17.3 oz. per 1,000 linear ft. of row.	Apply as a band application on each side of row and beneath the soil surface or in the seed furrow. 90-day PHI. <b>RUP.</b>
	<b>Foliar applied materials</b>	
	Actara® at 1.5-3 oz. per acre.	Do not exceed 6 oz. per acre per season. Control may require 2 applications at a 7-10 day interval. 14-day PHI.
	Ambush 25W® at 6.4-12.6 oz. per acre.	Do not exceed 1.6 lbs. a.i. per acre per season. 14-day PHI. <b>RUP.</b>
	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not exceed 0.35 lb. a.i. per acre per season. 7-day PHI. <b>RUP.</b>
	Assail 70WP® at 0.6-1.7 oz. per acre.	Do not exceed 4 applications per year. 7-day PHI.
	Baythroid® at 0.8-1.6 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Dimethoate 400® or Dimethoate 4E® at 0.5-1 pt. per acre, or Dimethoate 2.67EC® at 0.75-1.5 pts per acre.	0-day PHI for Dimethoate 400® and Dimethoate 2.67EC®, 2-day PHI for Dimethoate 4E®.
	Endosulfan 3EC® at 0.66-1.33 qts. per acre.	Do not exceed 4 applications or 2.66 qts. a.i. per acre per season. 1-day PHI.
	Furadan 4F® at 1-2 pts. per acre.	Do not make more than 2 foliar applications per season. Do not apply to foliage if Furadan® was used at planting. 14-day PHI. <b>RUP.</b>
	Lannate SP® at 0.5-1 lb. per acre.	Do not exceed 4.5 lbs. a.i. per acre per season. 6-day PHI. <b>RUP.</b>
	Leverage 2.7SE® at 3.0-3.8 fl. oz. per acre.	Do not use if Admire® was used at planting. Do not exceed 15 fl. oz. per acre per season. 7-day PHI. <b>RUP.</b>
	Monitor 4® at 1.5-2 qts. per acre.	Do not exceed 8 pts. per acre per season. 14-day PHI. <b>RUP.</b>
	Mustang Max® at 1.76-4 fl. oz. per acre.	Do not exceed 0.3 lb. a.i. per acre per season. 1-day PHI.
	Pounce 25WP® at 6.4-12.6 oz. per acre.	Do not exceed 1.6 lbs. a.i. per acre per season. 14-day PHI. <b>RUP.</b>

Insect Controlled	Treatment	Comments
Potato Leafhoppers (continued)	Provado 1.6F® at 3.8 fl. oz. per acre.	Do not use if Admire® was used at planting. Do not exceed 15 fl. oz. per acre per season. Allow 7 days between treatments. 7-day PHI.
	Sevin XLR PLUS® at 0.5-1 qts. per acre.	Do not exceed 6 qts. per acre per crop. 7-day PHI.
	Vydate C-LV® at 17-33 fl. oz. per acre, or Vydate L® at 2-4 pts. per acre.	Do not exceed 198 fl. oz. of Vydate C-LV® or 24 pts. of Vydate L® per are per season. 7-day PHI. <b>RUP.</b>
	Warrior® at 2.56-3.85 fl. oz. per acre.	Do not exceed 15.36 fl. oz. per acre per season. 7-day PHI.
Wireworms	Site selection.	Wireworms are most likely to be a problem in fields recently planted to sod or pasture, or in fields that have had a grassy weed problem.
	Sampling.	Check for the presence of wireworms by burying a potato 6 inches deep in 5 locations per field prior to planting. Mark the spots with flags. Dig up the potatoes and inspect for wireworms 7 days later.
	Admire PRO® at 5.7-8.7 fl. oz. per acre.	Apply directly to seed piece or below seed piece at planting. Can expect 70-90 days of control. Do not exceed 0.31 lb. a.i. per acre per season.
	Cruiser 5FS® or Cruiser Maxx®. Rates vary according to seeding rate and row spacing. See labels.	For best results plant potatoes immediately after treatment.
	Thimet 20G® before or at time of planting at the following rates: <b>Light or sandy soils:</b> 8.5-11.3 oz. per 1,000 linear ft. of row for any spacing (minimum 32 in. spacing). <b>Heavy or clay soils:</b> 13.0-17.3 oz. per 1,000 linear ft. of row.	No effective treatment after planting. Treatment at planting may only provide 65% control. Apply as a band application on each side of row and beneath the soil surface, or in the seed furrow. 90-day PHI. <b>RUP.</b>



Early blight of potatoes can be managed by crop rotation, fall tillage, and a combination of contact and systemic fungicides.



## Colorado Potato Beetle Resistance Management

In some areas of the Midwest, Colorado potato beetle populations are resistant to many insecticides. If a previously effective insecticide is no longer effective, consider switching to another chemical class. If insecticides are still effective, alternating between classes will help prolong their effective lives. If planting time applications of neonicotinoids (Admire<sup>®</sup>, Gaucho<sup>®</sup>, Genesis<sup>®</sup>, Platinum<sup>®</sup>) are used, foliar neonicotinoids (Actara<sup>®</sup>, Leverage<sup>®</sup>, Provado<sup>®</sup>) should not be used.

The following table shows the active ingredients and chemical classes of Colorado potato beetle insecticides, and should be used to make resistant management decisions. To avoid promoting insect resistance, make sure to rotate between products that have different Insecticide Resistance Action Committee (IRAC) Group Numbers.

Insecticide	Active Ingredient	Chemical Class	IRAC Group Number
Actara <sup>®</sup>	thiamethoxam	neonicotinoid	4A
Platinum <sup>®</sup>	thiamethoxam	neonicotinoid	4A
Admire <sup>®</sup>	imidacloprid	neonicotinoid	4A
Genesis <sup>®</sup>	imidacloprid	neonicotinoid	4A
Gaucho <sup>®</sup>	imidacloprid	neonicotinoid	4A
Provado <sup>®</sup>	imidacloprid	neonicotinoid	4A
Leverage <sup>®</sup>	imidacloprid + cyfluthrin	neonicotinoid + pyrethroid	4A + 3
Baythroid <sup>®</sup>	cyfluthrin	pyrethroid	3
Ambush <sup>®</sup>	permethrin	pyrethroid	3
Pounce <sup>®</sup>	permethrin	pyrethroid	3
Agri-Mek <sup>®</sup>	abamectin	GABA agonist	6
Epi-Mek <sup>®</sup>	abamectin	GABA agonist	6
Furadan <sup>®</sup>	carbofuran	carbamate	1A
Monitor <sup>®</sup>	methomidaphos	organophosphate	1B
Endosulfan <sup>®</sup>	endosulfan	cyclodiene	2A
Kryocide <sup>®</sup> , Cryolite <sup>®</sup>	sodium aluminofluoride	mineral	9A
M-Trak <sup>®</sup> , Novodor <sup>®</sup> , Raven <sup>®</sup>	<i>Bacillus thuringiensis</i>	bacterium	11C
Entrust <sup>®</sup>	spinosad	naturalyte	5
SpinTor <sup>®</sup>	spinosad	naturalyte	5
Warrior <sup>®</sup>	lambda cyhalothrin	pyrethroid	3

# Rhubarb

## Varieties

McDonald, Sutton, Valentine (produces fewer seed stalks than McDonald) — all red-fleshed varieties.

## Planting and Spacing

**Crowns:** Use only young, healthy crowns having preferably 2 or 3 buds. Rows 5 to 6 feet apart. Set crowns in rows 3 feet apart in shallow furrows so crowns will be 2 inches below surface.

## Age for Harvesting

Harvest no longer than 4 weeks, beginning with the third season of growth. Harvest for about 8 to 10 weeks after the third season. Do not remove more than two-thirds of the developed stalks from any plant at one time.

## Bolting (Seed Stalk Formation)

Infertile soil, extreme heat or cold, drought, or long days that expose plants to too much light may cause bolting. Old plants bolt more. Valentine is more sensitive than McDonald, Ruby, and most green-stalked varieties.

## Fertilizing

**Lime:** To maintain a soil pH of 6.2 to 6.8.

**Preplant:** N: 50 pounds per acre. P<sub>2</sub>O<sub>5</sub>: 0 to 150 pounds per acre. K<sub>2</sub>O: 0 to 200 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. Apply 25 additional pounds of P<sub>2</sub>O<sub>5</sub> directly in furrows when setting the rootstalks (divided crowns).

**Yearly:** Only N needed. Broadcast 50 pounds N per acre before beds are worked in the spring. Topdress with 35 pounds N per acre after new growth resumes.

## Disease Control

Diseases Controlled	Treatment	Comments
Ascochyta Leaf Spot	Fertilize in fall for growth in the spring.	Remove older, yellowed leaves or leaves with lesions in the fall.
Crown Rot	Use disease-free plants.	Plant only on well-drained soil.

## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
All Weeds	Before spring growth, harrow bed thoroughly but carefully to avoid injuring the crowns. During the growing season, cultivate row-middles and hand hoe to keep the planting clean. Following the first light freeze in fall, mulch with 3-4 in. straw around plants, but not on crowns.	If additional mulch is needed in the spring, apply before hot, dry weather. Add more mulch during summer (if needed) to control weeds and retain moisture.
Annuals (emerged) — treatment applied before rhubarb buds begin to grow	Gramoxone Inteon 2L <sup>®</sup> at 2.5-4 pts. per acre, or Gramoxone Max 3L <sup>®</sup> at 1.7-2.7 pts. per acre.	Use 1 qt. of COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply in spring before buds begin to grow. Do not exceed 2 applications per season. <b>RUP.</b>
Annuals and Perennials (emerged) — crop not present or protected from spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs. potassium salt/gal.) at 0.66-3.3 qts. per acre.	Broadcast before plants emerge, or apply between rows with wipers or hooded or shielded sprayers. Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. 14-day PHI.
Broadleaves (not emerged or emerged)	Callisto 4L <sup>®</sup> at 6 fl. oz. per acre.	Apply to dormant rhubarb. Use COC or nonionic surfactant to improve control of emerged weeds. Do not exceed 6 fl. oz. per acre per year, or 1 application per year. 21-day PHI.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves (emerged)	Aim EC® at 0.5-2 fl. oz. per acre.	Apply with hooded sprayers as a directed application between crop rows. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not allow spray to contact crop. Do not exceed 6.1 fl. oz. per acre per season.
Grasses (emerged)	Poast 1.5E® at 1-1.5 per acre.	Use 1 qt. of COC per acre. Spray on actively growing grass. Do not exceed 3 pts. per acre per season. 15-day PHI for Illinois, Indiana, and Minnesota. 30-day PHI for other states.
	Select Max® at 12-16 fl. oz. per acre, or Select 2EC® at 6-8 fl. oz. per acre.	Use 1 qt. of COC per 25 gallons of spray solution. Spray on actively growing grass. Wait at least 14 days between applications. Do not exceed 64 fl. oz. Select Max® or 32 fl. oz. Select 2EC® per acre per season. 30-day PHI.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects Controlled	Treatment	Comments
Aphids, Leafhoppers, Whiteflies	Admire PRO® at 4.4-10.5 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. per acre per season. 45-day PHI.
	Fulfill® at 2.75 oz. per acre.	Do not exceed 5.5 oz. per acre per season. 7-day PHI.
	Mustang Max® at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Pounce 25W® at 6.4-12.8 oz. per acre.	Apply every 3-5 days (or as needed) in sufficient water to obtain full coverage of foliage. Do not exceed 2 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
Armyworms, Corn Earworms, Cutworms, Loopers	Entrust® at 1.25-2.5 oz. per acre. <b>Armyworms and loopers only.</b>	Do not exceed 9 oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
	Intrepid 2F® at 4-10 fl oz. per acre. <b>Armyworms and loopers only.</b>	Do not exceed 64 fl. oz. per acre. 1-day PHI.
	Larvin 3.2® at 16-30 fl. oz. per acre. <b>Not for cutworms.</b>	Do not exceed 60 fl. oz. per acre per season. 14-day PHI. <b>RUP.</b>
	Mustang Max® at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Pounce 25W® at 6.4-12.8 oz. per acre. <b>Also for European corn borers.</b>	Apply every 3-5 days or as needed in sufficient water to obtain full coverage of foliage. Do not exceed 2 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	SpinTor 2SC® at 4-8 fl. oz. per acre. <b>Armyworms and loopers only.</b>	Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
Common Stalk Borers, Rhubarb Curculios	There are no registered insecticides that will give adequate control.	Control by cultivating field and margins. Remove curly dock, the normal host of rhubarb curculios.

# Root Crops

## Beet, Carrot, Parsnip, Radish, and Turnip

Varieties	
<b>Beets</b>	Ruby Queen, Crosby Greentop, Red Ace, Asgrow Wonder, Pacemaker III, Rosette
<b>Carrots</b>	Imperator: Premium, First Class, Avenger, Apache, Condor, Six-pack II, Navaho
	Dicer types: Red Cored Chantenay, Goliath, Royal Chantenay, Danvers 126, Gold King
	Slicer types: Heritage, Protege, PY 60 Improved
	Nantes: Atlanta, Bolero, Mokum
<b>Parsnips</b>	Harris' Model, Andover, Anoka
<b>Radishes</b>	Cherry Belle, Comet, Red Prince
<b>Turnips</b>	Purple Top White Globe, Seven Top (greens)

### Spacing

**Beets:** Rows 18 to 24 inches apart. Seed 8 to 10 pounds per acre for bunching.

**Carrots:** Rows 16 to 30 inches apart. Plant 20 to 30 per foot for slicing/fresh market; 10 to 20 plants per foot for dicing.

**Parsnips:** Rows 18 to 24 inches apart. Seed 2 to 3 pounds per acre.

**Radishes:** Rows 15 inches apart. Plant 12 to 15 per foot of row. Seed 10 to 15 pounds per acre.

**Turnips:** Rows 14 to 18 inches apart. Plant 2 to 3 inches apart in row. Seed 1 to 2 pounds per acre.

### Fertilizing

**Lime:** To maintain a soil pH of 6.0 to 6.8; for beets, 6.5 to 7.0.

**Preplant:** N: 60 pounds per acre. P<sub>2</sub>O<sub>5</sub>: 20 to 160 pounds per acre. K<sub>2</sub>O: 0 to 200 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. If soil tests indicate that a high amount of K is

necessary, plow down at least half the requirement. Beets also respond to boron when grown on sandy soils, light-colored silt and clay loams, and alkaline, dark-colored soils. Boron may be omitted on acid, dark-colored soils. Based on a boron soil test, include boron at 2 1/2 to 5 pounds per acre applied over the row at planting. Do not contact with seed. Boron is toxic to many vegetables, particularly beans, peas, and cucurbits. Thus, rotational plans may have to be adjusted. For carrots grown on muck soil with a soil pH greater than 6.0, add 6 pounds of manganese per acre.

### Sidedress N

**Beets, carrots, parsnips:** for soils with more than 3 percent organic matter and following soybeans, alfalfa or a grass-legume hay crop, apply 30 pounds N per acre 4 to 6 weeks after planting. For soils with less than 3 percent organic matter and the above rotation, apply 45 pounds N per acre. Following corn, rye, oats, wheat, or a vegetable crop, apply 60 pounds N per acre.

**Radish, turnip:** none needed.

### Disease Control

Diseases Controlled	Treatment	Comments
Cercospora Leaf Spot (Early blight), Alternaria Leaf Blight (Late Blight)	3-4 year crop rotation.	Start applying contact fungicides at the first sign of disease.
	Amistar 80WP® at the following rates: <b>Alternaria diseases:</b> 2-5 oz. per acre. <b>Alternaria leaf blight of carrot:</b> 3-5 oz per acre. <b>Cercospora leaf spot:</b> 3-5 oz. per acre.	Do not make more than 1 application before alternating to a fungicide with a different mode of action. 0-day PHI.
	Cabrio EG® 8-12 oz. per acre.	Do not apply make more than 2 applications before alternating to a fungicide with a different mode of action. 0-day PHI.
	Several chlorothalonil formulations (e.g., Bravo 500®, Echo 75WDG®, Equus DF®) are labeled for use at various rates. <b>Carrots and parsnips only.</b>	0-day PHI for carrot. 10-day PHI for parsnip.
	Endura 70WG® at 4.5 oz. acre. <b>Alternaria leaf blight on carrot only.</b>	Apply no more than twice before alternating to a fungicide with a different mode of action. 0-day PHI.
	Folicur 3.6F® at 3-7.2 fl. oz. per acre. <b>Garden beet only.</b>	7-day PHI.
	Pristine 38WG® at 8-10.5 oz. per acre. <b>Carrot only.</b>	Apply no more than twice before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris Flowable 2.08SC® at the following rates: <b>Alternaria leaf blight:</b> 6-15.5 fl. oz. per acre. <b>Cercospora leaf spot:</b> 9.2-15.4 oz. per acre.	Do not make more than 1 application before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris Opti® at 2.4 pts. per acre. <b>Carrot only.</b>	Do not make more than 1 application of Quadris Opti® before alternating to a non-group 11 fungicide. 0-day PHI.
	Rovral® at 1-2 pts. per acre for flowable (F) formulations. <b>Alternaria leaf blight on carrot only.</b>	When tank mixed with another fungicide registered for use on carrot, use low rate. 0-day PHI.
Switch® at 11-14 oz. per acre. <b>Alternaria leaf blight on carrot only.</b>	Do not make more than 2 applications before applying a fungicide with a different mode of action. 7-Day PHI.	

Diseases Controlled	Treatment	Comments
Downy Mildew, White Rust	3-year crop rotation. Plow crop residue as soon as possible after harvest.	Avoid volunteer plants and cruciferous weeds.
	Cabrio EG® at 8-16 oz. per acre. <b>White rust only.</b>	Do not apply Cabrio® more than twice before alternating to a fungicide with a different mode of action. 0-day PHI.
	Quadris® at 6-15.5 oz. per acre for root crops. <b>White rust only.</b>	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. 0-day PHI.
White Mold (carrot and parsnip)	3-4 year crop rotation.	Avoid including beans, cucurbits, celery, and late cabbage in the rotation.
Aster Yellows (carrot and parsnip)	Use an insecticide to control leafhoppers that transmit the disease.	Excellent early season leafhopper control is essential. Control must occur before leafhoppers feed.
Root Knot Nematode	Methyl bromide or sodium methyl dithiocarbamate or Vydate L®. <b>Carrot only.</b>	Sample fields for plant parasitic nematodes before planting. Avoid fields with high numbers of root-knot nematodes. Methyl bromide and sodium methyl dithiocarbamate give best results when nematode populations are moderate to high. Vydate® gives adequate control when populations are low to moderate. <b>Vydate® and methyl bromide formulations are RUPs.</b>

## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals (emerged) — treatment applied before crop emergence	Gramoxone Inteon 2L® at 2-4 pts. per acre, or Gramoxone Max 3L® at 1.3-2.7 pts. per acre. <b>Carrots and turnips only. Not for beets, horseradish, parsnips, or radishes.</b>	Use 1 qt of COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply before or after seeding but before crop emerges. <b>RUP.</b>
Annuals and Perennials (emerged) — crop not present or protected from spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs. potassium salt/gal.) at 0.66-3.3 qt. per acre.	Broadcast before seeding, or apply between crop rows with wipers or hooded or shielded sprayers. Use lower rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. 14-day PHI.
	Trifluralin products at 0.5-0.75 lb. a.i. per acre. Use 4EC formulations at 1-1.5 pts. per acre. <b>Carrots and radishes only.</b>	Use lowest rate on coarse soils. Apply and incorporate before planting. Not effective on soils with high organic matter.
	Lorox 50DF® at the following rates: <b>Carrots in Minnesota only:</b> 1-2 lbs. per acre. <b>Parsnips:</b> 1.5-3 lbs. per acre.	Do not use on sand, loamy sand, or soils with less than 1% organic matter. Apply after seeding before crop emerges. Plant seed at least 1/2 inch deep. Do not use on other root crops.
	Nortron SC® at the following rates: <b>Preemergence:</b> 60 fl. oz. per acre. <b>Early postemergence:</b> 5.25 fl. oz. per acre. <b>Postemergence:</b> 10.5 fl. oz. per acre. <b>Beets only.</b>	Apply preemergence at, or soon after seeding, and before weeds germinate. Apply early postemergence when beets have 2-4 true leaves. Apply postemergence when beets have 6-8 true leaves. May cause temporary leaf fusion. May injure stressed plants. Use on mineral soils only. Do not exceed 96 fl. oz. per acre per season.
	Outlook® at 12-21 fl. oz. per acre. <b>Horseradish only.</b>	Apply from 2-leaf stage to 8-leaf stage of horseradish. Cold, wet conditions at application may stunt horseradish. Will not control emerged weeds.
	Prowl H <sub>2</sub> O® at 2 pts. per acre. <b>Carrots only.</b>	Apply within 2 days after seeding and before crop and weeds emerge. Or apply at layby as a directed spray between rows. Do not allow spray to contact carrot plants. Will not control emerged weeds. Do not exceed 2 pts. per acre per season. 60-day PHI.
Broadleaves (not emerged)	Goal 2XL® at 2 pts. per acre. <b>Horseradish only.</b>	Apply after planting prior-crop emergence.
	Spartan 75DF® at 1.5-5.3 oz. per acre. <b>Horseradish only.</b>	Broadcast in the fall, or in the spring no more than 30 days before planting, or after planting but at least 5 days before crop emergence, or band into row middles after crop emergence. Applications made in the spring shortly before planting may be incorporated, but do not incorporate at other times. Rainfall or irrigation is required to move herbicide into the soil when not incorporated. Do not broadcast if seedlings are close to soil surface, or over top of emerged crop. Do not exceed 5.3 oz. per 12-month period.

**Root Crops (continued)**  
Weed Control (continued)

<b>Weeds Controlled<sup>1</sup></b>	<b>Treatment<sup>2</sup></b>	<b>Comments</b>
Broadleaves (not emerged or newly emerged)	Pyramin 4.5SC <sup>®</sup> at 2.75-3.25 qts. per acre, or Pyramin 65DF <sup>®</sup> at 4.6-5.4 lbs. per acre. <b>Beets only.</b>	Apply after seeding before crop emerges, or use high rate after beets have 2 expanded true leaves and before weeds have more than 2 leaves. Rainfall or irrigation necessary for effective control of nonemerged weeds. Do not apply if beets are stressed or injured. Do not use preemergence on muck soils; do not use at all on sands or sandy loam soils. Do not exceed 6.5 qts. of Pyramin 4.5SC <sup>®</sup> or 11.25 lbs. of Pyramin DF <sup>®</sup> per acre.
Grasses (not emerged)	Ro-Neet 6E <sup>®</sup> at 0.5-0.67 gals. per acre. <b>Beets only.</b>	Apply before planting and incorporate immediately. Mineral soils only.
Broadleaves (emerged)	Aim EC <sup>®</sup> at 0.5-2 fl. oz. per acre.	Apply with hooded sprayers as a directed application between crop rows. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not allow spray to contact crop. Do not exceed 6.1 fl. oz. per acre per season.
	Sencor 4F <sup>®</sup> at 0.5 pt. per acre, or Sencor 75DF <sup>®</sup> at 0.33 lb. per acre. <b>Carrots only.</b>	Broadcast after carrots have 5-6 true leaves and when weeds are less than 1 in. tall or across. Do not apply within 3 days of cool, cloudy weather, or other pesticide application, or when temperature is above 85°F. Do not exceed 1 application per season if carrots are rotated with onions, otherwise do not exceed 1 pt. of Sencor 4F <sup>®</sup> or 0.66 lb. of Sencor 75DF <sup>®</sup> per acre. 60-day PHI.
	Spin-Aid 1.3E <sup>®</sup> at 3-6 pts. per acre in 11-22 gals. of water. <b>Beets only.</b>	Apply to beets with 4 true leaves to avoid injury. Do not apply if beets are stressed. Does not control pigweed. 60-day PHI.
Broadleaves (emerged) — primarily composites and nightshade	Stinger 3L <sup>®</sup> at 8 fl. oz. per acre. <b>Beets and turnips only.</b>	Do not exceed 1 application per acre. 30-day PHI for beets and turnip roots.
Broadleaves and Grasses (emerged)	Lorox 50DF <sup>®</sup> at 1.5-3 lbs. per acre. <b>Carrots only.</b>	Apply when crop is at least 3 in. tall. Not for postemergence use on other root crops. Will provide some residual control of nonemerged weeds. Do not apply if temperature is above 85°F. Do not exceed 4 lbs. per acre per season. Do not use on sand, loamy sand, or soils with less than 1% organic matter. 14-day PHI.
	Nortron SC <sup>®</sup> at 5.25 fl. oz. per acre early postemergence, or 10.5 fl. oz. per acre postemergence. <b>Beets only.</b>	Apply early postemergence when beets have 2-4 true leaves. Apply postemergence when beets have 6-8 true leaves. May cause temporary leaf fusion. May injure stressed plants. Use on mineral soils only. Do not exceed 96 fl. oz. per acre per season.
Grasses (emerged)	Fusilade DX <sup>®</sup> at 10-12 fl. oz. per acre. <b>Carrots only.</b>	Use 1-2 pts. of COC or 0.5-1 pt. of nonionic surfactant per 25 gallons of spray solution. Spray on actively growing grass. 45-day PHI.
	Poast 1.5E <sup>®</sup> at 1-1.5 pts. per acre. <b>Beets, carrots, horseradish, parsnips, radishes, and turnips only. Not for beet greens.</b>	Use 1 qt. of COC per acre. Spray on actively growing grass. Do not exceed 2.5 pts. per acre per season for parsnips, radishes, and turnips; or 5 pts. per acre per season for beets, carrots, and horseradish. 14-day PHI for parsnips, radishes, and turnips. 30-day PHI for carrots. 60-day PHI for beets and horseradish.
	Select Max <sup>®</sup> at 12-16 fl. oz. or Select 2EC <sup>®</sup> at 6-8 fl. oz. per acre. <b>Beets, carrots, horseradish, radishes, and turnips only. Not for parsnips or beet greens.</b>	Use 1 qt. of COC per 25 gallons of spray solution. Apply to actively growing grass. Wait at least 14 days between applications. Do not exceed 64 fl. oz. Select Max <sup>®</sup> or 32 fl. oz. Select 2EC <sup>®</sup> per acre per season. 15-day PHI for radishes.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects Controlled	Treatment	Comments
<b>Beets</b>		
Aphids	Actara® at 1.5-3 oz. per acre.	Do not exceed 8 oz. per acre per season. 7-day PHI.
	Admire PRO® at 4.4-10.5 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. or 1 application per season. 21-day PHI.
	Diazinon 50W® at 0.5-1 lb per acre.	Do not exceed 5 applications per season. 14-day PHI. <b>RUP.</b>
	Malathion 5EC® at 2.5 pts. per acre.	7-day PHI.
	M-Pede® at 1-2% by volume.	Must contact aphids to be effective. 0-day PHI.
	Platinum® at 5-12 fl. oz. per acre.	30-day PHI.
Variegated Cutworms	Baythroid® at 1.6-2.8 fl. oz. per acre.	Do not exceed 14.0 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Lannate SP® at 0.5 lb. per acre.	Do not exceed 8 applications or 3.6 lbs. a.i. per acre per crop. 0-day PHI for roots. 10-day PHI for tops. <b>RUP.</b>
	Mustang Max® at 1.28-4 fl. oz. per acre.	Do not exceed 0.3 lb. a.i. per acre per season. 1-day PHI.
<b>Carrots</b>		
Aphids	Actara® at 1.5-3 oz. per acre.	Do not exceed 8 oz. per acre per season. 7-day PHI.
	Admire PRO® at 4.4-10.5 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. or 1 application per season. 21-day PHI.
	Diazinon 50W® at 1 lb. per acre, or Diazinon AG500® at 1 pt. per acre.	Do not exceed 5 applications per acre per season. 14-day PHI. <b>RUP.</b>
	Endosulfan 3EC® at 0.66-1.33 qts. per acre.	Do not exceed 1 application per year. 7-day PHI.
	M-Pede® at 1-2% by volume.	Must contact aphids to be effective. 0-day PHI.
	Platinum® at 5.12 fl. oz. per acre.	30-day PHI.
Cutworms	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not exceed 0.5 lb a.i. per acre per season. 7-day PHI. <b>RUP.</b>
<b>Cutworm Threshold</b> 25% of plants infested	Baythroid® at 1.6-2.8 fl. oz. per acre.	Do not exceed 14.0 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Diazinon 50W® at 4-8 lbs. per acre, or Diazinon AG500® at 2-4 qts. per acre.	Broadcast just before planting and immediately incorporate into the soil. Do not exceed 5 applications per season. 14-day PHI. <b>RUP.</b>
	Lannate SP® at 0.25-0.5 lb. per acre.	Do not exceed 6.3 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Sevin XLR PLUS® at 1-2 qts. per acre.	Do not exceed 6 qts. per acre per season. 7-day PHI.
Leafhoppers	Plant resistant varieties.	Use varieties resistant to aster yellows.
	Actara® at 1.5-3.0 oz. per acre.	Do not exceed 8 oz. per acre per season. 7-day PHI.
	Admire PRO® at 4.4-10.5 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. or 1 application per season. 21-day PHI.
	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not exceed 0.5 lb. a.i. per acre per season. 7-day PHI. <b>RUP.</b>
	Baythroid® at 1.6-2.8 fl. oz. per acre.	Do not exceed 14.0 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Lannate SP® at 0.5-1 lb. per acre.	Do not exceed 6.3 lbs. a.i. per acre per season. 1-day PHI. <b>RUP.</b>
	Platinum® at 5-12 fl. oz. per acre.	30-day PHI.
	Sevin XLR PLUS® at 0.5-1 qt. per acre.	Do not exceed 6 qts. per acre per season. 7-day PHI.
<b>Leafhopper Threshold</b> For susceptible varieties: 20 leafhoppers per 100 sweeps		

**Root Crops** (continued)  
Insect Control (continued)

Insects Controlled	Treatment	Comments
<b>Radishes</b>		
Aphids, Flea Beetles	Actara® at 1.5-3 oz. per acre.	Do not exceed 4 oz. per acre per season. 7-day PHI.
	Admire PRO® at 4.4-10.5 fl. oz. per acre.	Do not exceed 0.38 a.i. or 1 application per season. 21-day PHI.
	Asana XL® at 5.8-9.6 oz. per acre. <b>Flea beetles only.</b>	Do not exceed 0.1 lb. a.i. per acre per season. 7-day PHI. <b>RUP.</b>
	Baythroid® at 1.6-2.8 fl. oz. per acre. <b>Flea beetles only.</b>	Do not exceed 14.0 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Diazinon 50W® at 0.5-1 lb. per acre, or Diazinon AG500® at 0.5-1 pt. per acre.	Do not exceed 3 applications per acre per season. 14-day PHI. <b>RUP.</b>
	M-Pede® at 1-2% by volume. <b>Aphids only.</b>	Must contact aphids to be effective. 0-day PHI.
	Platinum® at 5-6.5 fl. oz. per acre.	30-day PHI.
	Sevin XLR PLUS® at 0.5-1 qt. per acre. <b>Flea beetles only.</b>	Do not exceed 6 qts. per acre per season. 7-day PHI.
Cutworms	Baythroid® at 1.6-2.8 fl. oz. per acre.	Do not exceed 14.0 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Diazinon 50W® at 4-8 lbs. per acre, or Diazinon AG500® at 2-4 qts. per acre.	Broadcast just before planting and immediately incorporate into the soil. 14-day PHI. <b>RUP.</b>
	Sevin XLR PLUS® at 1-2 qts. per acre.	Do not exceed 6 qts. per acre per season. 7-day PHI.
Root Maggots	Lorsban 4E® at 1 fl. oz. per 1,000 linear ft. of row, or Lorsban 75WG® at 0.67 oz. per 1,000 linear ft. of row. <b>Apply as a furrow application at planting.</b>	Apply as a water-based drench and use a minimum of 40 gallons of water. Do not exceed 1 application per season.
<b>Turnips</b>		
Aphids, Flea Beetles	Actara® at 1.5-3 oz. per acre.	Do not exceed 8 oz. per acre per season. 7-day PHI.
	Admire PRO® at 4.4-10.5 fl. oz. per acre.	Do not exceed 0.38lb. a.i. or 1 application per season. 21-day PHI.
	Align® according to label directions.	0-day PHI.
	Ambush 25W® at 3.2-6.4 fl. oz. per acre. <b>Aphids in Illinois and Indiana only.</b>	Do not exceed 8 applications per acre per season. 1-day PHI. <b>RUP.</b>
	Asana XL® at 5.8-9.6 oz. per acre. <b>Flea beetles only.</b>	Do not exceed 0.4 lbs. a.i. per acre. 7-day PHI. <b>RUP.</b>
	Baythroid® at 1.6-2.8 fl. oz. per acre. <b>Flea beetles only.</b>	Do not exceed 14.0 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Neemix® according to label directions.	0-day PHI.
	Platinum® at 5-12 fl. oz. per acre.	30-day PHI.
Root Maggots	Lorsban 4E® at 1.6-2.75 fl. oz. per 1,000 linear ft. of row, or Lorsban 75WG® at 1.1-1.8 oz. per 1,000 linear ft. of row. <b>Apply as a furrow application at planting.</b>	Apply as a water-based drench and use a minimum of 40 gallons of water. Do not exceed 1 application per acre per season.



# Sweet Corn

## Sweet Corn Types

Sweet corn is usually described by color (yellow, bicolor, or white) and by the major genes that make it sweet. The original sweet corn (called standard, sugary, or su) contains the su1 genetic variant that makes it sweet instead of starchy like field corn. Sugary sweet corn is grown today primarily for processing and specialized markets.

A second type of sweet corn is called sugar-enhanced, sugary enhancer, EH, or se corn because it contains the se1 genetic variant that increases sugar content and makes the kernels more tender. Heterozygous se corn has one copy of the se1 mutation, and homozygous se corn has two copies of the se1 mutation, increasing its effect. Sugar-enhanced sweet corn is grown primarily for direct retail sales and local wholesale markets.

A third type of sweet corn, called supersweet, ultrasweet, extra sweet, or shrunken-2 contains the sh2 genetic variation. This type typically has a higher sugar content than sugary corn, and the sugar content does not decline rapidly after picking, so it remains sweet for several days after harvest. Kernels typically are not as tender as se corn. Supersweet types are grown for retail sales, local fresh markets, and wholesale shipping markets.

Some of the newest sweet corn varieties combine the sh2 with su and/or se genetics in new ways. Many of these new varieties have performed well in Midwestern trials and are gaining popularity. The new types are often identified by trademarked brand names and described as having enhanced eating quality. Consult with seed company representatives and sweet corn trial researchers to identify varieties suitable for your needs.

## Isolation Requirements

Sweet corn flavor is affected by pollen source. All sweet corn types should be isolated from field corn pollen by 250 feet or by a 14-day difference in tasselling dates. Supersweet (sh2) varieties must be similarly isolated from sugary and sugar-enhanced types. If not isolated, kernels of both varieties will be starchy instead of sweet.

It is not essential to isolate sugar-enhanced (se) sweet corn from sugary (su) sweet corn: cross-pollination will not result in starchy kernels. However, isolation permits the full expression of sugar-enhanced traits. Likewise, to get the full benefits of new genetics, isolation is usually recommended for the new combinations of sh2 and se or su. If complete isolation is not possible, plants should at least be isolated from pollen that will increase the proportion of starchy kernels. Refer to the table below for isolation requirements or check with your seed supplier.

To maintain color purity, isolate white corn from yellow or bi-color corn. Pollen from yellow or bi-color corn will cause some yellow kernels in white varieties. Pollen from yellow corn will lead to extra yellow kernels in bi-color varieties. Pollen from white corn will not affect yellow or bi-color varieties.

### Sweet Corn Isolation Requirements<sup>1</sup>

Corn Type or Brand	Isolate from these Types or Brands
Standard (su)	Shrunken-2, Xtra Tender, Gourmet Sweet
Sugar-enhanced (se)	Shrunken-2, Xtra Tender, Gourmet Sweet
TripleSweet, Synergistic	Shrunken-2, Xtra Tender, Gourmet Sweet
Shrunken-2 (sh2)	Standard, Sugar-enhanced, TripleSweet, Synergistic
Xtra Tender, Gourmet Sweet	Standard, Sugar-enhanced, TripleSweet, Synergistic

<sup>1</sup> Isolate all types from field corn.

## Spacing

Rows 30 to 40 inches apart. Plant early varieties 8 to 10 inches apart in the row, late varieties 9 to 12 inches apart in the row.

Seed 10 to 15 pounds per acre.



*The chlorotic (yellow) leaf streaks and the stunting of the sweet corn plant on the right are symptoms of Stewart's wilt.*

## Fertilizing

**Lime:** To maintain a soil pH of 6.0 to 6.5.

**Preplant N:** 60 pounds per acre. P<sub>2</sub>O<sub>5</sub>L 0 to 100 pounds per acre. K<sub>2</sub>O: 0 to 150 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. For early season varieties, apply a starter fertilizer at planting. Do not exceed 80 to 100 pounds of N + K<sub>2</sub>O per acre in the fertilizer band (2 inches to the side of the row and 2 inches below the seed). A good starter fertilizer would be 200 pounds per acre of 6-24-24, or 10 gallons of 10-34-0 or similar

analysis. On sandy soils, broadcast 30 pounds or band 15 pounds of sulfur per acre.

**Sidedress N:** For loam or finer textured soils, apply 30 to 40 pounds N per acre when plants are 4 to 5 inches tall, and before they are 10 inches tall. If the soil organic matter content exceeds 3 percent and/or sweet corn follows a legume, this sidedressed N application could be skipped unless there has been excessive rainfall. For irrigated sandy loam soils along river areas, the N preplant application should be replaced with two sidedressings of approximately 40 pounds N per acre each: one when 4 to 5 inches tall (4th to 5th leaf), and the other at 10 inches tall (10th to 12th leaf).

## Disease Control

Diseases Controlled	Treatment	Comments
Anthracnose	Amistar® at 3-5 oz. per acre.	Do not apply Amistar® more than once before alternating to a fungicide with a different mode of action. 7-day PHI.
	Headline® at 6-12 fl. oz. per acre.	7 -day PHI.
	Quadris Flowable® at 9-15.5 fl. oz. per acre.	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. 7-day PHI.
“Helminthosporium” Leaf Blight	Plant resistant varieties <sup>1</sup> .	
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled at various rates.	Do not apply chlorothalonil to sweet corn to be processed. Do not feed treated forage to livestock. 14-day PHI.
	Folicur 3.6F® at 4-6 fl. oz. per acre.	7-day PHI.
	Headline® at 6-12 fl. oz. per acre.	7 -day PHI.
	Several formulations of mancozeb (e.g., Dithane®, Manzate®, Penncozeb®) and maneb (e.g., Maneb® and Manex®) are labeled at various rates.	7-day PHI.
	Propimax® at 2-4 fl. oz. per acre.	Begin applications when disease first appears. Repeat at 7-14 day intervals. Do not exceed 16 fl. oz. per acre per season. 14-day PHI.
	Quadris Flowable® at 6-15.5 fl. oz. per acre.	Do not apply Quadris® more than once before alternating to a fungicide with a different mode of action. 7-day PHI.
	Quilt® at 7-14 fl. oz. per acre.	Do not make more than 1 application of Quilt® (or any other group 11 fungicide) per year. 14-day PHI.
Tilt® at 2-4 fl. oz. per acre.	Begin applications when disease first appears. Repeat at 7-14 day intervals. Do not exceed 16 fl. oz. per acre per season. 14-day PHI.	
Rust	Plant rust-resistant hybrids <sup>1</sup> .	A new race of the rust fungus capable over overcoming resistance in many sweet corn hybrids has been observed in the Midwest for the past several years. Sweet corn hybrid resistance to rust will depend on the hybrid’s particular Rp-resistant gene, its general (background) resistance, and the race(s) of the rust fungus prevalent in the planting.
	Amistar® at 2-3 oz. per acre.	Do not apply Amistar® more than once before alternating to a fungicide with a different mode of action. 7-day PHI.
	Several chlorothalonil formulations (e.g., Bravo®, Echo®, Equus®) are labeled for use at various rates.	Do not apply chlorothalonil to sweet corn to be processed. Do not feed treated forage to livestock. 14-day PHI.
	Folicur 3.6F® at 4-6 fl. oz. per acre.	7-day PHI.

Diseases Controlled	Treatment	Comments
Rust (continued)	Headline® at 6-12 fl. oz. per acre.	7-day PHI.
	Several formulations of mancozeb (e.g., Dithane®, Manzate®, Penncozeb®) and maneb (e.g., Maneb®, Manex®) are labeled for use at various rates.	7-day PHI.
	Propimax EC® at 4 fl. oz. per acre.	Begin applications when rust pustules first appear. Repeat at 7-14 day intervals. Do not apply more than 16 fl. oz. per acre per season. 14-day PHI.
	Quadris Flowable® at 6-15.5 fl. oz. per acre.	Do not make more than 1 sequential applications of Quadris® before alternating to a fungicide with a different mode of action. 7-day PHI.
	Quilt® at 10.5-14 fl. oz. per acre.	Do not make more than 1 application of Quilt® (or any other group 11 fungicide) per year. 14-day PHI.
	Tilt® at 4 fl. oz. per acre.	Begin applications when rust pustules first appear. Repeat at 7-14 day intervals. Do not apply more than 16 fl. oz. per acre per season. 14-day PHI.
Smut	Some hybrids tend to have fewer smut infections; growers should use past experience to choose successful hybrids. Avoid mechanical damage to corn plants.	Growers should attempt to avoid plant stresses that would affect pollen production and silk emergence.
Stewart's Wilt	Plant wilt-resistant hybrids¹.	
	Use an insecticide or seed treatment to control flea beetles.	Insecticide treatments are more likely to be necessary in seasons following a mild winter.
Virus Diseases (Maize Dwarf Mosaic, Chlorotic Dwarf, Wheat Streak Mosaic)	Plant resistant or tolerant varieties¹.	
	Control Johnsongrass and volunteer wheat.	

¹For an up-to-date list of sweet corn hybrid reactions to prevalent diseases, visit the University of Illinois' Sweet Corn Disease Nursery Web site, [www.sweetcorn.uiuc.edu](http://www.sweetcorn.uiuc.edu). Or refer to the Purdue Extension bulletin, *Midwest Vegetable Variety Trial Report for 2008*, available from The Education Store at [www.extension.purdue.edu/store](http://www.extension.purdue.edu/store).

## Atrazine Restrictions

Many herbicides labeled for corn contain atrazine. Observe the following restrictions on atrazine from all sources:

1. On highly erodible soils with low residue, do not apply more than 1.6 lbs. a.i. atrazine per acre before corn emerges.
2. On all soils, do not apply more than 2 lbs. a.i. atrazine per acre in one application.
3. On all soils, do not apply more than 2.5 lbs. a.i. atrazine per acre per year.
4. Check [www.atrazine-watershed.info](http://www.atrazine-watershed.info) or call (800) 365-3014 for additional local restrictions on the use of any material containing atrazine.

## Weed Control

Weeds Controlled¹	Treatment²	Comments
Annuals (emerged) — treatment applied before crop emergence or crop protected from spray	Gramoxone Inteon 2L® at 2-4 pts. per acre, or Gramoxone Max 3L® at 1.3-2.7 pts. per acre.	Use 1 qt. COC or 4-8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply before or after seeding but before crop emerges. Or use 0.7 to 1.3 pts. of Gramoxone Max 3L® (1-2 pts. of Gramoxone Inteon 2L®) and apply between rows using hooded or shielded sprayers, or wait until corn is over 10 in. tall and apply between rows using directed spray that reaches no higher than 3 in. up the corn stalk. Corn plants contacted by spray may be injured or killed. <b>RUP.</b>
Annuals and Perennials (emerged) — crop not present or protected from spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations containing 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs. potassium salt/gal.) at 0.66-3.3 qts. per acre.	Broadcast before or after seeding but before crop emerges; or after corn is 12 in. tall, apply up to 0.75 lb. ae between crop rows with hooded sprayers. Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. 7-day PHI.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and some Grasses (not emerged or newly emerged)	Atrazine products at 1-2 lbs. active ingredient (a.i.) per acre. Use 4L formulations at 1-2 qts. per acre, or 90W formulations at 1.1-2.2 lbs. per acre.	To control emerged weeds, include 1 qt. of COC per acre. Apply before planting and incorporate, after planting before corn emerges, or after emergence before corn is 12 in. tall. Potential for carryover in soil and injury to following crops. Consult label for details. Do not exceed 1.6 lbs. a.i. per acre before corn emerges on highly erodible soils with low residue; do not exceed 2.5 lbs. a.i. total per acre per year. <b>RUP.</b>
	Bicep II Magnum <sup>®</sup> at 1.3-2.6 qts. per acre, or Bicep Lite II Magnum <sup>®</sup> at 0.9-2.2 qts. per acre.	Use low rates on coarse soils with low organic matter. Apply before planting and incorporate, or after planting before corn emerges, or after emergence before corn is 5 in. tall. May also be applied as a directed spray between rows when corn is 5-12 in. tall. Bicep II Magnum <sup>®</sup> contains 3.1 lbs. of atrazine and 2.4 lbs. of s-metolachlor per gallon. Bicep Lite II Magnum <sup>®</sup> contains 2.67 lbs. of atrazine and 3.33 of lbs. s-metolachlor per gallon. Do not exceed 3.2 qts. of Bicep II Magnum <sup>®</sup> or 3.75 qts. of Bicep Lite II Magnum <sup>®</sup> per acre per year if no other atrazine or s-metolachlor products are applied. 30-day PHI. <b>RUP.</b>
	Guardsman Max <sup>®</sup> at 2.5-4.6 pts. per acre.	Use low rates on coarse soils with low organic matter. Apply before planting and incorporate, or after planting before corn emerges, or after emergence before corn is 12 in. tall. Rates may be reduced by 1-1.5 pts. if corn will be cultivated or full-season control is not needed. Contains 3.3 lbs. of atrazine and 1.7 lbs. of dimethenamid-P per gallon. Do not exceed 4.6 pts. Guardsman Max <sup>®</sup> per acre per year if no other atrazine or dimethenamid products are applied. 50-day PHI. <b>RUP.</b>
Broadleaves (not emerged or emerged) and Grasses (not emerged)	Camix <sup>®</sup> at 2 or 2.4 qts. per acre.	Use low rate on soils with organic matter less than 3%. Apply up to 14 days before planting or apply after planting before corn emerges. To control emerged broadleaves include COC at 1% v/v or nonionic surfactant at 0.25% v/v. Note organophosphate insecticide precautions. Camix <sup>®</sup> contains 3.34 lbs. s-metolachlor and 0.33 lb. mesotrione per gallon. Lexar <sup>®</sup> contains 1.74 lbs. s-metolachlor, 0.224 lb. mesotrione and 1.74 lb. atrazine per gallon. Lumax <sup>®</sup> contains 2.68 lbs. s-metolachlor, 0.268 lb. mesotrione and 1 lb. atrazine per gallon. Do not use if other products containing mesotrione (e.g., Callisto <sup>®</sup> ) or topramezone (e.g., Impact <sup>®</sup> ) have been or will be applied the same growing season. Do not exceed 2.4 qts. of Camix <sup>®</sup> , 3.5 qts. of Lexar <sup>®</sup> , or 3 qts. of Lumax <sup>®</sup> per acre per year.
	Lexar <sup>®</sup> at 3 or 3.5 qts. per acre. <b>RUP.</b>	
	Lumax <sup>®</sup> at 2.5 or 3 qts. per acre. <b>RUP.</b>	
Broadleaves and Grasses (not emerged)	Acetochlor products including: Degree 3.8ME <sup>®</sup> at 2.75-5.5 qts. per acre. Harness 7EC <sup>®</sup> at 1.5-3.0 pts. per acre. Surpass 6.4EC <sup>®</sup> at 1.5-3.75 pts. per acre. TopNotch <sup>®</sup> at 2-3 qts. per acre. Degree Xtra <sup>®</sup> (acetochlor + atrazine 2.7 + 1.34 ai) at 2.9-3.7 qts. per acre. FullTime <sup>®</sup> (acetochlor + atrazine 2.4 + 1.6 ai) at 2.5-5.0 qts. per acre. Harness Xtra 5.6L <sup>®</sup> (acetochlor + atrazine 3.1 + 2.5 ai) at 1.4-3 qts. per acre. Harness Xtra <sup>®</sup> (acetochlor + atrazine 4.3 + 1.7 ai) at 1.8-3.3 qts. per acre. Keystone <sup>®</sup> (acetochlor + atrazine 3.0 + 2.25 ai) at 2.2-3.4 qts. per acre, or Keystone LA <sup>®</sup> (acetochlor + atrazine 4.0 + 1.5 ai) at 1.6-3.0 qts. per acre.	Do not apply postemergence. Use lower rates on coarse soils with low organic matter. Apply before planting and incorporate, or apply after planting before sweet corn emerges. May be mixed with atrazine or simazine. See label for details. Do not apply to light textured soils specified in the label where ground water is at 30 ft. or less. <b>RUP.</b>

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and Grasses (not emerged) (continued)	Alachlor products containing 4 lbs. active ingredient per gallon at 2-3.25 qts. per acre.	Use lower rates on coarse soils with low organic matter. Apply before planting and incorporate, or apply after planting before corn emerges. May be mixed with atrazine, see label for details. <b>RUP.</b>
	Define 60DF <sup>®</sup> at 12-21 oz. per acre, or Define SC <sup>®</sup> at 15-25 fl oz. per acre.	Do not apply postemergence. Use lower rates on coarse soils with low organic matter. Apply before planting and incorporate, or apply after planting before sweet corn emerges. May be tank-mixed with atrazine or simazine. See labels for details.
	Dual Magnum <sup>®</sup> or Dual II Magnum <sup>®</sup> at 1-2 pts. per acre.	Use lower rate on coarse soils. Apply before planting and incorporate, or apply after planting before corn emerges. May also be applied as a directed spray between rows when corn is 5-40 in. tall. Incorporate to control nutsedge. May be mixed with atrazine, see label for details. Do not exceed 3.9 pts. per acre per year.
	Frontier <sup>®</sup> at 1-2 pts. per acre.	Use lower rate on coarse soils low in organic matter. Apply before planting and incorporate, or after planting before corn emerges, or after emergence before corn is 12 in. tall. Apply preemergence for best activity. Do not exceed 2 pts. of Frontier <sup>®</sup> or 21 fl. oz. of Outlook <sup>®</sup> per acre per year. 50-day PHI.
	Outlook <sup>®</sup> at 10-21 fl. oz. per acre.	
	Prowl 3.3EC <sup>®</sup> at 1.8-4.8 pts. per acre, or Prowl H <sub>2</sub> O <sup>®</sup> at 2- 4 pts. per acre.	Use low rates on coarse soils with low organic matter. Apply after planting before corn emerges, or after emergence until corn is 20-24 in. tall or shows 8 leaf collars. Plant corn at least 1.5 in. deep and make sure seed is well covered. Use drop nozzles and directed spray for post applications if necessary to get spray to soil. Do not apply both pre- and postemergence.
Broadleaves (not emerged or emerged)	Callisto <sup>®</sup> at the following rates: <b>Preemergence:</b> 6-7.7 fl. oz. per acre. <b>Postemergence:</b> 3 oz. per acre.	Processing and fresh market varieties. Some varieties may be severely injured. To control emerged weeds use a nonionic surfactant at 0.25% v/v or COC at 1.0% v/v. Adding nonionic surfactant preferred over COC to reduce crop injury, COC will improve weed control under dry conditions. Do not add UAN or AMS. Adding atrazine PRE at 0.75 or POST at 0.25 to 0.5 lb a.i. per acre will improve weed control. Peas are very sensitive to Callisto <sup>®</sup> , observe rotation and drift management recommendations. Note organophosphate insecticide precautions. Not recommended if products containing mesotrione (e.g., Camix <sup>®</sup> , Lexar <sup>®</sup> , or Lumax <sup>®</sup> ) or topramezone (e.g., Impact <sup>®</sup> ) have been, or will be, applied to crop. Do not exceed 0.24 lb. mesotrione per acre per year (7.7 fl. oz. Callisto <sup>®</sup> ) from all sources. 45-day PHI.
Grasses (not emerged)	Define DF <sup>®</sup> at 12-21 oz. per acre.	Apply before planting with optional incorporation, after planting before corn emerges, or after emergence before corn shows 6 leaf collars. Sweet corn varieties may vary in response to Define <sup>®</sup> . Do not exceed 21 oz. per acre per season.
Grasses and Nutsedge (not emerged)	Eradicane 6.7E <sup>®</sup> at 4.75-7.33 pts. per acre.	Apply before planting and incorporate in same operation if possible. Must be incorporated to prevent loss of herbicide due to volatilization. May be tank-mixed with atrazine for broadleaf control.
	Sutan+ 6.7E <sup>®</sup> at 4.75-7.33 pts. per acre.	Apply before planting and incorporate immediately.

**Sweet Corn** (continued)  
Weed Control (continued)

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and Nutsedge (emerged)	Bentazon products at 0.75-1 lb. a.i. per acre. Use 4L formulations at 0.75-1 qt. per acre.	Use 1 qt. of COC per acre. Apply to small weeds. Do not apply to corn that is stressed because injury may result. Combine with atrazine to broaden weed control spectrum, or use the premix, Laddok <sup>®</sup> .
	Laddok S-12 <sup>®</sup> at 1.33-2.33 pts. per acre.	Use 1 qt. of COC per acre. Apply when sweet corn has 1-5 leaves and is less than 12 in. tall. Contains 2.5 lbs. bentazon and 2.5 lbs. atrazine per gal. Do not exceed 2.33 pts. per acre per year — less if other bentazon or atrazine products are used. <b>RUP.</b>
Broadleaves and Grasses (emerged)	See also: treatments under Broadleaves and some Grasses (not emerged or newly emerged)	
Broadleaves (emerged)	2, 4-D amine formulations at 0.25-0.75 lb. a.i. per acre, or 4L formulations at 0.5-1.5 pts. per acre.	Use lower rates on annual weeds and higher rates on perennial weeds in the bud stage. Use drop nozzles if corn is more than 8 in. tall. Do not apply to open whorls or within 2 weeks of teasel through harvest. Avoid drift onto other vegetable crops. Can cause severe injury to some varieties.
	Aim EC <sup>®</sup> at 0.5 fl. oz. per acre.	Use 8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply to weeds up to 4 in. tall and apply up to the 14 leaf-collar stage of sweet corn. To reduce injury, the label requires using drop nozzles or other directed sprayers to minimize application to the whorl. Do not exceed 2 fl. oz. of Aim EC <sup>®</sup> per acre per season.
	Cadet <sup>®</sup> at 0.6-0.9 fl. oz. per acre.	Apply from 2 collars to tasseling. Controls velvetleaf and several other broadleaves. Add COC or nonionic surfactant. Do not exceed 1.25 fl. oz. per acre per year. 40-day PHI.
	Impact <sup>®</sup> at 0.75 fl. oz. per acre.	Use 2-3 pt. of methylated seed oil or COC and 2.5-5 pts. of urea ammonium nitrate (UAN) or ammonium phosphate (10-34-0) per 25 gallons of spray solution. Not recommended if products containing mesotrione have been or will be applied to crop. Do not exceed 0.75 fl. oz. per acre per season. 45-day PHI.
Broadleaves (emerged) — primarily composites and nightshade	Stinger 3L <sup>®</sup> at 0.33-0.66 pt. per acre.	Spray on actively growing weeds before corn is 18 in. tall. Wait 21 days between applications. Do not exceed 0.66 pt. per crop per year. 30-day PHI.
Some Broadleaf Weeds (emerged) and Volunteer Potato (emerged)	Starane 1.5L <sup>®</sup> at 0.66 pt. per acre, or Starane Ultra 2.8L <sup>®</sup> at 0.4 pt., per acre.	Apply broadcast or as a directed spray to corn that has up to 4 fully exposed leaf collars. Use directed spray when corn is beyond the 4-leaf collar stage. For volunteer potato, can apply preplant to emerged potato followed by a second application postemergence to emerged potato. 31-day PHI.
Grasses and some Broadleaves (emerged)	Accent 75DG <sup>®</sup> at 0.33-0.66 oz. per acre.	Use 1 qt. of COC or 8 fl. oz. of nonionic surfactant per 25 gallons of spray solution. Apply broadcast or with drop nozzles on corn up to 12 in. or up to 5 leaf collars. For corn 12-18 in. tall use drop nozzles. Do not apply to corn over 18 in. tall or showing 6 leaf collars or more. Cultivars differ in sensitivity to this herbicide; get information on cultivars prior to use. Not recommended for use on corn previously treated with Counter <sup>®</sup> , Lorsban <sup>®</sup> , or Thimet <sup>®</sup> insecticides.
	Option 35WDG <sup>®</sup> at 1.5-1.75 oz. per acre.	Apply with MSO at 1.5 pts. per acre with either AMS at 1.5-3 lbs. per acre, or UAN at 1.5-2 qts. per acre. Not recommended or precautions apply for use on corn previously treated with Counter <sup>®</sup> , Lorsban <sup>®</sup> , or Thimet <sup>®</sup> insecticides (see labels). 45 day PHI.

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Broadleaves and many grasses (emerged)	Impact 75DG® at 0.5 to 0.75 oz. per acre.	Apply with 1.0-1.5% v/v COC or MSO, with UAN at 1.25-2.5 % v/v, or with AMS at 8.5-17 lbs. per acre. Tank-mixing with atrazine will improve efficacy and spectrum of weed species controlled. Not recommended to be tank-mixed with, or applied sequentially to, products containing mesotrione (Callisto® products). 45 day PHI.
	Laudis 3.5SC® at 3 oz. per acre.	Apply with 1% v/v MSO + 8.5 lbs. of AMS per 100 gallons of spray solution. COC is less efficacious than MSO but can be used instead of MSO when broadleaves are the main target and conditions for control are excellent. Tank-mixing with atrazine will improve efficacy and spectrum of weed species controlled.
Grasses (emerged)	Poast® at 0.75 to 1.5 pt. per acre. <b>Apply ONLY to Poast Protected® varieties or crop will be killed.</b>	Use 1 pt. Dash®, 1.5 pts. MSO, or 2 pts. COC per acre. UAN or AMS optional, see label. For use only on Poast® tolerant sweet corn varieties — these are <b>not</b> transgenic (not GMO) varieties. May repeat applications up to 3.0 pts. Poast® total per acre per season. 30-day PHI.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects Controlled	Treatment	Comments
Corn Leaf Aphids	Heavy infestations of corn leaf aphids are often limited to early-season plantings that develop on late whorl to early-tassel sweet corn. During this time, several beneficial organisms (including, lady beetles, minute pirate bugs, and parasites) will keep these infestations in check. Although infestations can exceed 100 aphids per plant on more than 50% of the plants, pollination is rarely affected. Fresh market growers may need to spray to avoid aphid colonies on the husks or sticky honeydew (excreted by aphids) on the husks. Choose products that will control both caterpillar pests (corn earworm, European corn borer, fall armyworm) and aphids if both are a problem.	
	Lannate SP® at 0.25-0.5 lb. per acre.	Do not exceed 6.3 lbs. a.i. per acre per crop. 0-day PHI for ears. 3-day PHI for forage.
	PennCap-M® at 2-3 pts. per acre.	Do not exceed 12 pts. per acre per season. 5-day PHI.
Corn Rootworms	Aztec 2.1G® at 6.7 oz. per 1,000 linear ft. of row.	Apply in a 7-inch band over the row and behind the planter shoe in front of the press wheel.
	Brigade 2EC® at 0.3 fl. oz. per 1,000 linear ft. of row.	Apply in a minimum of 3 gallons of finished spray as a 5-7 inch band over an open seed furrow (T-band). Do not exceed 0.1 lb. a.i. per acre per season at plant application. 30-day PHI.
	Counter 15G® at 6-8 oz. per 1,000 linear ft. of row.	If few or no rootworm beetles were present in the field the previous year, then there is little chance of a damaging infestation. If sweet corn was grown in the field the previous year and a regular spray schedule was followed during silking, then there is little chance of a damaging infestation. Do not exceed 1 application per acre per crop.
	Force 3G® at 4-5 oz. per 1,000 linear ft. of row.	Apply as a T-band or in furrow. Do not exceed 1 application per crop.
	Fortress 5G® at 3.0-4.5 oz. per 1,000 linear ft. of row.	Apply as a T-band over the row or in furrow at planting. Do not exceed 1 application per acre per season.
	Lorsban 15G® at 8 oz. per 1,000 linear ft. of row.	If few or no rootworm beetles were present in the field the previous year, then there is little chance of a damaging infestation. If sweet corn was grown in the field the previous year and a regular spray schedule was followed during silking, then there is little chance of a damaging infestation. Do not exceed 13 lbs. per acre per crop.

**Sweet Corn** (continued)  
Insect Control (continued)

Insects Controlled	Treatment	Comments
Corn Rootworms (continued)	Mocap 15G® at 8 oz. per 1,000 linear ft. of row.	Do not exceed 1 application per acre per crop. Do not place in the furrow or in direct contact with the seed.
	Thimet 20G® at 4.5-6 oz. per 1,000 linear ft. of row.	
Corn Rootworm Adults	Any of the insecticides labeled for control of European corn borers, corn earworms, or fall armyworms except Intrepid®, Entrust®, and SpinTor® will also control corn rootworm adults.	Corn rootworm adults may prevent pollination by feeding on green silks. Treat when silks are being clipped.
Cutworms	Ambush 25W® at 6.4-12.8 oz. per acre.	Do not exceed 1.2 lbs. a.i. per acre per season. 1-day PHI.
	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not exceed 0.5 lb. a.i. per acre per season. 1-day PHI.
	Baythroid 2E® at 0.8-1.6 fl. oz. per acre.	Do not exceed 28 fl. oz. per acre per season. 0-day PHI.
	Brigade 2EC® at 2.1-6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 1-day PHI.
	Lorsban 4E® at 1-2 pts. per acre.	Most effective when soil is moist. If ground is dry, cloddy, or crusty, shallow incorporation before (or soon after) treatment may improve control. 35-day PHI.
	Mustang MAX® at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 3-day PHI.
	Pounce 25WP® at 6.4-12.8 oz. per acre.	Do not exceed 1.2 lbs. a.i. per acre per season. 1-day PHI.
	Warrior® at 1.92-3.2 fl. oz. per acre.	Do not exceed 3.84 pts. per acre per season. 1-day PHI.
European Corn Borers, Corn Earworms, Fall Armyworms	Ambush 25W® at 6.4-12.8 oz. per acre.	Do not exceed 1.2 lbs. a.i. per acre per season. Control is poor when temperatures are above 90°F. 1-day PHI.
<b>Thresholds</b> <i>European Corn Borers</i> More than 10 moths per night in a black light traps while corn is in late whorl stage <i>Corn Earworms</i> More than 10 moths per night in pheromone traps while green silks are present <i>Fall Armyworms</i> Moths being caught in pheromone traps or larval damage present while corn is in late whorl stage	Asana XL® at 5.8-9.6 fl. oz. per acre. <b>Corn earworms only.</b>	Do not exceed 0.5 lb a.i. per acre per season. 1-day PHI.
	Baythroid 2E® at 1.6-2.8 fl. oz. per acre.	Do not exceed 28 fl. oz. per acre per season. 0-day PHI.
	Belt SC® at 2-3 fl. oz. per acre.	Do not exceed 12 fl. oz. per acre per season. 1-day PHI.
	Brigade 2EC® at 2.1-6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 1-day PHI.
	Entrust® at 0.5-2 oz. per acre.	More effective for European corn borers than corn earworms. Do not exceed 9 oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
	Intrepid 2F® at 4-8 fl. oz. per acre. <b>European corn borers only.</b>	Do not exceed 64 fl. oz. per acre per season. 3-day PHI.
	Lannate SP® at 0.25-0.5 lb. per acre. <b>European corn borers only.</b>	Do not exceed 6.3 lbs. a.i. per acre per crop. 0-day PHI for ears. 3-day PHI for forage.
	Larvin 3.2® at 20-30 fl. oz. per acre.	Do not exceed 300 fl. oz. per acre per season. 0-day PHI.
	Mustang MAX® at 2.8-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 3-day PHI.
	PennCap-M® at 2-3 pts. per acre. <b>European corn borers only.</b>	Do not exceed 12 pts. per acre per season. 5-day PHI.



Insects Controlled	Treatment	Comments
European Corn Borers, Corn Earworms, Fall Armyworms <b>(continued)</b>	Pounce 25WP® at 6.4-12.8 oz. per acre.	Do not exceed 1.2 lbs. a.i. per acre per season. Control is poor when temperatures are above 90°F. 1-day PHI.
<b>Thresholds</b> <i>European Corn Borers</i> More than 10 moths per night in a black light traps while corn is in late whorl stage <i>Corn Earworms</i> More than 10 moths per night in pheromone traps while green silks are present <i>Fall Armyworms</i> Moths being caught in pheromone traps or larval damage present while corn is in late whorl stage	Radiant SC® at 3-6 fl. oz. per acre.	Do not exceed 6 applications per season. 1-day PHI.
	Sevin XLR PLUS® at 1.5-2 qts. per acre.	Do not exceed 8 applications or 16 qts. per acre per season. 2-day PHI.
	SpinTor 2SC® at 1.5-6 fl. oz. per acre.	More effective for European corn borers than corn earworms. Do not exceed 29 fl. oz. per acre per season. Observe resistance management restrictions. 1-day PHI.
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 3.84 pts. per acre per season. 1-day PHI.
Flea Beetles	Plant resistant varieties.	Use varieties that are resistant to Stewart's wilt <sup>1</sup> , which is vectored by flea beetles.
	Ambush 25W® at 6.4-12.8 oz. per acre.	Do not exceed 1.2 lbs. a.i. per acre per season. 1-day PHI.
	Asana XL® at 5.8-9.6 fl. oz. per acre.	Do not exceed 0.5 lb. a.i. per acre per season. 1-day PHI.
	Brigade 2EC® at 2.1-6.4 fl. oz. per acre.	Do not exceed 12.8 fl. oz. per acre per season. 1-day PHI.
	Lannate SP® at 0.25-0.5 lb. per acre.	Do not exceed 6.3 lbs. a.i. per acre per crop. 0-day PHI for ears. 3-day PHI for forage.
	Lorsban 4E® at 1-2 pts. per acre.	Do not exceed 15 pts. per acre per crop. 35-day PHI.
	Mustang MAX® at 2.24-4.0 fl. oz. per acre.	Do not exceed 0.15 lb. a.i. per acre per season. 3-day PHI.
	PennCap-M® at 2-3 pts. per acre.	Do not exceed 12 pts. per acre per season. 5-day PHI.
	Pounce 25WP® at 6.4-12.8 oz. per acre.	Do not exceed 1.2 lbs. a.i. per acre per season. 1-day PHI.
	Sevin XLR PLUS® at 1-2 qts. per acre.	Do not exceed 8 applications or 16 qts. per acre per season. 2-day PHI.
Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 3.84 pts. per acre per season. 1-day PHI.	
Seedcorn Maggots, Seedcorn Beetles, Wireworms	Plant seed that has been treated with an insecticide prior to planting. Use diazinon, a diazinon-lindane combination, or Cruiser®. Follow label directions.	Although most sweet corn seed has been treated with a fungicide, it is seldom treated with an insecticide to prevent seed and seedling damage.
	Brigade 2EC® at 0.15-0.3 fl. oz. per 1,000 linear ft. of row.	Apply in furrow or T-band. May be applied in conjunction with pop-up fertilizers. Also controls cutworms and grubs. Do not exceed 0.1 lb. a.i. per acre per season at plant application. 30-day PHI.
	Fortress 5G® at 3-3.75 oz. per 1,000 linear ft. of row.	Apply as a T-band over the row or in furrow at planting. Do not exceed 1 application per acre per season.

## Monitoring European Corn Borer and Corn Earworm

One of the keys to successfully managing European corn borers and corn earworms on sweet corn is to determine when the insects are active. European corn borers can be monitored effectively with blacklight traps and field observations, and corn earworms can be monitored with pheromone traps. When moths are being caught in the traps, it means they are laying eggs.

Corn borer eggs are laid on leaves, usually on the undersides, in the region of the ear. Larvae feed on the leaves and later may migrate to the ears (if present).

Corn earworm moths lay their eggs directly on green silks. The larvae that hatch from those eggs will follow the silks down into the tips of the ears.

Because these two insects' egg laying behavior differ, control strategies also differ. Corn borers can be controlled by spraying during the late whorl, tasselling, and silking stages. The migrating larvae should contact a lethal dose of insecticide while moving to the ear zone. Corn earworms must be controlled by directing sprays at the silks so larvae will immediately contact the insecticide after hatching.

For corn borers, treat during the late whorl stage if 20 percent or more of the plants show larval feeding. The presence

of large numbers of moths in light traps also justifies treatment. One application during the late whorl stage, followed by additional treatments every five days up until seven days of harvest, usually provides adequate control.

For corn earworms, treatment is justified if fresh green silks are present and moths are being caught in pheromone traps. In general, the higher the moth catches, the shorter the interval between sprays. If fewer than five moths are being caught per night, a five-day spray interval should be adequate. As moth catches approach 50 to 100 per night, a two- to three-day spray interval would be more appropriate. Determining the spray interval exactly depends on many factors, including how much damage you can tolerate, the crop's value, and the cost and effectiveness of the insecticide. Stop treating for corn earworms when 90 percent of the silks are brown.

Obviously, growers should not treat separately for these two pests. Some of the insecticides recommended here are effective against both species. Choose insecticides that are more effective against the particular pest that is most prevalent at the time of application. If both pests are present, choose an insecticide that will adequately control both.

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## Sources of Traps

### Corn Earworm and European Corn Borer Traps

**Bob Poppeís Service**  
25738 N. 3200 East  
Lexington, IL 61753  
(309) 275-5477

**Pheromones/Traps**  
**Gemplerís**  
P.O. Box 270  
100 Countryside Drive  
Belleville, WI 53508  
(800) 382-8473  
www.gemplers.com

**Great Lakes IPM**  
10220 Church Road  
Vestaburg, MI 48891-9746  
(989) 268-5693  
www.greatlakesipm.com

**Insects Limited Inc.**  
16950 Westfield Park Road  
Westfield, IN 46074-9374  
(317) 896-9300  
www.insectslimited.com

**Pacific Biocontrol Corporation**  
620 E. Bird Lane  
Litchfield Park, AZ 85340  
(623) 935-0512 or (800) 999-8805  
www.pacificbiocontrol.com

**Scentry Biologicals, Inc.**  
610 Central Avenue  
Billings, MT 59102  
(800) 735-5323  
www.scentry.com

**Trece Incorporated**  
PO Box 129  
Adair, OK 74330  
(866) 785-1313  
www.trece.com

# Sweet Potato

Varieties	
Beauregard	Early, light red skin, orange flesh, increasingly popular
Centennial	Soft-fleshed type, orange skin
Covington	Orange-fleshed, smooth-skinned, rose-colored, 5-10 days later than Beauregard. Resistant to Fusarium wilt, southern root-knot nematode, and moderately resistant to streptomyces soil rot.
Hernandez	Copper skin, deep orange flesh
Julian	Deep orange, good quality (same as Centennial)
Nugget	Firm-fleshed type, orange skin, orange flesh, good quality, excellent keeper
For Trial	
Carolina Ruby	Dark red skin, orange flesh

## Plant Production

Select seed stock from high-yielding hills that are smooth, well-shaped, and free of diseases (scurf, internal cork, wilt, black rot) and insect injury. Where internal cork is present, obtain seed stock from suppliers who have cork-free stock. Store seed stock in new crates to avoid disease contamination. Seed potatoes should be at least 1.5 inches in diameter. One bushel of small- to medium-sized roots should produce 2,000 to 2,500 plants (slips) from three pullings.

Treating seed before planting with Mertect 340-F® will protect roots from infection by certain disease-causing organisms. Bed the seed stock in new, clean sand taken from upland banks or pits. Allow 10 to 12 square feet of bed area per bushel of seed. Maintain plant bed temperature at 75°F to 85°F.

## Planting and Spacing

Transplanting machines are available for mechanically planting sweet potato slips. Common spacing is 1 foot apart in the row, with rows 3 to 4 feet apart, depending upon the cultivating and harvesting equipment used. 14,520 slips per acre are required at the 1 foot by 3 feet spacing, while 10,890 are needed at the 1 foot by 4 feet spacing. Transplant only strong, stocky slips. Yields can be increased up to 100 bushels per acre by using strong transplants.

## Fertilizing

**Lime:** None usually necessary. Soil pH of 5.0 to 6.0 is satisfactory.

**Preplant:** N: 30 pounds per acre. P<sub>2</sub>O<sub>5</sub>: 0 to 75 pounds per acre. K<sub>2</sub>O: 0 to 250 pounds per acre. Adjust according to soil type, previous management, and soil test results for your state. Set the slips with a starter solution at the rate of 1 cup (8 ounces) per plant.

**Sidedress N:** None usually necessary on finer textured soils. On irrigated sands, sidedress with 30 to 50 pounds N per acre approximately 3 to 4 weeks after transplanting.

## Harvesting

Remove vines by cutting with a rotary mower. Dig only those potatoes that can be picked up immediately and not left out overnight. Temperatures below 50°F can chill potatoes and cause internal breakdown in storage. Potatoes will sunburn if left in direct sunlight for more than an hour. Field grading is important.

Prevent skinning and breaking. Use cotton gloves when placing potatoes in crates. Place well-shaped No. 1's with No. 2's, and cuts with culls.

## Storing

When the storage house is filled, raise the temperature to 85°F. Keep it at this temperature for 6 to 8 days, with 85 percent to 90 percent humidity for proper curing. After curing, the temperature may be gradually dropped to 55°F. Hold this temperature until potatoes are marketed or used for producing slips.

## Disease Control

Diseases Controlled	Treatment	Comments
Black Rot, Foot Rot, Fusarium Wilt, and Scurf	Plant disease-free seed and/or resistant varieties.	
	Follow 3-4 year crop rotations. Prevent bruising and maintain proper storage temperatures.	
	Dip roots or sprouts in Mertect 340F® at 8 fl. oz. per 7.5 gal. water.	Dip roots and sprouts in Mertect® solution for 2 minutes, and plant immediately. Do not use treated roots for food or feed.
Storage Rots	Fumigate storage boxes.	Cure and store only healthy, blemish-free tubers.

## Weed Control

Weeds Controlled <sup>1</sup>	Treatment <sup>2</sup>	Comments
Annuals and Perennials (emerged) — crop not present or protected from spray	Glyphosate products at 0.75-3.75 lbs. acid equivalent (ae) per acre. Use formulations of 3 lbs. ae/gal. (4 lbs. isopropylamine salt/gal.) at 1-5 qts. per acre, or formulations containing 4.5 lbs. ae/gal. (5 lbs potassium salt/gal.) at 0.66-3.3 qts. per acre.	Broadcast before planting, or apply between crop rows with wipers or hooded or shielded sprayers. Use low rate for annuals and higher rates for perennials. See label for suggested application volume and adjuvants. 14-day PHI.
Broadleaves and Grasses (not emerged)	Command 3ME® at 1.3-4 pts. per acre.	Use low rate on coarse soils. Apply before planting, or apply up to 1.5 pts. per acre after transplanting and before weeds emerge. 95-day PHI for rates up to 3.3 pts. per acre. 125-day PHI for rates more than 3.3 pts. per acre.
Broadleaves (not emerged)	Valor SX® at 2 oz. per acre.	Apply 2-5 days before transplanting. Do not use on greenhouse grown transplants, or on transplants harvested more than 2 days before transplanting. Do not use on varieties other than 'Beauregard' unless you have tested for phytotoxicity under your conditions. Do not exceed 2.5 oz. per acre per growing season.
Grasses (not emerged)	Dacthal W-75® at 6-14 lbs. per acre, or Dacthal Flowable® at 6-14 pts. per acre.	Apply at transplanting or layby. May be applied over the top of transplants.
Broadleaves (emerged)	Aim EC® at 0.5-2 fl. oz. per acre.	Apply with hooded sprayers as a directed application between crop rows. Use COC or nonionic surfactant. Weeds must be actively growing and less than 4 inches tall. Do not allow spray to contact crop. Do not exceed 6.1 fl. oz. per acre per season.
Grasses (emerged)	Fusilade DX 2E® at 10-12 fl. oz. per acre.	Use 1-2 pts. of COC or 0.5-1 pt. of nonionic surfactant per 25 gallons of spray solution. Apply to actively growing grass. Do not exceed 48 fl. oz. per acre per season. 55-day PHI.
	Poast 1.5E® at 1-1.5 pts. per acre	Use 1 qt. of COC per acre. Spray on actively growing grass. Do not exceed 5 pts. per acre per year. 30-day PHI.
	Select Max® at 12-32 fl. oz per acre, or Select 2EC® at 6-16 fl. oz. per acre.	Use 1 qt. of COC per 25 gallons of spray solution (1% v/v). Spray on actively growing grass. Wait at least 14 days between applications. Do not exceed 64 fl. oz. of Select Max®, or 32 fl. oz. of Select 2EC® per acre per season. 30-day PHI.

<sup>1</sup>For specific weeds controlled by each herbicide, check Table 19 on page 37.

<sup>2</sup>Rates given are for overall coverage. For band treatment, reduce amounts according to the portion of acre treated.

## Insect Control

Insects Controlled	Treatment	Comments
Aphids	Actara® at 3 oz. per acre.	Do not exceed 6 oz. per acre per season. 14-day PHI.
	Admire PRO® at 4.4-10.5 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. or 1 application per acre per season. 125-day PHI.
	Assail 70WP® at 1.0-1.7 oz. per acre.	7 day PHI.
	Movento® at 4-5 fl. oz. per acre.	7-day PHI.
	Platinum® at 5-8 fl. oz. per acre.	30-day PHI.
Colorado Potato Beetles	Actara® at 1.5-3 oz. per acre.	Do not exceed 6 oz. per acre per season. 14-day PHI.
	Assail 70WP® at 0.6-1.7 oz. per acre.	7-day PHI.
	Baythroid® at 1.6-2.8 fl. oz. per acre.	Do not exceed 16.8 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Rimon 0.83EC® at 9-12 fl. oz. per acre.	Do not exceed 24 fl. oz. or 2 applications per acre per season.
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 15.36 fl. oz. per acre per season. 7-day PHI.
Potato Leafhoppers	Actara® at 1.5-3 oz. per acre.	Do not exceed 6 oz. per acre per season. Control may require 2 applications at a 7-10 day interval. 14-day PHI.
	Admire PRO® at 4.4-10.5 fl. oz. per acre.	Do not exceed 0.38 lb. a.i. or 1 application per acre per season. 125-day PHI.
	Assail 70WP® at 0.6-1.7 oz. per acre.	7-day PHI.
	Baythroid® at 0.8-1.6 fl. oz. per acre.	Do not exceed 16.8 fl oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Mustang Max® at 1.76-4 fl. oz. per acre.	1-day PHI.
	Platinum® at 5-8 fl. oz. per acre.	30-day PHI.
	Warrior® at 2.56-3.84 fl. oz. per acre.	Do not exceed 15.36 fl. oz. per acre per season. 7-day PHI.
Wireworms, Flea Beetle Larvae	Baythroid® at 1.6-2.8 fl. oz. per acre. <b>Flea beetles only.</b>	Do not exceed 16.8 fl. oz. per acre per season. 0-day PHI. <b>RUP.</b>
	Lorsban 15G® at 13.5 lbs. per acre.	Evenly distribute granules over treated area. After application incorporate to a depth of 4-6 inches by rotary hoe or disc cultivator. Do not exceed 1 application per season. 125-day PHI.
	Lorsban 4E® at 4 pts. per acre, or Lorsban 75WG® at 2.67 lbs. per acre.	Apply to soil surface as a preplant broadcast spray. Incorporate immediately after application to a depth of 4-6 inches. Plant sweet potatoes no more than 14 days after treatment. Do not exceed 1 application per season. 125-day PHI.
	Platinum® at 5-8 fl. oz. per acre. <b>Seed treatment only.</b>	30-day PHI.

# Calibration of Application Equipment

Rate of application, granular and sprays, may vary with materials used. Equipment must be calibrated for each material applied to obtain accurate delivery. Here are suggested steps to calibrating three types of applicators.

## Boom Sprayer

1. Clean sprayer, and replace all worn or defective parts; fill tank with water.
2. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
3. Spray 1/4 acre (10,890 sq. ft.). Distance of travel will vary with boom width.

**For example, a 22 ft. boom must travel 495 ft. to cover 1/4 acre:**

$$\frac{1/4 \text{ acre (10,890 sq. ft.)}}{\text{Boom width (22 ft.)}} = \text{distance of travel (495 ft.)}$$

4. Measure amount of water needed to refill the tank. This amount was applied to the 1/4 acre; thus, four times this amount is the gallonage per acre.
5. Adjustment in gallonage may be made either by varying tractor speed or by changing nozzle size. Recalibrate after making an adjustment.
6. Calculate acres covered by tank of spray solution, and add required amount of pesticide for total area sprayed.

## Band Sprayer

1. Clean sprayer, and replace all worn or defective parts; fill tank with water.
2. Adjust spray pressure and speed of tractor for nozzle size and output using manufacturer's directions.
3. Spray 1/4 acre (10,890 sq. ft.). Distance traveled will vary with number of nozzles on the sprayer and width of the band sprayed by each nozzle.

**For example, spraying a 20-inch band over 4 rows using 1 nozzle per row requires 1630 ft. to cover 1/4 acre:**

$$\frac{1/4 \text{ acre (10,890 sq. ft.)}}{\text{Nozzles (4) x spray band width (1.67 ft.)}} = \frac{10,890 \text{ sq. ft.}}{6.68 \text{ ft.}} = \text{distance of travel (1630 ft.)}$$

4. Measure amount of water needed to refill the tank. This amount was applied to the 1/4 acre; thus, four times this amount is the gallonage per acre.
5. Adjustment in gallonage may be made either by varying tractor speed or by changing nozzle size. Recalibrate after making an adjustment.
6. Calculate acres covered by tank of spray solution, and add required amount of pesticide for total actual area to be band treated.

## Granular Band Applicator

1. Set applicator dial or dials to give desired delivery rate of granules suggested for band treatment according to manufacturer's instructions.
2. Fill hoppers with granules to be used.
3. Travel across field at planting speed for the distance required to cover 1/16 acre (2,722 sq. ft.) per row. Collect granules for each row in a bag, bucket, or other container.

**For example: granular band application for a 40-inch row requires 817 ft. to cover 1/16 acre:**

$$\frac{1/16 \text{ acre (2,722 sq. ft.)}}{\text{Row width (3.33 ft.)}} = \text{distance to travel (817 ft.)}$$

4. Weigh granules from each row separately, and multiply by 16 to find delivery per acre for each row.
5. Adjust each setting, and recalibrate until the desired delivery rate is obtained.



## Stay Current

For the most up-to-date version of this publication, visit:

[www.btny.purdue.edu/Pubs/ID/ID-56/](http://www.btny.purdue.edu/Pubs/ID/ID-56/)

Changes will be made throughout the year as they are received.

### Abbreviations Used in This Guide

<b>PHI</b>	Pre-Harvest Interval — the minimum allowable time in days between the latest pesticide application and crop harvest
<b>AI</b>	Active Ingredient
<b>COC</b>	Crop Oil Concentrate
<b>D</b>	dust formulation
<b>DF, DG</b>	dry flowable or water dispersible granule formulation
<b>E, EC</b>	emulsifiable concentrate
<b>F</b>	flowable formulation
<b>G</b>	granular formulation
<b>L, LC</b>	liquid concentrate formulation
<b>W, WP</b>	wettable powder formulation
<b>SC</b>	suspension concentrate
<b>RUP</b>	Restricted Use Pesticide

**Cover photos:** Sweet corn for processing and fresh market is an important crop in the Midwest. In 2007, Minnesota harvested 120,500 acres (nearly a third of the total U.S. acreage of processing sweet corn) and Illinois and Indiana harvested 12,000 acres of fresh market sweet corn worth more than \$24 million (*USDA Vegetables 2007 Summary*, January 2008). Improvements in sweet corn eating quality make this crop a continued favorite among growers and consumers.

Insect, disease, and weed control recommendations in this publication are valid only for 2009. If registration for any of the chemicals suggested is changed during the year since the time of publication (December 2008), we will inform all area and county Extension staff. If in doubt about the use of any chemical, check with your Extension agent or chemical company representative.

The information represented herein is believed to be accurate but is in no way guaranteed. The authors, reviewers, and publishers assume no liability in connection with any use for the products discussed and make no warranty, expressed or implied, in that respect, nor can it be assumed that all safety measures are indicated herein or that additional measures may be required. The user, therefore, must assume full responsibility, both as to persons and as to property, for the use of these materials including any which might be covered by patent. Always refer to the pesticide labels before each application. If the label information is different than the information presented in this guide, always follow the product label.



# Pesticide Emergency and Poison Control Centers

## Nationwide Emergency Number

**(800) 222-1222**

This number will automatically connect you to the poison center nearest you.

## Illinois

### Illinois Poison Center

222 S. Riverside Plaza, Suite 1900  
Chicago, IL 60606

**Emergency Number:** (800) 222-1222

**TDD/TTY:** (312) 906-6185

Web: [www.mchc.org/ipc](http://www.mchc.org/ipc)

Personnel at this number will give first aid instructions and direct callers to local treatment centers.

For immediate emergency treatment or ambulance service, always call 911.

## Indiana

### Indiana Poison Center

Methodist Hospital, Clarian Health Partners  
Interstate 65 at 21st Street  
Indianapolis, IN 46206-1367

**Emergency Number:** (800) 222-1222

**TTY/TDD:** (317) 962-2336

Fax: (317) 962-2337

Web: [www.clarian.org/poisoncontrol](http://www.clarian.org/poisoncontrol)

## Iowa

### Iowa Statewide Poison Control Center

Iowa Health Systems and the University of  
Iowa Hospitals and Clinics  
2910 Hamilton Boulevard Lower A  
Sioux City, IA 51104

**Emergency Number:** (800) 222-1222

**Local Number:** (712) 277-2222

**TTY:** (800) 222-1222

Web: [www.iowapoison.org](http://www.iowapoison.org)

## Kansas

### Mid-America Poison Control Center

University of Kansas Medical Center  
B400 KU Hospital  
3901 Rainbow Boulevard  
Kansas City, KS 66160-7231

**Emergency Number:** (800) 222-1222

**Kansas City Residents May Phone:** (913) 588-6633

**Emergency TDD:** (913) 588-6639

Web: [www.kumed.com/poison](http://www.kumed.com/poison)

## Minnesota

### Minnesota Poison Control System

Hennepin County Medical Center  
701 Park Avenue, Mail Code RL  
Minneapolis, MN 55415

**Emergency Number:** (800) 222-1222

**Local Number:** (612) 873-3141

**TTY:** (800) 222-1222

Web: [www.mnpoison.org](http://www.mnpoison.org)

## Missouri

### Missouri Regional Poison Center

7980 Clayton Road, Suite 200  
St. Louis, MO 63117

**Emergency Number:** (800) 222-1222

**In St. Louis:** (314) 772-5200

**TDD/TTY:** (314) 612-5705