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# Vegetable Production Guide for Commercial Growers, 2016-17





# 2016-17 Vegetable Production Guide for Commercial Growers

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Trade names are used to simplify information in this publication. No endorsement is intended, nor is criticism implied of similar products that are not named.

**This guide is for reference only:** The most recent product label is the final authority concerning application rates, precautions, harvest intervals, and other relevant information.

Contact your county Cooperative Extension Service agent if you need assistance.



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# Introduction

## Fruit and Vegetable Production and Marketing

Successful vegetable production generally requires the grower to make daily decisions regarding pest management, irrigation, and cultural practices. Would-be growers unwilling to make serious investments of time (and money) should not attempt to expand beyond a space at the farmers' market. It is important for vegetable growers to have a market outlet for their product before they choose to start production. Good marketing plans start with the customer and work backward to production. Potential growers should first determine exactly what buyers want, how they want it, and when they want it. They then must determine how these crops should be grown. Even selecting varieties and determining planting times are basic marketing decisions. Kentucky growers should pay particular attention to comparisons of marketing time required, compatibility with off-farm employment, and compatibility with tobacco production. Individual situations vary, and producers often must learn about their particular markets by starting small and getting a foot in the door.

## Marketing Options

**Direct Marketing.** Marketing directly to consumers includes sales at local farmers' markets, on-farm markets, roadside stands, farm festival markets, pick-your-own sites, or any combination of these methods. Direct marketing of vegetables has expanded considerably in Kentucky in recent years. Growers have gravitated to direct marketing because they have the flexibility to determine how much or little they wish to grow and, because they can often charge retail prices for their product, their per-acre revenue may be higher.

**On-Farm or Roadside (Tailgate) Markets.** These markets need not be elaborate but do need to be highly visible and located close to high-traffic areas for success. Direct marketing can also succeed in more remote locations but will require more advertising and promotion.

Many consumers in urban centers now consider visits to on-farm or farmers' markets recreational activities because people enjoy seeing farms and talking with farmers. Some growers have developed seasonal festival days and markets to satisfy this demand. Such "entertainment farming" and some other forms of direct

marketing require liability insurance coverage, large time commitments, and employees with friendly, courteous attitudes.

**Pick-Your-Own, or "U-Pick" Sales.** This type of direct marketing appears to be declining nationally because consumers have less time and energy available for harvesting produce. U-picks eliminate some of the harvesting, transportation, and marketing costs for growers but may require additional management, supervision, and liability insurance coverage.

**Local Town, County, or Community Farmers' Markets.** The number of registered farmers' markets has continued to grow in Kentucky. According to the Kentucky Department of Agriculture, over 159 markets were operating in Kentucky in 2015, representing over 2,500 different vendors from 106 different counties. Markets located in larger metropolitan areas tend to generate greater overall sales as well as greater per-vendor sales. These markets are probably the easiest way for new growers to sell small volumes of produce. Less marketing time is required, and individual growers do not usually bear all advertising and promotion costs. Farmers should check with their local county agents to determine what rules and regulations each market may have. Those producers wanting to market a processed food product should also check with the Departments of Agriculture and Public Health about the regulations governing the sale of processed food. In addition, the Kentucky Department of Agriculture has printed a farmers' market manual. An electronic version of this manual can be found at [kyagr.com/marketing/farmmarket](http://kyagr.com/marketing/farmmarket).

**Community Supported Agriculture (CSA).** Though the concept of community supported agriculture (CSA) began in Europe as early as the 1960s, it is still relatively new to many regions of the United States. Basically, a CSA consists of "shareholders" who pay a set fee to a grower or group of growers for a weekly supply of fresh vegetables during the growing season. Because the members of a CSA pay for their "subscription" at the beginning of a growing season, they share some of the risk with the farmer. As part of their agreement with the grower, members acknowledge that a poor harvest due to unfavorable weather or pests means their shares may be smaller than usual. By direct sales to community members, growers receive better prices for their crops and can gain some financial security. Shareholders often have a greater sense of community involvement, knowing that they are helping support local agriculture.

**Produce Auctions.** Produce auctions have been popular for small growers in some parts of Kentucky. Growers bring produce to the auction facility, where it is sold to the highest bidder. The auction company (sometimes a growers' organization) charges a flat commission of about 10 to 15 percent. Both large and small lots are accommodated at some auctions. At the large auctions, some of the bidders are operators of medium-to-large retail produce markets and stands.

**Marketing Cooperatives.** A marketing cooperative is just one form of indirect marketing in which the producer deals with an intermediary rather than the final consumer. Although most forms of indirect marketing require less time of individual growers, they usually demand more product uniformity, quality, and post-harvest care.

Grower-owned cooperatives or marketing associations are able to assemble truckloads of produce required by large customers, which would not be possible for small growers acting individually. Formally organized cooperatives also may provide technical assistance to growers and help secure seed, boxes, and other needed supplies. In some cases, specialized equipment is shared by growers.

Co-ops usually own and operate facilities with some combination of grading, packing, cooling, and storage equipment for their members. Members typically employ a manager to oversee the co-op's daily operations. There are several small growers' cooperatives with grading, packing, and cooling facilities in Kentucky. Co-ops can offer good marketing opportunities for new growers in counties near the co-op facilities. For long-term success it is advisable that rules requiring minimum standards for quality be set. Poor quality produce that is allowed into the co-op can depress profits for all those involved.

**Local Wholesalers, Grocers, and Restaurants.** Many potential buyers can be found among local wholesalers, grocery stores, and restaurants. Most metropolitan areas have produce wholesalers who can be dependable buyers of moderate volumes. Local grocery stores (and some chain stores) are sometimes willing to buy directly from growers through direct store deliveries (DSDs). DSDs often are possible with smaller grocery stores or chains but are discouraged by many larger chains.

Many restaurants buy from local or regional wholesalers. However, more and more of them (usually upscale establishments) are promoting locally grown

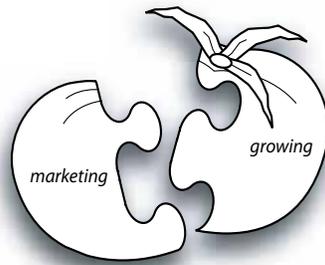
and seasonal items on their menus, so individual growers may be able to sell to them. Like most other forms of produce marketing, restaurant sales are based on good relationships developed over time.

**Regional Wholesalers, Chain Store Distribution Centers, and Brokers.** Marketing to regional wholesalers or large chain-store distribution centers requires consistent quality, often significant volumes, and in some cases, year-round supplies. These buyers often have specific and demanding requirements for product uniformity, types of containers, cooling, transportation, and delivery of fresh produce. In some cases, especially when supplies are plentiful, produce quality must exceed USDA grading standards. Increasingly, grower-shippers also are being asked to supply produce to their supermarket chain buyers with price-lookup (PLU) stickers already applied.

Larger buyers look for quality and consistency. They need good incentives to interrupt year-round supplies from other parts of the country to buy more local produce. Some chain store buyers will pay a premium for top-quality local produce.

Some growers use brokers to market produce. The brokers negotiate either purchases on behalf of the buyer or produce sales on behalf of the seller. Unlike wholesalers, brokers do not take delivery nor assume ownership (title) of the produce. Brokers usually never see what they are quoting for sale or negotiating to buy. Brokers charge a percentage commission on all sales or a flat rate for each carton of produce sold.

**Processors.** Nationwide consumption and demand for most canned and frozen vegetable products have been flat or declining. Much consolidation of production and processing vegetables has occurred in recent years, with most of the industry now located in California and a handful of northern states. No traditional vegetable processing companies are left in Kentucky.



*Vegetable marketing and production plans need to be developed simultaneously; the most successful growers put equal emphasis on growing and marketing their products.*

Several fresh-cut processors exist in the state and have indicated a desire to buy more products from within Kentucky. It is unlikely, however, that fresh-cut and other forms of processing will represent a significant market for Kentucky produce in the near future.

#### Getting Help

A number of organizations are working to create new marketing opportunities for Kentucky vegetable growers:

**Cooperative Extension Service.** Many county Extension agents know the production and marketing opportunities in their counties. They can provide vegetable production information and access to marketing and production specialists. In addition, county Extension offices can obtain information from produce industry directories such as *The Red Book* or *The Blue Book*. These publications list produce buyers by city and state and also include ratings for promptness of payment and other pertinent information.

**Kentucky Vegetable Growers Association.** This organization sponsors annual educational meetings (usually during the first week of January) that include special sessions on produce marketing. Ask your county Extension agent to put you on the mailing list for the annual meeting



*The Kentucky Department of Agriculture Office of Agricultural Marketing and Product Promotion supplies this logo to qualified growers and marketers.*

program and registration form. The KVGA Web site is [kyvga.org](http://kyvga.org).

**Kentucky Department of Agriculture (KDA).** The Kentucky Department of Agriculture Division for Value-Added Horticulture and Aquaculture maintains a directory of Kentucky vegetable growers, marketing cooperatives, and produce markets and is working to develop several new programs linking vegetable producers and buyers. The department also supplies the "Kentucky Proud" logo to qualified growers and marketers and administers the Kentucky organic certification program. See Appendix A for KDA Web site addresses.

**Kentucky Farm Bureau.** The Kentucky Farm Bureau's Certified Roadside/Farm Market Program can put your farm market on the map. Attractive brochures with your market location, featured products, and other details are made available at the state's welcome centers, at some state tourist attractions, and on the Internet. Contact your local Kentucky Farm Bureau office or see Appendix A for the Web site address.

**The Internet.** A wide variety of information on vegetable production and marketing is available on the Internet. Internet resources include Extension publications on how best to grow, harvest, cool, grade, and pack vegetable crops. Wholesale prices are also posted from markets around the country along with situation reports for certain crops. For some of the best Web sites for commercial vegetable growers, see Appendix A.

## General Production Considerations

### Variety Selection

Most of the varieties listed in this guide have been selected through extensive trialing at the University of Kentucky and on farms across the Commonwealth. The varieties have been selected because they have shown the ability to produce high yields while maintaining a uniform quality. Most of the varieties also have been

selected based on having some level of disease resistance. Judicious selection of resistant varieties can help growers reduce pesticide costs and increase profits. However, for many farmers selling direct retail, the absolute highest yield may not be as important as a particular quality attribute such as flavor or color. Keep in mind that the recommendations that are listed are simply that—recommendations. This means that these varieties have proven themselves have reliable performance, and should do well for those who grow them. However, the omission of a variety

does not mean it is necessarily a bad variety, just that we may not have enough information to recommend it.

### Plant Spacing

The plant spacings listed throughout this guide reflect the optimum growing conditions to produce maximum commercial yields of a given crop. However, many vegetable growers in Kentucky produce a wide variety of crops. Therefore, you may find yourself planting on a slightly different spacing than is recommended simply to make the crops you are growing

fit better into your production system. The "Plant Populations" table below lists the plant populations required per acre for a given row and in-row spacing.

### Drip Irrigation for Vegetable Crops

A good guideline for commercial vegetable production is "if you can't irrigate it, don't plant it." Droughts are not uncommon in Kentucky; the drought of 1999 was worse than severe droughts that occurred in 1988, 1954, and 1930. The high temperatures and dry conditions during the summer of 2012 meant the entire state was considered to be under "severe or extreme" drought conditions. No one should consider commercial vegetable production without 1) access to water for irrigation and 2) access to a good high-pressure sprayer for disease control (see the "Disease Management" section). Drip irrigation makes sense for many vegetable crops grown in Kentucky. It has become standard practice for growers wanting to participate in wholesale vegetable markets and cooperatives. High yields from drip irrigation help keep growers in business during years when produce supplies are plentiful and margins are lower than usual. Those able to increase yields with drip can often achieve good returns in spite of lower prices. Results from numerous on-farm demonstrations at the University of Kentucky and Kentucky State University have shown that yields are usually doubled (sometimes tripled) with drip compared to non-irrigated, rain-fed production.

Although drip is best used together with plastic mulch on crops such as tomatoes, peppers, melons, and squash, even bare-ground plantings can benefit from drip irrigation. Some Kentucky growers have rolled out drip tube on bare-ground plantings of cabbage, sweet corn, and pumpkins. This practice has often made the difference between having a crop and not having one.

### Water Resources

Water savings with drip are substantial—roughly half as much water can do the same or better job than a sprinkler system. A constant water source is essential. Even with water-saving drip, there are cases of water supplies drying up or being cut off in a drought year. County water has been used successfully by a number of growers in the state; it has been profitable in nearly all cases where it has been used. Other growers use streams, lakes, springs, or farm ponds. Several growers have constructed large farm ponds specifically for drip irrigation on vegetables. The

size of the pond is critical, because some vegetable crops use enormous volumes of water (see "Tomato Crop Water Usage" graphic on page 7).

### Installation and Equipment Costs

Contrary to popular opinion, drip irrigation is a relatively cheap and easy technology. It does not require an engineering degree or years of experience to install and operate a typical small-farm system. Costs for reusable equipment and components, together with annual disposable supplies, are about \$2,550 (see box, right) for a one-acre system, with an additional \$400 per-acre expense for each additional acre for systems up to about 10 acres in size. The \$400 per-acre annual costs are for disposable drip irrigation tube (often called drip "tape") and embossed black plastic mulch.

The most costly piece of farm equipment required is the plastic layer/bed shaper; this machine costs from around \$1,200 for a flatbed layer to about \$5,000 for a plastic layer plus bed shaper with hydraulic counter-sway. Plastic layers are now also for lower horsepower tractors. These smaller plastic layers require only 35 hp to be pulled and do a fine job. Most growers who are farming a limited acreage have found these bed shapers/layers to be a better choice than traditional bed shapers. The waterwheel setter that is commonly used for transplanting through plastic mulch costs about \$1,900-\$2,300. Mulch layers that also form raised beds will require considerably more tractor horsepower. Raised beds may not be necessary on well-drained ground where standing water does not occur.

To help introduce the technology and reduce costs, many counties have bought machinery to rent or loan to local farmers. In addition, UK Horticulture Department Extension associates and county Extension

#### DRIP IRRIGATION COSTS:

(for up to 5-acre system)

Item .....	Cost (2015)
2 in. centrifugal pump w/163cc engine.....	\$700
Filter, sand* (100 gpm).....	725
Single filter backflush valve.....	260
Fertilizer Injector.....	200
Layflat, 2" (300 ft. roll).....	105
Suction hose and strainer.....	95
Fittings, valves, gauges, etc.....	100
<b>Total (5-7 yrs. reusable).....</b>	<b>\$2,185</b>

#### Annual per-acre expenses

- 8-10 mil drip tape and black plastic mulch (1 mil, 4 ft wide): \$0.05/ft x 7,260 linear ft ~ \$400
- depreciation/rental costs on mulch layer and waterwheel setter

\*If using 2 sand filters a dual flush manifold adds \$170 over a single flush manifold.

sion offices conduct annual on-farm demonstrations that help new growers install small farm drip systems.

Setting up a small, low-pressure drip system involves more plumbing than engineering. Although most growers will need some experienced help with the initial layout and design specifications (pump sizes, filter, delivery line size, field zoning, etc.), actual installation and maintenance are very easy.

### System Components

A small drip system consists of:

- Water source
- Pump at the water source
- Check valve and/or backflow prevention valve<sup>1</sup> (for city water)
- Fertilizer injector
- Filter
- Pressure regulator and gauge
- Intake and delivery lines
- Drip tubes (drip tape)

<sup>1</sup>Growers using city water are required by law to install a more sophisticated backflow prevention device rather than a simple check valve. Most of the items listed are available from dealers in Kentucky. See your county Extension agent for a list of irrigation dealers in the state.

### PLANT POPULATIONS PER ACRE FOR A GIVEN ROW AND IN-ROW SPACING<sup>1</sup>

Row-spacing: center to center (inches)	In-row spacing (inches) <sup>2</sup>									
	6	9	12	15	18	24	30	36	42	48
30	34,848	23,232	17,424	13,939	11,616	8,712	6,970	5,808	4,978	4,356
36	29,040	19,360	14,520	11,616	9,680	7,260	5,808	4,840	4,149	3,630
42	24,891	16,594	12,446	9,956	8,297	6,223	4,978	4,149	3,556	3,111
48	21,780	14,520	10,890	8,712	7,260	5,445	4,356	3,630	3,111	2,723
54	19,360	12,907	9,680	7,744	6,453	4,840	3,872	3,227	2,766	2,420
60	17,424	11,616	8,712	6,970	5,808	4,356	3,485	2,904	2,489	2,178
66	15,840	10,560	7,920	6,336	5,280	3,960	3,168	2,640	2,263	1,980
72	14,510	9,673	7,255	5,804	4,837	3,628	2,902	2,418	2,073	1,814
78	13,403	8,935	6,702	5,361	4,468	3,351	2,681	2,234	1,915	1,675
84	12,437	8,291	6,219	4,975	4,146	3,109	2,487	2,073	1,777	1,555
90	11,616	7,744	5,808	4,646	3,872	2,904	2,323	1,936	1,659	1,452
96	10,890	7,260	5,445	4,356	3,630	2,723	2,178	1,815	1,556	1,361

<sup>1</sup> Assuming an entire acre is planted, drive rows are not accounted for.

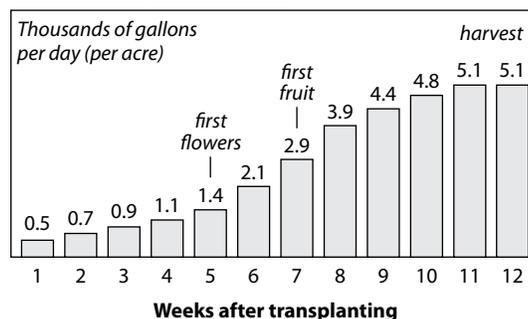
<sup>2</sup> Assumes a single row

## Fertigation

Fertigation is the application of water-soluble fertilizer through the drip system using an injector that feeds the solution into the drip lines. Our fertigation recommendations are relatively simple and are found under the individual crops in this publication. We recommend not fertigating phosphorus on medium-textured soils in Kentucky. All the soil test-recommended potassium should be applied prior to planting on some soils, but additional potassium applied through the fertigation system may help reduce blotchy ripening in tomatoes (see the “Tomato” chapter for details). Phosphorus and potassium should be broadcast with rates determined by soil test results prior to laying plastic.

Although all of the crop’s nitrogen (N) requirement can be applied prior to laying plastic, most growers prefer to split N applications between a preplant dose and sidedressings applied at intervals through the drip system. Apply about half to two-thirds the N requirement preplant and dividing the remaining amount into weekly fertigations. Most growers use calcium or potassium nitrate, usually dissolved in water prior to fertigating. Although many fertilizers are easily soluble together, care must be taken not to mix fertilizers that may precipitate when together. This can

**TOMATO CROP WATER USAGE**



lead to clogs at emitters, resulting in inadequate irrigation. Often, high-phosphorous fertilizers can precipitate when mixed with sufficient concentrations of calcium.

## Insect Management

Proper early identification of insect problems is essential in achieving satisfactory control. The following guidelines should aid in avoiding economic damage to vegetable crops from insect pests.

Although insecticides are important tools, successful management of insect and mite pests relies primarily on cultural practices. Proper cultural practices can minimize the chance for initiation and buildup of infestations. Early detection and diagnosis are key to pest management, as are the proper choice and proper application of pesticides when they are required. Vegetable producers should recognize and understand which pests have caused problems on their farms in the past and use nonchemical, preventive methods to help manage these pests when possible. Producers should regularly monitor insect and mite pests known to be problems in their areas and on the crops they are growing. Integrated pest management (IPM) guidelines for several commercial vegetable crops (cabbage, sweet corn, peppers, pumpkins) have been published by the University of Kentucky and are available through your county Extension office or on the Internet (see Appendix A).

Use crop rotation as a means of controlling certain insects such as corn rootworms in sweet corn. Grow varieties that are resistant to insects and disease when possible. Destroy or plow under crop residues immediately after the crop is harvested to reduce overwintering pest populations. Stimulate plant growth by proper irrigation and fertilization. Control weeds in and around crop fields. Weeds can be attractive to pest insects and may serve as hosts to insect-vectored diseases.

The following suggestions primarily are preventive methods rather than controls, and most should be carried out far in advance of the insect’s appearance:

- Always properly identify and evaluate your insect problem.
- Learn to identify and conserve beneficial and harmless insects.
- Scout your fields on a regular basis to monitor insect activity and possible damage.
- Use IPM guidelines and treatment thresholds—available for most vegetable crops—to help you determine what level of damage can be tolerated before economic losses occur and treatment is required.
- If an insecticide is needed, select one that best fits your situation.
- Select an insecticide that is labeled for a wide variety of crops; this will minimize the chance of accidentally treating a crop that should not be treated with that insecticide and will reduce the number of products that must be purchased and stored.
- If possible, buy pesticides in quantities small enough to use up during the growing season.
- Select insecticides that do not require a long waiting period from application to harvest so you are not hampered in harvesting when the crop is ready.

Insecticides used to control vegetable insect pests come in several different forms. Dusts, baits, and granules are dry forms used as purchased. Baits are formulated with a pest attractant; dusts and granules include an inert carrier. Dry flowables (DF), emulsifiable concentrates (EC), flowables (F), liquids (L), soluble powders (SP), suspension concentrates (SC), water-dispersable granules (WDG), and

wettable powders (WP) are formulations of insecticides that disperse when mixed in water. The latter are all used as sprays. For best results when applying dusts and sprays, thoroughly cover surfaces of infested plants.

### Greenhouse Insect and Mite Management

The warm, humid conditions and abundant food in the greenhouse are ideal for pest buildup. Problems can be chronic unless recognized and corrected. Many insecticides used on vegetables in the field are prohibited in the greenhouse (see the “Relative Efficacy of Insecticides” table on the inside back cover).

### Cultural Controls

Pests may enter the greenhouse in the summer when the ventilators are open. Others may be brought into the greenhouse on new plant material or in soil. Many are able to survive short periods of time between harvest or plant removal and production of the next crop. Cultural controls are the primary defense against infestation.

The following are proper cultural practices that will help prevent pest infestations:

- Maintain a clean, closely mowed area around the greenhouse to reduce pests that develop in rank growth.
- Remove all plants or any plant debris, and clean the greenhouse thoroughly after each production cycle.
- Keep doors, screens, and ventilators in good repair; use insect-proof netting when possible. (The extremely fine netting for thrip exclusion has been shown to limit air movement and may negatively impact disease management.)

- Use clean or sterile soils or ground media, tools, flats, and other equipment.
- Inspect new plants thoroughly to prevent introduction of insect or disease-infested material into the greenhouse.
- Watch for leaks or pooled water that can lead to fungus gnat infestations.
- If possible, allow the greenhouse to freeze in winter to eliminate tender insects such as whiteflies.
- Avoid wearing yellow clothing, which is attractive to many insect pests.
- Eliminate infestations by discarding or removing heavily infested material.

### Monitoring

Early detection and diagnosis of pest infestations will allow you to make pest control decisions before the problem gets out of hand. It is good practice, therefore, to make weekly inspections of plants in all sections of the greenhouse.

Insect monitoring devices are also available. Yellow sticky cards (PT Insect Monitoring Cards, or Gempler's—gemplers.com) are highly attractive to winged aphids, leafminer adults, whiteflies, leafhoppers, thrips (blue cards can also be used with thrips), various flies, and other insects. These cards can be used to alert you to the presence of a pest and identify hot spots in the greenhouse. One to three cards per 1,000 square feet in the greenhouse is recommended; the cards should be changed weekly. If you cannot identify a trapped insect, contact your county Extension agent for assistance. Mass trapping products such as sticky tapes also are available for thrips, whitefly, leafminer, and fungus gnat detection and management.

### Protecting Honey Bees from Pesticides

Many valuable crops cannot be economically produced unless adequate numbers of honey bees are present to pollinate them. In addition, honey bees produce more than \$50 million in honey and beeswax annually. Many pesticides are extremely hazardous to honey bees, but damage can be minimized if the pesticide user and the beekeeper cooperate and each takes the proper precautions.

### Crops Pollinated by Honey Bees

Some of the crops that require bee pollination are cucumber, squash, pumpkin, watermelon, and muskmelon. Honey-bee colonies can be rented in many areas. One or two good hives of bees per acre is suggested to ensure a good yield of high quality fruit, particularly now that parasitic mites are killing many of the wild honey bees.

### BIOLOGICAL PRODUCTS FOR INSECT CONTROL IN GREENHOUSES

Biocontrol Agent	Insects and Mites to be Controlled	Comments
<i>Encarsia formosa</i>	Greenhouse whitefly	Minute wasp that is a parasitoid of whiteflies immatures (3rd and 4th instars). Not effective against silverleaf whiteflies.
<i>Eretmocerus eremicus</i> , <i>Eretmocerus mundus</i>	Silverleaf whitefly	Minute wasp that is a parasitoid of whiteflies immatures (3rd and 4th instars). Will also attack greenhouse whitefly.
<i>Delphastus catalinae</i>	Whiteflies, both greenhouse and silverleaf	A tiny predatory beetle that feeds on the eggs and nymphs.
<i>Verticillium lecanii</i>	Whiteflies, thrips and spider mites	A white entopathogenic fungus that attacks insects, killing them in 7 to 10 days. More effective on whiteflies than the other pests.
<i>Amblyseius swirskii</i> , <i>Hypoaspis miles</i> , <i>Neoseiulus cucumeris</i>	Immature thrips and whiteflies	Small predatory mites that hunt for insect prey. Often found under leaves near the main vein.
<i>Mesoseiulus longipes</i> , <i>Neoseiulus californicus</i> , <i>Phytoseiulus persimilis</i> , <i>Galendromus occidentalis</i>	Spider mites	Small predatory mites that hunt for spider mites. Will feed on pollen in the absence of prey.
Minute pirate bugs: <i>Orius insidiosus</i> , <i>Orius laevigatus</i> , <i>Orius strigicollis</i>	Thrips, and to a less extent aphids, and other insect eggs.	Tiny predatory bugs that can be used against thrips.
Green lacewings: <i>Chrysoperla carnea</i>	Aphids, but will also feed on thrips, whiteflies and moth eggs.	Both the larvae are predatory on these greenhouse pests. Sold as eggs or larvae.
Lady beetles: <i>Adalia bipunctata</i> , <i>Hippodamia convergens</i>	Various species of aphids	
<i>Aphidius colemani</i> , <i>Aphidius ervi</i> , <i>Aphidius matricariae</i> , <i>Aphelinus abdominalis</i>	Various species of aphids	These minute wasps are parasitoids of aphids and aphids will form mummies when attacked. Different species has a preference to different aphid hosts.
<i>Aphidoletes aphidimyza</i>	Various species of aphids	A predatory midge that feeds on aphids.

### The Pesticide User's Role

- Know if and where managed honey bee colonies are located near your fields and how to contact these beekeepers.
- Use pesticides only when needed and only at the rates recommended on the label.
- If possible, select one of the least hazardous pesticides to pollinators, especially for use on flowering plants that attract bees.

- Do not apply pesticides when honey bees are active in the field. Applications late in the afternoon (after 6:00 pm) or at night are least likely to damage bees. Do not apply pesticides when plants are in flower unless absolutely necessary.
- Avoid pesticide drift into apiaries or areas where crops or wild plants are flowering. Plant crops requiring heavy pesticide applications in areas as far from managed honey bee colonies as possible.

### INSECTICIDE RESISTANCE ACTION COMMITTEE (IRAC) GROUPINGS

These insecticide groupings now appear on many labels. The groupings are based on mode of action of the insecticides. The codes allow users to determine if different insecticides share the same mode of action. This information should be used by growers to prevent/delay the development of resistance by not overusing products with the same mode of action.

Insecticide	Grouping	Insecticide	Grouping	Insecticide	Grouping
Acramite	25	Diazinon	1B	Oberon	23
Actara	4A	Dibrom	1B	Platinum	4A
Admire	4A	Dicofol	20	Portal	21A
Agri-Mek	6	Dimethoate	1B	Pounce	3
Asana XL	3	Dimilin	15	Proaxis	3
Assail	4A	Di-Syston	1B	Proclaim	6
Avaunt	22	Exirel	28	Provado	4A
Aztec	1B, 3	Force	3	Radiant	5
Battalion	3	Fortress	1B	Renounce	3
Baythroid	3	Fulfill	9B	Rimon	15
Belay	4A	Hero	3	Scorpion	4A
Beleaf	9C	Intrepid	18	Sevin	1A
Belt	28	Knack	7C	Sivanto	4D
Blackhawk	5	Lannate	1A	Synapse	28
Brigade	3	Larvin	1A	Thimet	1B
Bt kurstaki	11B2	Lorsban	1B	Torac	21A
Closer	4C	Malathion	1B	Transform	4C
Confir	18	Miteus	21A	Trigard	17
Coragen	28	Mocap	1B	Venom	4A
Counter	1B	Movento	23	Verimark	28
Courier	16	Mustang Max	3	Vydate	1A
Danitol	3	Nealta	25	Warrior	3
Diazinon	1B				

- Notify nearby beekeepers several days before you apply a pesticide as indicated by the labeling.

### The Beekeeper's Role

- Locate colonies away from areas of heavy pesticide use when practical.
- Post your name, address, and phone number conspicuously at your apiary, and tell neighboring farmers where your colonies are located.
- Know what pesticides are commonly used in your area, and be prepared to confine or remove your bees if notified that a pesticide will be applied. Commonly used pesticides, grouped according to hazard, are listed, right. A plastic sheet can be used at night or in the early morning to confine bees and protect them from short-residual pesticides. However, heat builds up rapidly once the plastic is exposed to the sun, and it must be removed. Wet burlap can be used for periods of a day or more. This may be impractical for large numbers of hives.
- Relocate colonies that are in danger of repeated contact with pesticides in Group 1 in the table "Commonly Used Pesticides," right.

### COMMONLY USED PESTICIDES AND THEIR RELATIVE HAZARDS TO HONEY BEES<sup>1</sup>

Group 1. Hazardous	Group 2. Moderately Hazardous	Group 3. Relatively Nonhazardous
abamectin (Agri-Mek)	disulfoton (Di-Syston)	azadirachtin (Align, Neem)
acephate (Orthene)	DSMA	Bacillus thuringiensis
bifenthrin (Brigade, Capture)	endosulfan (Thionex)	Bordeaux mixture
carbaryl (Sevin)	MSMA	bromoxynil
chlorothoxyfos (Fortress)	oxamyl (Vydate)	cyromazine (Trigard)
chlorpyrifos (Lorsban)	paraquat (Gramoxone)	captan
clothianidin (Belay)	phorate (Thimet)	copper oxychloride sulfate
cyantraniliprole (Exirel, Verimark)	pyriproxifen (Esteem, Knack)	copper 8-quinolinolate
cyfluthrin (Baythroid)	spinosad (Entrust, Tracer)	copper sulfate (Monohydrated)
deltamethrin (Decis)	spinetorin (Radiant)	dazomet (Basamid)
diazinon	thiodicarb (Larvin)	dicamba (Banvel D)
dimethoate (Cygon)		diflubenzuron (Dimilin)
dinotefuran (Scorpion, Venom)		dinocap (Karathane)
emamectin benzoate (Proclaim)		diquat
esfenvalerate (Asana)		dodine (Cyprex)
fenpropathrin (Danitol)		endothall
gamma-cyhalothrin (Proaxis)		EPTC (Eptam)
imidacloprid (Admire)		kaolin (Surround)
indoxacarb (Avaunt)		mancozeb
lambda-cyhalothrin (Warrior)		MCPA
malathion		nicotine sulfate
methomyl (Lannate)		pyrethrins
methylparathion (PennCap M)		simazine (Princep)
naled (Dibrom)		sulfur
permethrin (Ambush, Pounce)		thiram
phosmet (Imidan)		Zineb
thiamethoxam (Platinum, Actara)		Ziram
tolfenpyrad (Torac)		2,4-D
zeta-cypermethrin (Mustang)		2,4-DB

<sup>1</sup> Adapted from E-53, "Protecting Honey Bees from Pesticides," G. Hunt, R. Edwards, R. Foster, Purdue University Cooperative Extension Service.

## Weed Management

The use of herbicides suggested in this publication is based on research at the University of Kentucky and elsewhere in the region. We have compiled lists of the most effective herbicides with their rates and times of application with selected information on the use and precautions of each pesticide. It is not possible to include every comment and suggestion in the limited space allowed in this publication, and growers are encouraged to obtain a copy of the label and read it carefully. In addition, keep in mind that most herbicides are now manufactured by many companies under different trade names. Only one representative trade name is presented in this publication for each active ingredient. Growers are encouraged to compare costs of different brands that may have the same active ingredient. Herbicide and other pesticide labels may change after the printing of this publication, so growers must always consult the label for the final word on crops covered, precautions, rates, and application methods.

Carefully follow the precautions stated on the bag or container label. The use of herbicides for purposes other than those

specified on the approved label is a violation of federal law. Such applications can be hazardous to the environment and to people and can severely injure crops. Use herbicides only on crops for which they are approved and recommended on the label. Use only recommended amounts. In addition to wasting money and violating the law, using too much material may damage the crop and make it unsafe for consumption. The EPA is authorized to seize any raw agricultural commodity moving in interstate commerce that carries a pesticide residue in excess of the established tolerance. Note that residues of unlabeled chemicals detected on fresh produce can be traced back to your farm.

Apply herbicides only at times specified on the label and observe the recommended intervals between the time of treatment and time of planting or harvesting the crop. Guard against possible drift injury to nearby susceptible crops. Finally, the use of herbicides should supplement other good weed-management practices.

### Types of Herbicide Formulations

Herbicides are formulated as solutions (L), emulsifiable concentrates (EC), microencapsulated (ME), wettable powders (WP), flowables (F), wettable dispersible granules (WDG), and granules (G), to

name a few. Many herbicides are added to water and applied as solutions. Most spray mixtures require constant agitation to prevent the herbicides from settling to the bottom of the tank. On the other hand, granular herbicides are applied dry. Do not mix different granular pesticides or mix them with fertilizers. Some herbicides are labeled for application through an irrigation system, others as fertilizer mixtures. Fumigants such as metam sodium can also be used to kill weed seeds in the soil and reduce weed pressure. Soil fumigants are often used for disease control in high-value crops, but they also help control weeds. Growers producing plants in transplant beds may consider fumigation as a method to improve weed control.

### Method and Time of Treatment

Herbicides are applied in the following ways:

- **Preplant incorporated:** incorporated into the soil prior to planting the crop
- **Pre-emergence:** on the soil after planting but before crop or weeds emerge
- **Post-transplant:** on the soil after crop is transplanted either before weeds emerge or after clean cultivation
- **Post-emergence:** on weeds after both weeds and the crop have emerged

**HERBICIDE LABEL RESTRICTIONS\* ON VEGETABLE CROP ROTATIONS**

Herbicide	Tomato <sup>1</sup>	Pepper	Snap Bean	Sweet Corn	Pumpkin	Melon <sup>2</sup>	Cole Crops <sup>3</sup>
<b>Soybean or Tobacco Herbicides</b>							
Canopy	10-B	18-B	18-B	18-B	18-B	18-B	18-B
Classic	10-B	30-B	12-B	18-B	18-B	18-B	18-B
Command	9-12 <sup>4</sup>	NR	9	9	NR	9	12
Dual4	2	2	NR	NR	2	12	2
TriCor	4-10	18	18	18	18	18	18
Prowl	AH	AH	AH	AH	AH	AH	AH
Pursuit	18	18	NR	18	30	18	30
Reflex	18	18	NR	18	18	18	18
Roundup	NR	NR	NR	NR	NR	NR	NR
Scepter	18	18	11	18	18	18	18
Spartan	12	12	12	18	12	12	6 <sup>6</sup>
Blazer or Status	AH	AH	AH	AH	AH	AH	AH
<b>Corn Herbicides</b>							
Aatrex	SY	SY	SY	NR	SY	SY	SY
Accent	10 <sup>5</sup>	10 <sup>5</sup>	10 <sup>5</sup>	10	10 <sup>5</sup>	10	10 <sup>5</sup>
Beacon	18	18	18	8	18	18	18
Bicep	24	24	24	NR	24	24	24
Callisto	18	18	18	NR	18	18	18
Lightning	40	40	9.5	18	40	40	40
Permit	8	10	9	3	9	9	15-18
Princep	SY	SY	SY	NR	SY	SY	SY
Roundup	NR	NR	NR	NR	NR	NR	NR
Spirit	10	18	10	8	18	18	10 <sup>6</sup>

\* Waiting period (number of months after application) before the vegetable crop can be planted.

<sup>1</sup> Transplanted tomatoes only.

<sup>2</sup> Muskmelons and watermelons.

<sup>3</sup> Broccoli, cabbage, and cauliflower.

<sup>4</sup> Depends on rate applied; consult label.

<sup>5</sup> 18 months with a soil pH of greater than or equal to 6.5.

<sup>6</sup> Cabbage only.

B: Field or soil bioassay should be conducted before planting the crop; consult label.

NR: No rotation restriction exists or herbicide labeled for the crop.

AH: After harvest—can be planted in fall or spring following application.

SY: The crop cannot be planted until the second year after application (cannot be planted the year following application).

**WARNING:** This information is for preliminary planning only! Follow manufacturer's instructions on product labels to determine the most up-to-date rotation restrictions and other special conditions that may apply.

**RELATIVE RESPONSE OF WEEDS TO HERBICIDES\***

	Cocklebur	Crabgrass	Fall Panicum	Foxtail	Galinsoga	Jimsonweed	Johnsongrass (seedlings)	Lambsquarters	Morningglory	Nutsedge, Yellow	Pigweed	Purslane	Ragweed, Common	Ragweed, Giant	Smartweed	Velvetleaf	Black Nightshade
<b>Preplant Incorporated</b>																	
Command	P	G	G	G	G	P	F	G	P	N	P	E	G	P	G	G	P
Devrinol	N	G	G	G	P	N	F	F	N	P	F	G	F	N	N	P	P
Eptam	P	G	G	G	F	N	G	P	N	G	F	P	P	P	P	P	N
Prefar	P	G	G	G	P	P	P	G	P	N	G	P	P	P	N	F	P
Treflan	N	G	G	G	P	N	G	F	N	N	G	F	P	N	N	N	N
<b>Pre-emergence</b>																	
Atrazine	G	P	P	F	G	G	N	G	G	P	G	G	G	G	G	G	G
Curbit	N	G	G	G	P	N	G	G	N	N	G	G	N	N	N	N	N
Dual	N	G	G	G	G	N	F	F	N	G	G	G	P	P	F	N	G
Goal	N	F	F	F	G	F	N	F	N	N	G	G	G	G	G	G	G
Micro-Tech	N	G	G	G	G	N	F	F	N	G	G	G	P	P	F	N	G
Sandea	G	N	N	N	P	P	N	F	F	G	G	N	G	G	G	G	N
Sencor	F	P	P	P	G	G	P	G	F	N	G	G	G	F	G	F	P
Lorox	F	F	F	F	G	F	P	G	F	N	G	G	G	F	F	F	P
Prowl	N	G	G	G	F	N	F	F	N	N	G	F	P	P	F	F	P
<b>Post-emergence</b>																	
Basagran	G	N	N	N	G	G	N	G	G	N	F	G	G	F	G	G	G
Fusilade	N	G	G	G	N	N	G	N	N	N	N	N	N	N	N	N	N
Poast	N	G	G	G	N	N	G	N	N	N	N	N	N	N	N	N	N

G = Good F = Fair P = Poor N = None

\* This table should be used only as a guide for comparing the relative effectiveness of herbicides to a particular weed. The response listed is based on using the maximum recommended rates for a particular herbicide under adequate and good growing conditions. If growers are getting satisfactory results under their conditions, they should not necessarily change products as a result of the information in this table.

- **Directed post-emergence:** as a directed or shielded post-emergence on small weeds in rows of taller crops or in row middles. When using a post-emergence herbicide, the entire weed must be covered for maximum control.

Follow specified gallonages and pressures on the label in order to achieve complete coverage.

**Tank Mixtures**

For broad-spectrum weed control, more than one herbicide may be necessary. It is quite common to tank-mix two or more pre-emergent herbicides to obtain adequate weed control in vegetable crops. In this publication, we have included only labeled combinations or tank mixes. Furthermore, due to space limitations, only a fraction of the allowable tank mixes are listed. Look on the label for a complete list.

**COMMON/TRADE NAMES OF HERBICIDES**

Common Name	Trade Name
2,4-D amine	Several names
acetochlor	Surpass
alachlor	Micro-Tech, Partner
atrazine	Aatrex
bensulide	Prefar
benzoxynil	Basagran
bromoxynil	Buctril
carfentrazone	Aim
clethodim	Select
clomazone	Command
clopyralid	Stinger, Clopyr Ag
DCPA	Dacthal
dicamba	Clarity
dimethenamid-P	Outlook
diquat	Reglone
diuron	Karmex
EPTC	Eptam, Eradicane
ethalfuralin	Curbit, Sonalan
fluzafop-p	Fusilade DX
flumioxazin	Chateau
fluroxypyr	Starane
fomesafen	Reflex
glufosinate	Rely
glyphosate	Roundup
halosulfuron	Permit, Sandea
imazamox	Raptor
imazethapyr	Pursuit
linuron	Lorox
mesotrione	Callisto
metolachlor	Dual Magnum
metribuzin	Tricor
napropamide	Devrinol
nicosulfuron	Accent
norflurazon	Solicam
oxyfluorfen	Goal
paraquat	Gramoxone
pendimethalin	Prowl
pronamide	Kerb
quizalofop	Assure II
rimsulfuron	Matrix
sethoxydim	Poast
terbacil	Sinbar
topramezone	Impact
trifluralin	Treflan

## Crop Rotation

Because soil residual activity varies considerably among different herbicides, follow the directions closely for crop rotation on the labels of all products used. See the "Herbicide Label Restrictions" table on page 10 for restrictions on planting vegetables after using specific herbicides.

## Herbicide Sprayers

Even distribution of herbicides at the proper rate is essential to good weed control. A small variation in the rate of application of some herbicides may result in failure to control weeds, or it may cause crop injury. For spray applications of herbicides, a low-pressure sprayer that accurately sprays between 15 to 40 pounds per square inch is the most suitable either for broadcast or band spraying. Hand sprayers of 3- or 4-gallon capacity are suitable for small areas or for spot spraying. Tractor-mounted sprayers, pump-driven from the power takeoff, are quite satisfactory for field spraying.

A good herbicide sprayer should:

- Have a pump that is easily replaced, be resistant to wear and chemical oxidation, and have a capacity of 8 to 15 gallons per minute.
- Have a boom equipped with nozzles with replaceable tips. Nozzle spacing will depend on many factors, such as your crop and your equipment. For broadcast spraying, many manufacturers recommend 16- to 20-inch spacings between nozzles on the boom.
- Have mesh screens for the suction line and nozzles and a gauge that measures pressure accurately from 0 to 100 pounds per square inch. Mesh screen size may vary with the herbicide used. For most herbicides, a 50-mesh size is quite adequate.
- Have a mechanical or jet agitator to keep the spray solution well mixed and prevent the herbicide from settling to the bottom of the tank.

## Hand Sprayers

To spray herbicides on small areas, the most reliable method of application is the 1- to 3-gallons compressed-air sprayer. These sprayers are simple to operate but require careful calibration to assure even distribution of the herbicide over the sprayed area. A general rule is to use 1 gallon of the herbicide mixture for every 400 square feet of soil surface. This volume should be sprayed evenly over the 400 square feet. Do not guess distances or areas to be sprayed. If you have not used a hand sprayer previously, it is a good idea to

## WEED SUSCEPTIBILITY OF SELECTED HERBICIDES LABELED FOR USE IN VEGETABLE CROPS

Herbicide	Weeds Controlled	
	Grasses	Broadleaves
Basagran (bentazone)	yellow nutsedge	Canada thistle, purslane, lambsquarters, ragweed, galinsoga, jimsonweed, smartweed, velvetleaf, wild mustard, cocklebur
Buctril (bromoxynil)		mustard, cocklebur, pennycress, jimsonweed, annual morningglory, nightshade, lambsquarters, smartweed, pigweed
Command (clomazone)	barnyardgrass, crabgrass, fall panicum, foxtail, goosegrass, seedling Johnson grass	purslane, ragweed, jimsonweed, lambsquarters, smartweed, velvetleaf
Curbit (ethalfluralin)	annual bluegrass, crabgrass, barnyardgrass, foxtail, goosegrass, fall panicum, seedling Johnson grass, shattercane, witchgrass	wild buckwheat, carpetweed, chickweed, lambsquarters, pigweed, nightshade, purslane
2,4-D amine		carpetweed, dandelion, dock, galinsoga, pigweed, jimsonweed, lambsquarters, morningglory, plantain, ragweed, smartweed, thistle, wild mustard
Devrinol (napropamide)	barnyardgrass, crabgrass, goxtail, goosegrass, seedling Johnson grass, panicum, annual bluegrass	chickweed, purslane, common groundsel, prostrate knotweed, lambsquarters, pigweed, prickly lettuce
Dual II Magnum (s-metolachlor)	barnyardgrass, crabgrass, fall panicum, foxtail, goosegrass, witchgrass, yellow nutsedge	nightshade, carpetweed, galinsoga, pigweed
Eptam (EPTC)	annual bluegrass, crabgrass, barnyardgrass, foxtail, goosegrass, shattercane, witchgrass	annual morningglory, carpetweed, chickweed, lambsquarters, nightshade, purslane
Fusilade DX (fluzifop-P)	bermudagrass, goosegrass, Johnson grass, wild proso millet, barnyardgrass, fall panicum, foxtail, crabgrass, witchgrass, volunteer cereals	
Goal 2XL (oxyfluorfen)	barnyardgrass, weedy brome, crabgrass, foxtail, goosegrass, seedling Johnson grass	evening primrose, pigweed, common groundsel, purslane, black nightshade, shepherdspurse
Gramoxone Inteon (paraquat)	most annual grasses	most annual broadleaves
Karmex, others (diuron)	barnyardgrass, crabgrass, annual bluegrass, foxtail	pigweed, purslane, ragweed, chickweed, mustard, pennycress, velvetleaf
Kerb (pronamide)	barnyardgrass, brome, annual bluegrass, panicum, foxtail, goosegrass, volunteer small grains	carpetweed, chickweed, henbit, knotweed, purslane, lambsquarters, nightshade, morningglory
Tricor (metribuzin)	downy brome, crabgrass, foxtail, seedling Johnson grass	pigweed, purslane, ragweed, chickweed, jimsonweed, lambsquarters, pepperweed, shepherdspurse, smartweed, prickly sida
Lorox (linuron)	barnyardgrass, crabgrass, fall panicum, goosegrass	annual morningglory, carpetweed, groundsel, lambsquarters, mustard, cocklebur, pigweed, prickly sida, purslane, smartweed, velvetleaf
Micro-Tech (alachlor)	barnyardgrass, crabgrass, foxtail, goosegrass, fall panicum, witchgrass	carpetweed, pigweed, galinsoga, nightshade, purslane
Poast (sethoxydim)	bermudagrass, goosegrass, Johnson grass, quackgrass, wild proso millet, barnyardgrass, fall panicum, foxtail, crabgrass, witchgrass, volunteer cereals	
Prefar (bensulide)	crabgrass, foxtail, fall panicum, goosegrass	
Prowl (pendimethalin)	barnyardgrass, crabgrass, fall panicum, foxtail	carpetweed, lambsquarters, pigweed, purslane
Pursuit (imazethapyr)		nightshade, pigweed, kochia, wild mustard
Roundup (glyphosate)	most annual and perennial grasses; see discussion of reduced tillage systems	most annual broadleaves; see discussion of reduced tillage systems
Sandea (halosulfuron)	yellow nutsedge	cocklebur, common lambsquarters, common ragweed, honeyvine milkweed, kochia, morningglory, nutsedge, pigweed, smartweed, velvetweed, wild mustard
Sinbar (terbacil)	crabgrass, foxtail, seedling Johnson grass, barnyardgrass, annual bluegrass	chickweed, lambsquarters, wild mustard, pepperweed, shepherdspurse, dandelion, knotweed, pigweed, purslane, plantain, ragweed, henbit, jimsonweed
Treflan (trifluralin)	annual bluegrass, crabgrass, barnyardgrass, foxtail, seedling Johnson grass, goosegrass	carpetweed, chickweed, knotweed, lambsquarters, pigweed, purslane

practice using the sprayer with water the first time. Accurately measure the amount of herbicide that is to be added to the sprayer. See Appendix C for converting rates per acre to rates for small areas.

## Cleaning Sprayers

Herbicide sprayers should be thoroughly cleaned after each use. For many products, the screens and filters should also be taken apart and cleaned. For example,

residues of triazine products can adhere to screens and will injure nontarget, sensitive crops. Flushing tanks, lines, booms, and nozzles with water is usually sufficient for sprayers used only with pre-emergence herbicides. For most other herbicides, the sprayer should first be rinsed with water, then cleaned with one of the following in 50 gallons of water:

- A half-gallon of household ammonia (let stand in sprayer overnight)

- 4 pounds trisodium phosphate cleaner
- 2 ½ pounds sal soda (washing soda/sodium carbonate)
- 2 pounds activated charcoal (leave in sprayer and lines 10 minutes)

**NOTE:** To remove traces of oil-based herbicides such as ester formulations of 2,4-D, rinse the sprayer with kerosene before rinsing it with water and the cleaners listed above. For specific cleaning directions, refer to the label.

Herbicide sprayers should not be used to apply other pesticides on vegetable crops. In addition to the potential hazard to the crop from traces of herbicides left in the system, pressures used in herbicide sprayers are inadequate for spraying insecticides and fungicides. When an enterprise requires two herbicide sprayers, use only growth regulator type herbicides (2,4-D) in one sprayer and use the other for other herbicides.

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## Disease Management

All vegetable crops grown in Kentucky are affected by one or more diseases, and these diseases cause economic loss by reducing the quality and quantity of produce harvested. Managing diseases also adds to a grower's input costs, thereby cutting into potential profits. Disease management programs are a necessity for most vegetables, allowing for economic control of problems while maximizing yield and quality.

The practices and products that we use to manage plant diseases generally are most effective in a preventative program. The explosive nature of plant diseases makes them difficult, if not impossible, to control once they become established. To develop an effective management strategy for any vegetable crop, it is important to understand the diseases that may affect that crop and also the environmental factors that favor disease development.

### General Principles for Managing Plant Diseases

When developing a disease management plan, consider the following:

- **Use disease-resistant varieties whenever possible.** Planting resistant varieties, where available, can significantly reduce pesticide use and the cost associated with fungicides.
- **Maintain an unfavorable environment for pathogens around your crops.** Environmental factors are huge influences on the development of plant diseases. We can't change the weather, but we can implement cultural practices that allow for good air movement (and less leaf wetness) and soil drainage.
- **Employ sound sanitary practices in your vegetable operation.** Locate cull piles off the farm or as far as possible from production fields. Keep greenhouses clean and weed-free. Removing, disking, or chopping crop residues immediately after harvest followed by deep tillage

rapidly reduces populations of pathogens that can overwinter in plant debris.

- **Delay the onset of disease.** This principle is key in disease management and is accomplished through sound cultural practices and careful use of agricultural chemicals. Stopping epidemics early in the season is especially important. Once well established, many diseases are nearly impossible to control under favorable weather conditions. This is particularly true with bacterial diseases—antibiotics, for the most part, are not available to control bacterial diseases in plants as they are for bacterial diseases in humans and animals.
- **Buy or produce disease-free seeds and transplants.**
- **Control weeds and insects.** Certain diseases are spread by insects and may survive between crops in their insect vectors or in weeds. Timely weed or insect pest control is critical in these cases. Classic examples are bacterial wilt of cucurbits and cucumber beetle control and mosaic virus of corn and Johnson grass control.

### Timely Diagnosis of Plant Diseases

Accurate and timely diagnosis of vegetable diseases and disorders is a critical step in disease management. It is next to impossible to apply the appropriate management practice if the problem has not been identified properly. Application of the wrong fungicide or other tool can result in poor disease control, wasted product and time, and may cause a serious loss of yield.

The following guidelines will help in obtaining a timely and accurate diagnosis:

- Scout vegetable plantings frequently and regularly. Make a field-by-field record of what was found, and maintain these records from year to year.
- Pay careful attention to patterns of affected plants in the field or greenhouse. This information can be extremely helpful in obtaining a timely and accurate diagnosis.

- Know what pesticides were used and when they were applied.
- Examine the plant carefully for symptoms (including roots and soil). Collect (by digging, not by pulling) several whole plants representing a range of stages of the disease or disorder. Also collect at least one healthy plant. Why the healthy plant? This plant may not be as healthy as it appears, and poor health can predispose plants to certain other problems.
- Rule out soil nutrient problems—both deficiencies and toxicities. Soil test results and records of fertilizers used should be made available to the person making the diagnosis.
- Know the variety that has been planted.
- Take the plant samples and all the information available to the county Extension office.

### Crop Rotation and Tillage—The Foundation of a Good Disease Management Program

**General Considerations.** Crop rotation is a powerful tool for managing diseases of vegetables. When coupled with resistant varieties, fumigants, or fungicides, rotation will usually improve or extend control of most plant diseases.

The idea behind rotation for plant disease control is to force the pathogen population to survive without its host so that future crops encounter lower populations of that pathogen. This practice slows the buildup of pathogens in fields routinely used for vegetables, even for pathogens whose populations do not decline during rotation.

Short rotations can be used to reduce disease pressure in fields after a serious disease outbreak, although longer intervals between susceptible crops are usually recommended. Unfortunately, rotation is not effective against all diseases. Where effective, it is an invaluable and environmentally safe disease management tool.

In rotating vegetable crops, avoid planting the same crop species or closely related species in the same place more than once every three years. Crops grouped together below are subject to the same disease and insect problems:

- Corn, sorghum, small grains, grasses
- Chives, garlic, leeks, onions, shallots
- Beets, Swiss chard, spinach
- Cabbage, cauliflower, kale, collards, Brussels sprouts, broccoli, kohlrabi, turnips, rutabaga, Chinese cabbage, mustard
- Peas, snap beans, Lima beans, soybeans, clover, alfalfa
- Carrots, parsley, celery, celeriac, parsnips
- Pumpkins, squash, watermelons, cucumbers, muskmelons
- Endive, salsify, lettuce
- Potatoes, eggplant, tomatoes, peppers, tomatillo, tobacco.

Some soilborne problems (especially nematodes and Phytophthora root rots) affect several of these groups. Also, crop rotation will not impact many airborne diseases that come in from outside the field. In addition, root and bulb crops—though often not related botanically—are susceptible to many of the same soil pests; avoid other root crops and botanically related plants in the rotation. Many unrelated vegetable crops can act as hosts to root knot nematodes, so major changes in rotational patterns are needed where nematodes become a problem.

Grasses (cool- or warm-season grasses, cereals, corn, sweet corn, and sorghum) are excellent crops to use in rotation with most vegetables. Since sweet corn is an important crop in many Kentucky vegetable operations, fields to be planted to corn should be chosen carefully to obtain full benefit from its disease-control value.

### Application of Fungicides

Timing fungicide applications relative to when disease develops is very important. For protectant fungicides, applications must be made before the disease begins. These materials stop development by preventing spore germination and by preventing subsequent infections—not by eradicating the pathogen after it is already inside the plant.

All fungicides are subject to weathering and must be applied early in the disease cycle and reapplied at regular intervals. This practice keeps plants adequately covered due to new growth and environmental breakdown of the pesticides. Follow all label directions concerning alternating and mixing fungicides. The Fungicide Resistance Action Committee (FRAC) has classified the active ingredients found in fungicides by their mode of action (target site) and assigned them a group number, called the “FRAC code.” Fungicides with the same FRAC code have the same mode of action and essentially cause the same challenge to fungi, even if they belong to different chemical classes. Fungicides that are at risk for development of resistance will contain the FRAC code along with specific resistance management guidelines.

It is not necessary to memorize modes of action for each fungicide used; use the product’s FRAC code to decide how each fits in a season-long spray program. Careful adherence to resistance-management guidelines will go a long way toward delaying or preventing the development of resistance. Refer to the “FRAC Code” table on this page for a complete list of fungicides, their modes of action, FRAC codes, and chemical classes.

A good resistance-management practice is to avoid back-to-back applications of fungicides that have very specific modes of action (such as strobilurins [FRAC 11] or sterol biosynthesis inhibitors [FRAC 3]), as the likelihood of developing resistance to these types of compounds is much greater than for broad spectrum materials such as chlorothalonil, copper, or mancozeb.

### FUNGICIDE RESISTANCE ACTION COMMITTEE (FRAC) CODES

Product	FRAC Code	Active Ingredient	Chemical Group
Actigard	21	acibenzolar-S-methyl	SAR inducer
Aftershock	11	fluoxastrobin	QoI fungicide
Agri-Mycin 17	25	streptomycin	antibiotic
Aliette WDG	33	fosetyl-AI	phosphonate
Amide Propiconazole	3	propiconazole	DMI fungicide
Approach	11	picoxystrobin	QoI fungicide
Ariston	M/27	chlorothalonil + cymoxanil	inorganic + cyanoacetamide-oxime
Avaris	3/11	propiconazole + azoxystrobin	DMI + QoI
Badge SC	M	copper hydroxide + copper oxychloride	inorganic
Badge X2			
Basic Copper 53	M	basic copper sulfate	inorganic
Blocker 4F	14	PCNB	aromatic hydrocarbon
Blocker 10G			
Botran 75 W	14	dicloran	aromatic hydrocarbon
Botran 5F			
Bravo Ultrex	M	chlorothalonil	chloronitrile
Bravo WeatherStik			
Bravo ZN	M	chlorothalonil + zinc	chloronitrile
Bumper 41.8 EC	3	propiconazole	DMI fungicide
Cabrio	11	pyraclostrobin	QoI fungicide
Cabrio Plus	11/M	pyraclostrobin + metiram	QoI fungicide + dithiocarbamate
Cannonball WP	12	fludioxonil	phenylpyrrole
Catamaran	M/33	chlorothalonil + potassium phosphite	chloronitrile + phosphonate
Champ DP	M	copper hydroxide	inorganic
Champ Formula 2 FL			
Champ WG			
Chloronil 720	M	chlorothalonil	chloronitrile
Chlorothalonil 720 SC			
COC DF	M	copper oxychloride	inorganic
COC WP			
C-O-C-S WDG	M	copper oxychloride + basic copper sulfate	inorganic
Copper-Count-N	M	copper-ammonium complex	inorganic
Cueva	M	copper octanoate	inorganic
Cuprofix Ultra 40 Dispers	M	basic copper sulfate	inorganic
Cuprofix MZ Dispers	M	basic copper sulfate + mancozeb	inorganic + dithiocarbamate
Curzate 60 DF	27	cymoxanil	cyanoacetamide-oxime
Decree 50 WDG	17	fenhexamid	hydroxylanilide
Dithane F-45 Rainshield	M	mancozeb	dithiocarbamate
Dithane M-45			
Echo 720	M	chlorothalonil	chloronitrile
Echo 90 DF	M	chlorothalonil	chloronitrile
Endura	7	boscalid	carboxamide
Equus 720 SST	M	chlorothalonil	chloronitrile
Equus DF			
Evito 480 SC	11	fluoxastrobin	QoI fungicide
Evito T	3/11	tebuconazole + fluoxastrobin	DMI + QoI fungicide
Fitness	3	propiconazole	DMI fungicide
Flint	11	trifloxystrobin	DMI fungicide
Folicur 3.6F	3	tebuconazole	DMI fungicide
Fontelis	7	penthiopyrad	carboxamide
Forum SC	40	dimethomorph	cinnamic acid
Fracture	n/a	BLAD	n/a
Gavel 75 DF	22/M	zoxamide + mancozeb	benzamide + dithiocarbamate
Gem	11	trifloxystrobin	QoI fungicide
Harbour	25	streptomycin	antibiotic
Headline	11	pyraclostrobin	QoI fungicide
Headline SC			
Headline AMP	11/2	pyraclostrobin + metconazole	QoI + DMI
Incognito	1	thiophanate-methyl	thiophanate
Initiate 720	M	chlorothalonil	chloronitrile
Inspire Super	3/9	difenoconazole + cyprodinil	DMI + anilinopyrimidine
Iprodione 4L AG	2	iprodione	dicarboximide

(continued on next page)

Water quality is an important factor in fungicide performance, particularly the pH of the water source. Some products undergo a chemical degradation called alkaline hydrolysis when the pH is above 7. Likewise, there are fungicides that degrade in acid water; these include most copper materials. Have water tested to avoid such problems, especially when using water from wells or ponds, the pH of which can change through the growing season. Spray adjuvants or surfactants should be used if the product label recommends them to ensure uniform coverage. Do not use these materials unless the label indicates they are needed. Surfactants are most valuable in cole crops and peppers because of waxy leaf surfaces on these crops.

Consideration should be given to the time of day applications are made. When possible, applications should be made when the air is still. With high pressure and tiny droplets, drift can be significant. In some cases, crop damage may result from fungicide applications made during hot, humid, or high-sunlight parts of the day.

### Sprayer Configurations for Fungicides

A properly equipped and calibrated spray rig is a part of any disease control program. Accurate delivery translates to good coverage, and good coverage is essential for fungicides to perform to their maximum potential. The chemical must therefore be applied precisely to reach and cover all microscopic surfaces of the foliage during spore germination. Only with systemic fungicides is coverage sometimes less demanding.

Ground-operated spray equipment should be set to deliver 40 to 150 gallons per acre at 70 to 400 psi to ensure thorough coverage of plant surfaces. For protective fungicide applications, piston pumps and diaphragm pumps are best, although some roller pumps are also suitable. Lower volumes and pressures usually are not as effective.

Hollow-cone or twin-jet nozzles are preferred for fungicide applications. Two-piece cone nozzles (consisting of core and whirl plate-orifice disc) are best used with high pressures. The core is a fan-shaped insert that shapes the spray pattern; the orifice uses a small hole in a disc to control the volume that passes through at a given pressure. These components come in different sizes that can be used in different combinations to greatly impact delivery and coverage.

Spray nozzles are made from brass, stainless steel, polymers, and ceramic. Brass nozzles are relatively inexpensive but wear out quickly, requiring frequent replacement and re-calibration of the rig. Ceramic nozzles have the longest life but can be expensive. Keep in mind that these nozzles won't need to be replaced as often as brass nozzles and will hold calibration longer because of reduced wear. Stainless steel nozzles are less expensive than ceramic nozzles and provide long service life as well.

The type of spray boom needed varies greatly from crop to crop. Ground crops such as melons and most crops early in the season can be sprayed effectively with a broadcast boom sprayer. Sprayers used on upright crops such as staked tomatoes and peppers, however, should be modified with drops and multiple nozzles to achieve success. During application, nozzles should be turned about 15 to 20 degrees towards the direction of travel (front) to achieve a more vigorous spray action and improve coverage. The change in angle reduces immediate contact with leaves (which block delivery) and increases the stirring of leaves/ foliage (at high pressure). This aids in the coverage of the under-sides of leaves and areas of leaf overlap.

### FRAC CODES (continued)

Product	FRAC Code	Active Ingredient	Chemical Group
Kentan DF	M	copper hydroxide	inorganic
Kocide 2000			
Kocide 3000			
Kocide 4.5 LF			
Kocide DF			
Overall	M	mancozeb	dithiocarbamate
Luna Experience	7/3	fluopyram + tebuconazole	carboxamide + DMI fungicide
Luna Tranquility	7/9	fluopyram + pyrimethanil	carboxamide + anilinopyrimidine
ManKocide	M	copper hydroxide + mancozeb	inorganic + dithiocarbamate
Manzate Flowable	M	mancozeb	dithiocarbamate
Manzate Pro-Stick			
Manzate Max			
Mastercop	M	copper sulfate pentahydrate	inorganic
Maxim 4 FS	12	fludioxonil	phenylpyrrole
Maxim MZ	12/M	fludioxonil	phenylpyrrole + dithiocarbamate
Maxim Potato Seed Protectant	12	fludioxonil	phenylpyrrole
Mertect 340 F	1	thiabendazole	benzimidazole
MetaStar 2E AG	4	metalaxyl	phenylamide
Meteor	2	iprodione	dicarboximide
Moncut 70 DF	7	flutolanil	carboxamide
Monsoon	3	tebuconazole	DMI fungicide
Nevado 4F	2	iprodione	dicarboximide
Nordox 75 WG	M	cuprous oxide	inorganic
Nu-Cop 3 L	M	copper hydroxide	inorganic
Nu-Cop 50 DF			
Nu-Cop 50 WP			
Nu-Cop 50 HB	M	cupric hydroxide	inorganic
Nufarm T-Methyl 4.5F	1	thiophanate-methyl	thiophanate
Nufarm T-Methyl 70 WSB			
Omega	29	fluazinam	2,6-dinitroaniline
Orius 3.6F	3	tebuconazole	DMI fungicide
Onset 3.6F			
Penncozeb 75 DF	M	mancozeb	dithiocarbamate
Penncozeb 80 WP			
Polyram 80 DF	M	metiram	dithiocarbamate
Presidio	43	fluopicolide	benzamide
Previcur Flex	28	propamocarb	carbamate
Priaxor	7/11	fluxapyroxad + pyraclostrobin	carboxamide + QoI inhibitor
Pristine	7/11	pyraclostrobin + boscalid	QoI fungicide + carboxamide
Procare 480SC	3	triflumizole	DMI fungicide
Proline 480 SC	3	prothioconazole	DMI fungicide
Propimax EC	3	propiconazole	DMI fungicide
Propi-Star EC			
Prosaro	3	prothioconazole + tebuconazole	DMI fungicide
Quadris	11	azoxystrobin	QoI fungicide
Quadris Opti	11/M	azoxystrobin + chlorothalonil	QoI fungicide + chloronitrile
Quadris Top	11/3	azoxystrobin + difenoconazole	QoI fungicide + DMI fungicide
Quash	3	metconazole	DMI fungicide
Quilt	3/11	azoxystrobin + propiconazole	QoI fungicide + DMI fungicide
Quilt Xcel	11/3	azoxystrobin + difenoconazole	QoI fungicide + DMI fungicide
Quintec	13	quinoxyfen	quinolene
Rally 40 WSP	3	myclobutanil	DMI fungicide
Ranman SC	21	cyazofamid	QoI fungicide
Reason 500 SC	11	fenamidone	QoI fungicide
Revus	40	mandipropamid	mandelic acid
Revus Top	40/3	mandipropamid + difenoconazole	mandelic acid + DMI fungicide
Ridomil Gold Bravo SC	4/M	mefenoxam + chlorothalonil	phenylamide + chloronitrile
Ridomil Gold Copper	4/M	mefenoxam + copper hydroxide	phenylamide + inorganic
Ridomil Gold GR	4	mefenoxam	phenylamide

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Air-blast sprayers and motorized backpack sprayers can be used successfully for many vegetable crops. They are usually not as effective as properly equipped broadcast boom sprayers for most commercial vegetables, except where each row is being sprayed from both sides.

Finally, all types of sprayers should be properly calibrated. Because of nozzle wear, this needs to be done often when fungicides are used (see Appendix F).

### Vegetable Seed Treatments

Quality of seed is important to a vegetable grower's success. Planting high-quality seeds that have been treated with fungicides will help achieve the best control of seedling diseases. This is truly the first step in producing quality, disease-free transplants for the field. Seed should not be saved from a previous crop. Purchase fresh seed from reputable dealers. Most commercially available vegetable seeds come treated with one or more fungicides and possibly an insecticide. Check the product packaging or with the seed dealer to find out what treatments have been applied. Most seed companies also sell untreated seed for use by organic growers or those who wish to apply their own seed treatments.

See Appendix H for specific information on disinfection of vegetable seeds. In the case of fungicide seed treatments, many registrations have been cancelled over the years, so check and follow current labels carefully. The majority of labeled seed treatments are restricted to commercial treatment only. This is due in part to concerns about applicator exposure during seed treatment and handling. Captan WP, available at many farm supply stores, can be applied by end-users. Many vegetable seeds are treated prior to sale with both fungicides and insecticides. Be sure to check seed-package labels to avoid double treatment and to ensure your own safety. If in doubt about how seed has been treated, ask for specifics from your seed company representative or from company headquarters. Never use chemically treated seed for food or feed.

### FRAC CODES (continued)

Product	FRAC Code	Active Ingredient	Chemical Group
Ridomil Gold MZ	4/M	mefenoxam + mancozeb	phenylamide + dithiocarbamate
Ridomil Gold PC GR	4/M	mefenoxam + PCNB	phenylamide + aromatic hydrocarbon
Ridomil Gold SL	4	mefenoxam	phenylamide
Rovral 4 Flowable	2	iprodione	dicarboximide
Scala	9	pyrimethanil	anilinopyrimidine
Shar-Shield PPZ	3	propiconazole	DMI fungicide
Stratego	3/11	propiconazole + trifloxystrobin	DMI fungicide + QoI fungicide
Stratego YLD	3/11	prothioconazole + trifloxystrobin	DMI fungicide + QoI fungicide
Sulfur	M	sulfur	inorganic
Switch	9/12	fludioxonil + cyprodinil	phenylpyrrole + anilinopyrimidine
Tanos	11/27	cymoxanil + famoxadone	cianoacetamide-oxime + QoI fungicide
Tebu-Crop 3.6F	3	tebuconazole	DMI fungicide
Tebustar 3.6L			
Tebuzol 3.6F			
Terramaster	14	etridiazole	aromatic hydrocarbon
Thiophanate-Methyl 85 WDG	1	thiophanate-methyl	thiophanate
Tilt	3	propiconazole	DMI fungicide
Toledo	3	tebuconazole	DMI fungicide
Topaz	3	propiconazole	DMI fungicide
Topsin 4.5 FL	1	thiophanate-methyl	thiophanate
Topsin M 70 WP			
Topsin M WSB			
Torino	U6	cyflufenamid	phenyl-acetamide
Ultra Flourish	4	mefenoxam	phenylamide
Vertisan	7	penthiopyrad	carboxamide
Vivando	U8	metrafenone	methanone
Zampro	45/40	ametoctradin + dimethomorph	QxI inhibitor + cinnamic acid
Zing!	M/22	zoxamide + chlorothalonil	benzamide + chloronitrile
Ziram	M	ziram	dithiocarbamate

### NON-FUMIGANT NEMATICIDES

Product	Product Amt/A	Application Method/Timing	Crops	Restricted Use	Re-Entry Interval (hrs)
Mocap 15G	13 to 80 lb	preplant broadcast or banded at-plant	beans (succulent), cabbage, cucumber, irish potato, sweet corn, sweetpotato	Yes	48
Mocap EC	2.4 to 6.9 fl oz/1,000 row-feet	preplant broadcast or banded at-plant	cabbage, irish potato, sweetpotato	Yes	48
Nemacur 3	2.33 qt	at-plant banded	eggplant	Yes	48
Vydate L	2 to 8 pt	preplant in-furrow, post-emergence (drip irrigation and foliar)	carrot, cucurbits, eggplant, pepper, sweetpotato, tomato	Yes	48

### Nematode Control

Nematodes are problematic for Kentucky vegetable producers mainly in sandy or rocky soils. The root-knot nematode tends to be the one found most commonly, and usually in warm and dry summers. Soybean cyst nematode can be a problem with bean crops, and special consideration is needed where soybeans and other bean crops are grown on the same farm.

Nematodes are microscopic roundworms that feed mainly on plant roots. They cause damage by reducing root health, reducing the quality of root crops, and increasing susceptibility to other diseases—especially the vascular wilts. Poor uptake of nutrients and water usually contribute to the most

common symptoms. Unthrifty, stunted, or wilting plants should be examined for nematodes when symptoms are noticed. Root galling and irregular root enlargement are usually present if root-knot nematode is involved, although these symptoms may not be obvious with all crops.

Management of plant parasitic nematodes hinges on correct diagnosis of the problem and knowledge about the population level of the nematode(s). Samples should be collected during the growing season while symptoms are present. The sample of affected plants should include tops with roots attached plus a composite soil sample collected from 10 areas of the field. In addition, healthy plants and a separate soil sample from areas of the field

not affected should be included. A number of nonchemical and chemical tools are available for management of nematodes.

Crop rotation to non-host or poor-host plants, such as grasses or small grains, is the key to keeping populations low once they are present. Yield losses can usually be minimized in most Kentucky soils through proper nutrition, irrigation, and reduction of plant stress where populations are low. This approach still allows nematode numbers to build; other controls will be needed to avoid serious damage to later plantings. Plants can tolerate much higher nematode levels in our heavier and cooler soils than they can in the lighter and warmer soils to the south, especially when irrigation is being used.

## FUMIGANTS FOR VEGETABLE CROPS

Trade Name	Common Name	Rate/A (gal)	Target Pests	Timing (Plant-back) <sup>1</sup>	Restricted Use	Re-Entry Interval
Chloropicrin	chloropicrin (99.5%)	10.9 to 12.8	nematodes, soilborne diseases	2 to 3 weeks	Yes	5 days
K-Pam HL	metam-potassium (54%)	15 to 62	weeds, nematodes, soilborne diseases	2 to 3 weeks	Yes	5 days
Telone II	1,3-dichloropropene (97.5%)	9 to 12	nematodes	1 to 2 weeks	Yes	5 days
Telone C-17	1,3-dichloropropene (81.2%) + chloropicrin (16.5%)	10.8 to 17.1	nematodes, soilborne diseases	1 to 2 weeks	Yes	5 days
Telone C-35	1,3-dichloropropene (63.4%) + chloropicrin (34.7%)	13 to 26	nematodes, soilborne diseases	2 to 3 weeks	Yes	5 days
Vapam HL or Sectagon-42	metam-sodium (42%)	37.5 to 75	weeds, nematodes, soilborne diseases	2 to 3 weeks	Yes	5 days

<sup>1</sup> Dissipation of fumigants will be slower in cool, wet, or heavy soils. Under these conditions, allow more time for materials to escape soil, and aerate by tillage before planting. Failure to aerate fully can result in severe plant injury or death. If no fumigant odor is detected, aeration is generally sufficient.

Spread of nematodes must be prevented. Nematodes are easily moved on infested soil or on infested plant material through human activities. Take steps to limit field-to-field spread of nematode-infested soil; clean equipment, vehicles, and shoes thoroughly after working in infested fields.

Prompt and proper crop destruction after harvest followed by replanting with a non-host cover crop prevents further increases in the nematode population. Non-host cover crops suppress nematodes by starving them and preventing reproduction. Antagonistic crops (French marigolds or certain rapeseed crops) suppress through direct toxic effects to nematodes.

Cover crops that are nematode hosts can be used to trap and reduce nematode populations by destroying the host plant (cover crops) before the nematode can reach a reproductive life stage (from which it can survive to the next crop). Timing with trap crops is critical because even more serious problems exist when crop destruction is delayed until after nematodes have reproduced.

The introduction of large amounts of organic matter in the soil is suppressive to plant parasitic nematodes. Maximum benefit is achieved when large amounts of organic matter are incorporated as green manure; however, sufficient time must be allowed for adequate decomposition to avoid crop damage from organic matter toxicity and other problems.

Nematode-resistant varieties are available in only a few crops. For example, the N in 'VFN'-resistant tomato variety descriptions indicates resistance to root-knot nematode. Resistance does not solve all root-knot nematode problems on tomatoes in Kentucky, however. The gene involved confers resistance to most, but not all, species of root-knot nematode. The northern root-knot nematode (*Meloidogyne hapla*) is not controlled by this gene. Since the northern root-knot nematode is native to Kentucky soils, problems can still occur with commercial tomato varieties labeled VFN on sites where rotation is not practiced.

### Soil Fumigants for Control of Nematodes and Soilborne Diseases

When proper rotation is not an option, or when populations of soilborne fungi and nematodes have reached damaging levels, soil fumigants should be considered. These materials have a broad spectrum of activity and can be relatively expensive. Their use tends to be limited to high-value crops such as staked tomatoes. Fumigation of soils will, if properly done, reduce soil pathogen populations early in the season, alleviating plants from pathogen stress and allowing for increased productivity. However, pest populations at the end of the season may be equal to or greater than that prior to fumigation.

Materials available for general fumigation and nematode control on most vegetable crops are described in this section. Follow labels carefully for application methods, waiting intervals before planting, and all safety precautions. Most soil fumigants are extremely dangerous to people and animals; specialized equipment is required to apply these materials properly. Regulations governing the application of soil fumigants have become very stringent ([caes.uga.edu/commodities/fruits/veg/fumigant.html](http://caes.uga.edu/commodities/fruits/veg/fumigant.html)). Growers who wish to apply soil fumigants must receive training on these new regulations, and failure to comply with fumigation regulations could result in significant fines. Because of these issues, growers should consider hiring a licensed applicator to put out soil fumigants.

Sites that are to be fumigated must be prepared properly. Debris from the previous crop should be removed, the soil should be free of clods and stones, and soil moisture must be adequate to permit activation and movement of fumigant materials. If the soil is inadequately prepared, fumigation will not be effective because the fumigant will not penetrate the clods and large debris—it will flow around them, following the path of least resistance. Irrigate the site, if necessary, several days in advance to revive dormant soil organisms. If the site is too wet, however, soil pores will be filled with water and

fumigant movement in soil will be reduced (along with efficacy). Soil temperature at the 4- to 6-inch depth should be between 50°F and 80°F; cooler temperatures slow fumigant movement in soil, and higher temperatures allow for the gases to escape too rapidly.

Fumigant materials trapped in soil can cause plant injury when crops are transplanted. Following fumigation, soil must be sealed by irrigation or tarping to maximize pathogen kill. Allow sufficient time for residues to dissipate so as to avoid crop injury; the plant-back period for these materials varies by product, soil temperature, and moisture.

**Nematicides.** Telone II and Telone EC (1,3-dichloropropene) are fumigant nematicides labeled for most vegetables. These products can be applied broadcast or in beds, using chisels (shanks) spaced up to 12 inches apart and set to a 8 to 10 inch depth. Strictly a nematicide, 1,3-dichloropropene has little effect on fungi or weeds.

**Multipurpose Fumigants.** A mixture of methyl bromide plus chloropicrin (67/33%) is a biocidal mixture that will reduce nematodes, weeds, and soilborne fungi. This material is labeled for most vegetable crops and must be tarped after application. The production of methyl bromide was significantly reduced in the United States in compliance with the Montreal Protocol, with only specific critical uses being permitted. Existing stocks, however, can be used.

Metam sodium, chloropicrin, and mixtures of 1,3-dichloropropene plus chloropicrin (Telone C-17, Telone C-25, InLine) are multipurpose soil fumigants that are labeled on many vegetables for controlling nematode and fungal diseases. All can be injected into soil as fumigants, and metam sodium, chloropicrin, and InLine can be applied through irrigation systems. Metam sodium also can be sprayed onto soil surfaces and incorporated. The plant-back period ranges from three to four weeks or longer, which requires careful planning. Where erosion controls will allow, fall applications are an option, especially for early plantings. The table "Fumigants for Vegetable Crops"

**BIOPESTICIDES FOR VEGETABLE DISEASE MANAGEMENT**

Active Ingredient	Product	Crops	Target Diseases/Pests	Green-house Use	Comments
Acibenzolar-S-methyl	Actigard	chili pepper, cucurbits, lettuce, onion, spinach, tomato	bacterial blights, downy mildew, powdery mildew; crop dependent—refer to label	No	Do not apply to plants stressed by heat, cold, or moisture extremes.
<i>Bacillus amyloliquefaciens</i> D747	Double Nickel	cole crops, bulb vegetables, cucurbits, tomato, pepper, lettuce and greens, legumes, root vegetables	powdery mildews, fungal leaf spots, root rots	Yes	OMRI-listed. May be applied through drip, as drench or transplant dip, or as foliar spray, depending on the target disease(s).
<i>Bacillus pumilus</i> QST2808	Ballad Plus, Sonata	cole crops, cucurbits, legumes, bulb vegetables, root crops, pepper, tomato, sweet corn	early blight, late blight, downy mildew, powdery mildew, leaf blights, rust	Yes	OMRI-listed. Ballad Plus can be used on sweet corn only.
<i>Bacillus subtilis</i> GB03	Companion	most vegetables (see label)	root diseases	Yes	OMRI-listed.
<i>Bacillus subtilis</i> MBI 600	Subtilex NG	cucurbits, eggplant, pepper, tomato	root diseases, powdery mildew	Yes	Apply to soil or potting medium; use as a foliar spray for powdery mildew.
<i>Bacillus subtilis</i> QST713	Cease, Serenade Max, Serenade ASO, Serenade Optimum, Serenade Soil	cole crops, leafy vegetables, legumes, cucurbits, pepper, tomato	downy mildew, powdery mildew, leaf blights	Yes	OMRI-listed.
<i>Coniothyrium minitans</i>	Contans WG	most vegetables (see label)	Sclerotinia sclerotiorum (white mold, timber rot, drop)	Yes	OMRI-listed. Apply to soil or potting medium.
<i>Gliocladium cantenulatum</i>	PreStop Biofungicide	most vegetables (see label)	seed rots, root diseases, Botrytis stem canker	Yes	-
<i>Gliocladium virens</i> GL-21	SoilGard 12G	most vegetables (see label)	seed rots, root diseases	Yes	OMRI-listed. Do not apply in conjunction with chemical fungicides.
Harpin protein	ProAct, Messenger	most vegetables (see label)	foliar diseases	n/a	-
Hydrogen peroxide	Oxidate, Terricide	most vegetables (see label)	root diseases, leaf blights	Yes	OxiDate is OMRI-listed.
<i>Myrothecium verrucaria</i>	DiTera DF	cole crops, cucurbits, eggplant, leafy vegetables, legumes, pepper, root and tuber vegetables, tomato	nematodes	Yes	OMRI-listed.
Neem oil	Trilogy	most vegetables (see label)	foliar diseases	Yes	OMRI-listed. May cause leaf burn; test a small number of plants before spraying entire crop.
Oil (cottonseed, corn, and garlic)	Mildew Cure	pepper, tomato	bacterial spot, speck	Yes	May cause leaf burn; test a small number of plants before spraying entire crop.
Oil (clove, rosemary, thyme)	Sporatec	most vegetables (see label)	powdery mildew, fungal leaf blights	Yes	OMRI-listed. Addition of a spray adjuvant (spreader or penetrant) is recommended.
Oil (soybean)	Oleotrol-M	most vegetables (see label)	Botrytis gray mold, downy mildew, powdery mildew	Yes	OMRI-listed. Tank-mix with a spreader-sticker.
<i>Paecilomyces lilacinus</i>	MeloCon WG	most vegetables (see label)	nematodes	Yes	OMRI-listed.
Phage	AgriPhage	most vegetables (see label)	bacterial spot, speck	Yes	-
Phosphorous compounds	Alude, Fosphite, Fungi-Phite, Phostrol, ProPhyt, Rampart	most vegetables (see label)	downy mildew, powdery mildew, leaf blights	Yes	-
Potassium bicarbonate	Armicarb, Kaligreen, Milstop	most vegetables (see label)	powdery mildew, fungal leaf blights	Yes	Kaligreen and Milstop are OMRI-listed. pH of spray solution should not be below 7.0.
Potassium salts of fatty acids	M-Pede	most vegetables (see label)	powdery mildew	Yes	Do not mix with surfactants or apply to stressed plants to avoid plant injury.
Potassium silicate	Sil-MATRIX	most vegetables (see label)	powdery mildew, Botrytis gray mold	Yes	OMRI-listed. Tank-mix with a non-ionic surfactant for best results.
<i>Pseudomonas chloroaphis</i>	Ateze	most vegetables (see label)	stem, root diseases	Yes	Greenhouse use only.
<i>Reynoutria sachalinensis</i>	Regalia	most vegetables (see label)	powdery mildew, fungal leaf blights	Yes	OMRI-listed. First application should be made before symptoms appear.
<i>Streptomyces griseoviridis</i>	Mycostop	most vegetables (see label)	seedling, root, and stem rots	Yes	OMRI-listed. Can be added to potting mix or applied in-furrow to field soil.
<i>Streptomyces lydicus</i>	Actinovate AG	most vegetables (see label)	seedling, root, and stem rots; foliar blights	Yes	OMRI-listed. Can be used as a soil or foliar treatment.
<i>Trichoderma harzianum</i>	T-22, RootShield, PlantShield	cole crops, eggplant, leafy vegetables, pepper, tomato	seedling, root, and stem rots	Yes	OMRI-listed. Can be added to potting mix or applied in-furrow to field soil.
<i>Trichoderma viride</i>	Binab	most vegetables (see label)	seedling, root, and stem rots	Yes	-

on page 16 summarizes fumigant materials that can be used on many vegetable crops grown in Kentucky. Check product labels for specific crop listings, application instructions, and safety precautions.

**Non-fumigant Nematicides.** Several non-fumigant materials can be applied pre- and post-planting to suppress nematodes in a number of vegetable crops. Most are insecticidal as well, and all are extremely dangerous. The table “Non-

fumigant Nematicides” on page 15 lists products registered in Kentucky. Consult product labels for rates on specific crops and for application types permitted on each crop.

**Air Pollution Injury in Vegetables**

Ozone injury is the most common air pollution problem diagnosed in Kentucky vegetable crops. It results from high ozone levels during midsummer stagnation events. It appears as small

stipple- to fleck-like lesions visible on upper leaf surfaces. Lesion color varies with the crop, ranging from white to dark. The most susceptible tissues are those leaves that recently matured at the time of the pollution episode; very young and very old foliage are less affected. In some crops damage is more common toward the tips and margins of the leaf. When ozone is involved, many plant species in the area will have been affected; other problems

**FUNGICIDES AND BACTERICIDES FOR GREENHOUSE-GROWN VEGETABLES**

Product	FRAC Code	Preharvest Interval (days)	Crops	Target Diseases	Comments
<b>Labeled for Greenhouse Use<sup>1</sup></b>					
Blocker Flowable	14	n/a	beans, broccoli, Brussels sprouts, cabbage, cauliflower, pepper, tomato	Rhizoctonia root and stem rots, clubroot	Transplant production only. Apply as a drench to seedlings in beds or containers.
Botran 75 W	14	10	cucumber, lettuce (leaf), tomato	Botrytis blight and gray mold; white mold (cucumber)	Tomato: direct spray at stems; cucumber and lettuce: apply to foliage. Rates and application restrictions are crop-specific; see label.
Catamaran	M/33	0-3 <sup>2</sup>	beans, cole crops, cucurbits, pepper, tomato	foliar blights	Rates and preharvest intervals are crop-dependent; refer to label.
Copper fungicides <sup>3</sup>	M	0	most vegetables (see label)	bacterial diseases, foliar blights, powdery mildew	-
Decree 50 WDG	17	0-60 <sup>2</sup>	cucumber, lettuce, tomato	Botrytis gray mold	Do not make more than 2 consecutive applications.
Fontelis	7	0-1 <sup>2</sup>	cucurbits, tomato	Alternaria diseases, Botrytis gray mold, powdery mildew, Sclerotinia diseases, Septoria diseases	-
Mancozeb (Dithane, Manzate, Penncozeb)	M	5-10 <sup>2</sup>	most vegetables (see label)	foliar blights, bacterial diseases (+ fixed copper)	-
Micora	40	n/a	cole crops, leafy vegetables, eggplant, pepper, tomato	downy mildew, late blight	Use only on transplants grown for retail sale.
Pageant Intrinsic	11/7	0	tomato	Botrytis gray mold, fungal leaf spots	-
Previcur Flex	28	5 - 7	cucurbits, lettuce (leaf), pepper, tomato	damping-off and root rot ( <i>Pythium</i> spp. and <i>Phytophthora</i> spp.)	-
Procure	3	0-1 <sup>2</sup>	cole crops, cucurbits, leafy greens	powdery mildew	-
Ranman	21	n/a	tomato	Pythium damping-off	Transplant production only. Only 1 application is permitted during growing cycle. Treat no later than 1 week before transplanting.
Scala SC	9	1	tomato	early blight and Botrytis gray mold	Must be tank-mixed with another early blight or Botrytis fungicide. Ventilate greenhouse for a minimum of 2 hours after application to avoid plant injury.
Switch	9/12	0-7 <sup>2</sup>	beans, cole crops, cucurbits, pepper, tomato	foliar diseases including early blight, Botrytis gray mold, and powdery mildew	Do not apply to cherry or grape tomatoes.
Terramaster 4EC	14	3	tomato	Pythium and Phytophthora root rots	Apply in drip irrigation or as a drench.
<b>Not Prohibited for Greenhouse Use<sup>1</sup></b>					
Agri-Mycin 17	25	n/a	pepper and tomato, celery	bacterial leaf spot, bacterial blight	Transplant production only.
Curzate 60DF	27	3	cucurbits, lettuce, tomato	downy mildew, late blight	-
Gavel	M/22	5	cucurbits, tomato	downy mildew, late blight	-
Inspire Super	3/9	0	cole crops, cucurbits, pepper, tomato	Alternaria diseases, Botrytis gray mold, leaf mold, powdery mildew	-
ManKocide	M	5-10 <sup>2</sup>	most vegetables (see label)	foliar blights, bacterial diseases (+ fixed copper)	-
Quadris Top	11/3	0-1 <sup>2</sup>	cole crops, cucurbits, tomato	leaf mold, powdery mildew, Alternaria diseases	Do not use for transplant production
Revus	40	1	beans, cole crops, cucurbits, lettuce, pepper	downy mildews	-
Revus Top	3/40	1	tomato	late blight, fungal leaf spots	-
Sulfur	M	0	cole crops, cucurbits, pepper, tomato	powdery mildew and fungal leaf spots	Check label for greenhouse compliance
Tanos	11/27	3	cucurbits, pepper, tomato	downy mildew, late blight	Must be tank-mixed with mancozeb or copper fungicide.
Torino	U6	0	cucurbits	powdery mildew	-

<sup>1</sup> Pesticides may be used in greenhouses and high tunnels if the product label clearly states that greenhouse use is permitted (labeled) for a particular crop. Pesticides whose labels do not explicitly allow or prohibit greenhouse use may also be used as long as that particular pesticide is labeled for the crop to be treated and label instructions are followed—even though clear instructions for greenhouse use do not appear on the label.

<sup>2</sup> Crop dependent, see label.

<sup>3</sup> Greenhouse-approved copper fungicides include Badge X2, Champ DP, Champ Formula 2, Champ WG, Copper-Count-N, Cueva, Cuprofix, Kentan DF, Kocide 2000, Kocide 3000, Kocide DF, MasterCop, Nordox, Nu-Cop 50DF, and Nu-Cop HB. Badge X2, Champ WG, Cueva, Nordox, and Nu-Cop HB are approved for use in organic systems (OMRI-listed).

for which ozone injury can be confused tend to be scattered or limited to just the crop. The most sensitive crops to ozone include beans, cucurbits, potatoes, and tomatoes. Much less ozone damage occurs in some of these crops if mancozeb was in the spray program before the air pollution event occurred.

Injury from PAN (peroxyacetyl nitrate) also occurs, although much less frequently than ozone injury in Kentucky. It, too, affects mainly the newly matured leaves.

Symptoms include bronzing or glazing of the leaf undersides, with some areas of complete tissue collapse appearing in diffuse bands across the width of the leaf (tissues of the same age are affected). The most sensitive plants are lettuce, mustard, Swiss chard, beets, and cantaloupes.

Damage from other localized air pollution events is occasionally observed in Kentucky. These include sulfur-dioxide damage following scrubbing operations at power plants and damage from ammonia and chlorine associated with local spills.

## Biopesticides

A number of products derived from plants, microorganisms, or from GRAS (Generally Recognized as Safe) chemistries are labeled for disease control in vegetable crops (see “Biopesticides” table on page 17). Some of these products are effective under certain conditions, and others have very limited disease-control potential. Most are not as effective as the recommended conventional pesticide labeled for the disease in question. The EPA looks

only at safety issues during the labeling process and does not test the efficacy of the product. Some of these “soft” chemicals are also not EPA-registered because they do not specifically claim to be pesticidal. These alternative products include living microorganisms (bacteria, viruses, fungi, nematodes, and protozoa), “natural chemicals,” plant extracts, etc. Our goal is to help commercial growers integrate all available tools in a manner that provides effective disease control with minimal risk to producers, consumers, and the environment. The “Biopesticides” table lists alternative products and provides some general information on these new materials but does not constitute a recommendation. Growers interested in these products should first test them in small-scale trials before dropping or changing from a recommended spray program. Many are approved for greenhouse use; check product labels.

### Post-Harvest Decays

Vegetable crops are subject to great losses after harvest because of environmental conditions and microbes. Bacteria and fungi are present in wounds and on surfaces of fresh produce. Many post-harvest pathogens cannot invade the plant unless a wound is present. Significant losses occur as these pathogens spread and increase due to improper harvesting, poor handling, and improper cooling. Proper post-harvest handling, precooling, storage, and packaging procedures are all disease-control practices that are essential to successful commercial vegetable production.

Chlorination of water bath washes or sprays is an important practice to reduce pathogen numbers and spread and to improve shelf life. The wash-water temperature should be about 10°F warmer than the internal temperature of the product being washed. This avoids microbes being

drawn into the tissues, which occurs when colder water is used.

Although chlorine can be added to wash water in several forms, the water pH must be adjusted so that chlorine remains available and active. Wash water pH should always be 6.5 to 7.5 to ensure that adequate chlorine is available. The following forms of chlorine are used in post-harvest water baths:

- Sodium hypochlorite 5.25 percent (household bleach)—use 13 to 17 fluid ounces per 100 gallons of water. The label covers most vegetables as a dip and rinse.
- Calcium hypochlorite (Magnum 65%)—use 1 ounce per 100 gallons of water; labeled for most vegetables as a dip and rinse.

For detailed information regarding post-harvest handling, storage, and care of fresh produce, including chlorination procedures, see the “Post-harvest” section of Appendix A.

### Disease Management in Greenhouse Vegetable Crops

Sanitation and moisture control are two important strategies for disease management in the greenhouse. Few fungicides are labeled for use in greenhouses, and a limited number of resistant varieties is available. Excluding pathogens and reducing disease-favorable environments are the most important control measures in greenhouses.

Sanitation is extremely important. Everything that goes in the greenhouse should be new or sanitized to a like-new condition to prevent problems with damping-off and root and stem diseases. Many pathogens, especially bacterial pathogens, may persist on unclean benches, stakes, clips, or wires. Repair leaks or tears in greenhouse plastic, and avoid wetting

leaf surfaces as much as possible. The wetter the production system, the more critical is the sanitation program.

Solarize the greenhouse by closing it tightly for several weeks during the hot and sunny parts of summer so that air temperatures reach 140°F. This will reduce populations of many pathogens. This treatment will not penetrate soil much more than ½ inch, nor will it control tobacco mosaic virus. Deeper penetration can be obtained in areas covered with clear plastic near the soil. Remove all heat-sensitive materials and clean out all debris before solarizing. Keep the system moist to encourage microbe activity during this solarization period; this will make microbes more sensitive to being killed by heat.

Steaming at 180°F for 30 minutes effectively sanitizes any material that can tolerate it. Lower temperatures are helpful but not as effective. Chloropicrin may be used for fumigating soil beds and soils where nematodes and soilborne fungi are present. Read and follow the labels for all products carefully, as these are extremely poisonous materials, especially in enclosed areas.

Foliar diseases in most greenhouse crops can be suppressed if relative humidity is kept below 90 percent. Manage the heat and temperature and keep the air circulating with fans and tubes. Consult a greenhouse specialist for more information on how to best manage the greenhouse environment. To avoid virus disease problems, do not produce vegetable transplants in greenhouses together with tobacco or ornamental plants.

The table on page 18 summarizes the fungicides and bactericides registered for use on greenhouse-grown vegetables (including transplants). Consult product labels for crops covered by each material and for application instructions.

## Asparagus

Lily family (Liliaceae): *Asparagus officinalis*

### Planting and Culture

New asparagus plantings can be started as crowns or transplants. Fields to be planted with asparagus should be well drained, fairly level, free from rocks, and relatively weed-free.

Using 10- to 12-week-old transplants that have been started in the greenhouse is a good method for establishing a new planting. One-year-old crowns purchased

from a plant producer is the traditional method of planting. Direct seeding into the field is not recommended. Furrows 5 to 6 inches deep are prepared for crowns or transplants. Problems associated with heavy rains filling in the furrows and smothering small transplants or direct-seeded plants make 1-year-old crowns the most reliable method.

One-year-old crowns should be planted in furrows with the buds up and 6 inches below the soil surface. Cover crowns with 1½ to 2 inches of soil at the time of planting. Furrows gradually are filled in as the spears begin growing.

#### VARIETIES: *Asparagus*

UC 157	Jersey Knight
Jersey Giant	Jersey Supreme
	Purple Passion

Space crowns or transplants 14 to 18 inches apart in the furrow. Furrows should be 5 to 6 feet apart. You will need 5,808 plants per acre at 5-foot row spacing and 4,840 plants per acre at a 6-foot spacing.

Crowns should be planted in March or early April (see Appendix J). Transplanting should be done in late April or early May. See *Commercial Asparagus Production* (HO-66) for additional information.

## Fertilizing

Apply fertilizer based on soil test results. Broadcast and disk in before establishing a new planting. Continue to apply fertilizer each year if needed. Apply animal manure or plow under a green manure cover crop before planting. Apply lime if needed to bring the soil pH to 6.5 to 6.8 and to supply calcium, deeply incorporating it prior to planting. Asparagus does not tolerate acid soils. Apply 200 pounds per acre of triple superphosphate (0-46-0) in the bottom of the trench just before planting. This is 2.3 pounds per 100 feet of row at a 5-foot spacing and 2.8 pounds per 100 feet of row at a 6-foot row spacing. This application is in addition to the phosphorus applied based on the soil test. Topdress an annual application of 70 to 75 pounds of nitrogen about two weeks before the end of the harvest season. Soil magnesium should be checked before planting and every three to four years after establishment.

## Harvest

Harvest only five to six spears per plant if any the first year. After two years of growth, harvest for about 6 to 8 weeks in the spring in order to allow fern growth to develop for the rest of the season. Harvest spears when 5 to 10 inches long. Harvest during early morning hours and place in cold storage as soon as possible.

Cut asparagus spears to uniform length, tie in 2- to 2½-pound bunches and pack them in pyramid crates for the wholesale market.

Ferning out—feathering of the head of the asparagus spear—indicates poor quality with high fiber content. High temperatures will cause the tips of shoots to fern out at a shorter height.

## FERTILIZER: *Asparagus*

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
<b>Phosphorus</b>	<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>	
Low	<31	121-240
Medium	31-60	61-120
High	61-80	21-60
Very High	>80	0-20
<b>Potassium</b>	<b>Potash (K<sub>2</sub>O)</b>	
Low	<201	201-300
Medium	201-300	101-200
High	301-450	51-100
Very High	>450	0-50
<b>Nitrogen</b>	<b>N</b>	
	75	

## After Harvest

After the final harvest, herbicides can be applied to help keep fern growth free from weed competition late in the season. It is important to keep the plants growing well after harvest until frost. The tops can then be mowed down with a rotary mower in the late winter or early spring before spear emergence.

## Common Diseases/Management

**Fusarium root and crown rot.** Site selection and cultural practices are important management tools. Jersey hybrids have some tolerance, although none are completely resistant. Select well-drained sites that have not been previously planted in asparagus. Alternatively, use a site rotated out of asparagus for eight or more years. Use disease-free crowns or transplants produced from bleach-treated seed.

**Phytophthora crown and spear rot.** *Phytophthora* diseases are favored by standing water and a high soil pH. *Avoid planting in poorly drained sites*, and take steps to improve surface and internal drainage.

## PESTICIDE SAFETY: *Asparagus*

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>INSECTICIDES</b>			
Bt products	C	12	0
Coragen 1.67 SC	-	4	1
Dimethoate 4	W	48	180
Fulfil 50 WDG	C	12	170
Radiant SC	C	4	60
Sevin XLR	C	12	1
<b>Restricted Use</b>			
Lannate 90 SP	DP	48	1
Permethrin 3.2 EC	C	12	1
<b>FUNGICIDES</b>			
Aliette WDG <sup>2</sup>	C	12	110
Fixed coppers <sup>3</sup>	W	24/48	0
Chlorothalonil <sup>3</sup>	C	12	190
Flint	C	12	180
Mancozeb <sup>3</sup>	C	24	180
MetaStar 2EC AG	W	48	1
Quadris	C	4	100
Rally 40 WSP	W	24	180
Ridomil Gold SL	C	48	1
Sulfur <sup>3</sup>	C	24	0
Tebuconazole <sup>3</sup>	C	12	180
UltraFlourish	W	48	1

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> The use of Aliette in the following Kentucky counties has certain restrictions to protect endangered freshwater mollusks and their habitat, so read labels carefully: Campbell, Green, Hart, Kenton, Logan, Marshall, Rockcastle, Todd, Warren, and Wayne.

<sup>3</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

**Rust and Cercospora leaf blight.** Burning of old ferns during the winter to help reduce overwintering inoculum of these pathogens is recommended, or cut or mow stubble and remove it from the planting. Rust-resistant varieties are available but are only partially effective; preventive fungicide sprays are usually needed in commercial plantings. The Jersey hybrids, because of their vigorous dense growth, appear to be very susceptible to *Cercospora* leaf blight.

## INSECT CONTROL: *Asparagus*<sup>1</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>SPEAR TREATMENTS</b>			
<b>Armyworms</b>			
Bt products	See labels	-	-
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	-
Sevin XLR	1 to 2 qt	5 applications	Limit 3 applications before harvest.
<b>Asparagus Beetles:</b> Only the common asparagus beetle (blue and brown with white spots) injures the plants. Monitor plants in the early afternoon when beetles are active. Treat when 10% of the plants are infested with the beetles.			
Pounce 3.2 EC	2 to 4 fl oz	16 fl oz	-
Sevin XLR	1 to 2 qt	5 applications	Limit 3 applications before harvest.
<b>Cutworms</b>			
Pounce 3.2 EC	2 to 4 fl oz	16 fl oz	-
Sevin XLR	1 to 2 qt	5 applications	Limit 3 applications before harvest.
<b>FERN TREATMENTS</b>			
<b>Asparagus Beetles</b>			
Dimethoate 4	1 pt	5 applications	-
Pounce 3.2 EC	4 fl oz	16 fl oz	Controls Japanese beetle.
Radiant SC	4 to 8 fl oz	24 fl oz	For post-harvest use only.
Sevin XLR	2 to 4 qt	5 applications	Controls Japanese beetle.

<sup>1</sup> Generic products available (Appendix E).

**WEED CONTROL: Asparagus**

Product	Amt/A	Lb A.I./A	Comments
<b>ESTABLISHED BEDS ONLY</b>			
3.0-7.7 oz Callisto	0.09-0.24	mesotrione	Apply prior to spear emergence in spring or post-harvest or both. Can be applied broadcast in spring before spear emergence or banded post-harvest. Do not apply more than 7.7 fl oz/A per season. Use a NIS at 0.25% v/v if weeds are already emerged. Use of an adjuvant post-harvest may cause crop injury.
6.0 oz Chateau WDG	0.19	Flumioxazin	For pre-emergence control of weeds in dormant asparagus. Apply at least 2 weeks prior to asparagus emergence in spring or unacceptable crop injury will result. Apply no more than 6 oz/A for the entire season.
8-16 fl oz Clarity	0.25-0.5	dicamba	For control of broadleaf weeds. Do not cultivate within 7 days after application. Apply to actively growing weeds in 40 to 60 gal water immediately after a harvest but at least 24 hours before the next harvest. Use high rate for perennial weeds. Can be used in tank-mix with 2,4-D or Roundup for control of Canada thistle or field bindweed. Discard crooked spears after harvest. Maximum of 1 pt/A per year.
8 lb Devrinol 50 DF	4	napropamide	For control of annual grasses and broadleaves. Apply as a surface applied or incorporated treatment in 10 to 50 gal water/A to stands established at least 1 season. Do not allow contact with crop foliage. Apply before crop emergence in the spring and incorporate 1 to 2 inches. Rainfall or irrigation may be used for incorporation.
1.5-2 qt Formula 40 3.67L	1.38-1.84	2,4-D	For selective post-emergence control of broadleaf weeds only. Apply in 60 gal water/A to actively growing weeds, usually in April or May. If spears are present, treat immediately after cutting. Make no more than 2 applications (spaced at least 1 month apart) during harvest season. For post-harvest application, use drop nozzles to avoid spraying the fern.
2-4 lb Karmex XP	1.6-3.2	diuron	For pre-emergence control of annual grasses and broadleaf weeds. Apply 1 to 2 lb per acre on light sandy soils and 2 to 4 lb per acre on heavier soils. Apply after disking or chopping fern in the spring at least 4 weeks before spears emerge. A second application may be made at the end of the harvest season if rainfall is expected. Max. rate of 6 lb/A per year. 6 to 8 weeks of residual activity.
1.5-2 pt Reglone	0.38-0.5	diquat	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply as a preplant or as a directed spray on non-bearing asparagus only in min. 15 gal water/A. Do not use for food or feed for 1 year after application.
16-22 fl oz Roundup WeatherMax	0.56-0.77	glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Solicam + Roundup tank-mix has been very effective against a broad spectrum of weed species. PHI = 14 days. Min. 30 days before replanting with any non-labeled crop. May be applied following final spring harvest, when all asparagus is cut to ground level over the entire planting, to help control both annual and perennial weeds.
1.5 lb Sinbar 80 WP	1.2-1.6	terbacil	For control of annual grasses and broadleaf weeds. Apply before spear emergence. Can be applied immediately after clean cutting.
2.5-5 lb Solicam DF	3-4	norflurazon	For control of annual grasses and broadleaf weeds and suppression of yellow nutsedge. Allow newly planted fields to become established for 1 season before 1st application. Apply as broadcast pre-emergent in min. 20 gal water/A. Apply in fall after chopping fern or in spring before fern emergence. Use low rate on sandy soils. PHI = 14 days. Apply only once per season.
3-4 pt Treflan HFP 4 E	1.5-2	trifluralin	For control of annual grasses and broadleaf weeds. Can be applied to dormant asparagus after fern has been removed or after last harvest. For split application, use 1.5 to 2 lb/A each time.
1.33-2.67 lb TriCor DF	1-2	metribuzin	For control of annual grasses and broadleaf weeds. Apply in 10 to 40 gal water/A before spear emergence. Do not use on young plants during the first growing season. Can also be applied as a split application of pre-emergence (0.67 to 1.33 lb/A) and after final harvest (1.33 to 2.0 lb/A) with a max. rate of 2.67 lb/A per season. PHI = 14 days.
<b>ESTABLISHED BEDS AND NEW PLANTINGS</b>			
1-1½ pt Fusilade DX	0.25-0.38	fluazifop-p	For selective post-emergence control of annual grasses and suppression of perennial grasses. Include 1% v/v crop oil or 0.25% v/v non-ionic surfactant/A. PHI = 1 day. Repeat applications must be at least 14 days apart. Max. rate is 48 fl oz/A per season and 24 fl oz/application.
2-4 pt Gramoxone Inteon	0.69-1.38	paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply as a band treatment over the row or as broadcast pre-emergence in min. 10 gal water/A. In new seedlings apply before, during, or after planting but before emergence of the crop. In plantings established at least 2 years, apply min. 6 days before crop emergence or after last harvest. Use with non-ionic surfactant 0.25% v/v. Max. 3 applications/season.
1-2 lb Lorox 50 DF	0.5-1	linuron	For control of annual grasses and broadleaves. Make 1 application pre-emergence at least 1 day before harvest. If used post-emergence, make 1 to 3 applications of 1 to 2 lb/A on weeds <4 inches tall. At the fern stage, apply 1 application of 4 lb/A as a directed spray to base of ferns. For newly planted crowns, use as pre-emergence application of 2 to 4 lb/A after planting. Activated charcoal as a band over the planted row is needed for protection of the newly planted crowns. For post-emergence, use 1 to 2 applications of 1 to 2 lb/A when ferns are 6 to 18 inches tall and weeds <4 inches tall. Do not exceed 4 lb/A per year.
0.5-2.5 pt Poast	0.09-0.49	sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. Apply over the top of bearing asparagus with min. 1 day before harvest. Max. rate of 2.5 pt/application and 5 pt/season.
2.4-8.2 pt Prowl H2O	1.14-3.90	pendmethalin	Not for use on newly seeded beds. Do not apply over the top of emerged spears. On sandy soils do not use more than 2.4 pts per acre. Do not apply more than 8.2 pts in a season. 14 day PHI.
16-22 fl oz Roundup WeatherMax 5.5L	0.69-0.94	glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Solicam + Roundup tank-mix has been very effective against a broad spectrum of weed species. PHI = 14 days. Min. 30 days before replanting with any non-labeled crop.
0.5-1 oz Sandea 75 DF	0.023-0.047	halosulfuron	For weed control of broadleaf weeds and yellow nutsedge. May be applied post-emergence broadcast during the harvesting season in at least 15 gal water/A. After harvest, direct application below the ferns for complete weed coverage and avoid contact with the fern. Max. 2 applications/season and 2 oz/A per season. PHI = 1 day. For first-year transplants, apply at least 6 weeks after fern emergence.
9-16 fl oz Select Max	0.07-0.14	clethodim	Apply to actively growing grasses. Use NIS at 0.25% v/v. PHI = 1 day. Do not apply more than 16 fl oz/A in a single application and no more than 64 fl oz/A (0.5 lb ai/A) per season. Apply in a volume of at least 10 and no more than 40 gal/A. For repeat applications make on a minimum of a 14-day interval.

**DISEASE CONTROL: Asparagus**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Cercospora Blight, Rust</b>					
Chlorothalonil <sup>4</sup>					
Bravo Ultrex	M	190	1.8 to 3.6 lb	11 lb	Apply after harvest of spears. Apply every 14 to 28 days when symptoms are first observed or when conditions favor disease.
Bravo WeatherStik	M	190	2 to 4 pt	12 pt	
Fixed coppers <sup>4</sup>					
Badge SC	M	0	1 to 2.5 pts		Apply every 10 days. See label for mixing instructions and tank-mix precautions.
Badge X2	M	0	1 to 2.5 pts		Rust only.
Mancozeb <sup>4</sup>					
Dry formulations	M	180	2 lb	8-8.5 lb	Products include Dithane, Koverall, Manzate, Penncozeb.
Liquid formulations	M		1.6 qt	6.4 qt	Apply after harvest of spears. Apply every 10 days when symptoms are first observed or when conditions favor disease.

(continued on next page)

**DISEASE CONTROL:** *Asparagus* (continued)

Product	FRAC Code	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Rally 40 WSP	3	180	5 oz	6 apps	Rust. Apply after harvest of spears. Apply with a spray adjuvant. Treat every 7 to 14 days when symptoms are first observed or when conditions favor disease.
Sulfur <sup>4</sup>	M	0			Rust. Apply after harvest of spears. Apply every 7 to 10 days when symptoms are first observed or when conditions favor disease. Phytotoxicity may occur when sulfur is applied when temperatures exceed 90°F.
Tebuconazole <sup>4</sup>	3	180			Rust. Apply after harvest of spears. Treat every 14 days when symptoms are first observed or when conditions favor disease.
<b>Fusarium Crown Rot</b>					
Mancozeb <sup>4</sup>					Products include Dithane, Koverall, Manzate, Penncozeb.
Dry formulations	M	180	2 lb <sup>3</sup>		Wash crowns before treatment. Pack crowns loosely in a burlap bag and dip in mancozeb solution for 5 min, agitating gently and continuously. Drain and plant immediately.
Liquid formulations	M	180	1.6 qt <sup>3</sup>		
<b>Phytophthora Crown/Spear Rot</b>					
Aliette <sup>6</sup>	33	110	5.0 lb	1 app	Apply to fully expanded ferns.
MetaStar 2E AG	4	1	4 pt	2 apps	<b>Cutting beds.</b> Apply as a broadcast spray over beds in 10 gal/A of water. Make first application 30 to 60 days before first cutting; make a second application, if necessary, just before harvest. <b>New plantings.</b> Apply immediately after planting seedlings or covering 1-year crowns. See label for plantback restrictions.
Ridomil Gold SL	4	1	1 pt	2 apps	
Ultra Flourish	4	1	2 pt	2 apps	
<b>Stemphylium Purple Spot</b>					
Azoxystrobin <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxy 2SC	11	100	6.0 to 15.5 fl oz <sup>5</sup>	92.3 fl oz	Apply before disease onset, continue every 14 days.
AzoxyStar	11	100	6.0 to 15.5 fl oz <sup>5</sup>	92.3 fl oz	
Quadris	11	100	6.0 to 15.5 fl oz <sup>5</sup>	4 apps	
Satori	11	100	6.0 to 15.5 fl oz <sup>5</sup>	92.3 fl oz	
Flint	11	180	3 to 4 oz <sup>5</sup>	3 apps	

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Per 100 gallons of water.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>5</sup> Use higher rate when pressure is severe.

<sup>6</sup> Restricted in some Kentucky counties. See fungicide safety table on page 20.

## Beans

Pea family (Fabaceae): *Phaseolus vulgaris*—snap bean, *P. lunatus*—Lima bean, *Glycine max*—soybean

### Planting and Culture

Begin first plantings after danger of frost and once soil has warmed to 60 to 65° F (see Appendix J). Successive plantings of bush snap beans at two- to three-week intervals may be desirable for roadside markets, U-pick, farmers' markets, and shipping.

**Bush Beans.** Plant in rows 24 to 30 inches apart. Plant seeds 2 to 3 inches apart in the row and 1 ½ inches deep in a well-prepared seedbed. See also "Production with Plasticulture."

**Lima Beans.** Plant in rows 24 to 30 inches apart for bush lima beans and 5 feet apart for pole lima beans. Space seeds 3 to 5 inches in the row, 1 to 2 inches deep.

**Pole Beans.** Plant seed in rows and thin plants to 6 to 8 inches apart in the row. Sow seed 1 to 2 inches deep. Space rows 5 feet apart, and prepare a wire trellis for plants to grow on.

**Dry Beans (pea-beans).** Plant seed in rows 28 inches apart with seed spaced 2 to 3 inches apart in the row and 1 inch deep. The first plantings should be made after danger of the last killing frost in the spring. Beans will not withstand frost and

do not do well when planted in cold soils, which make them more susceptible to rotting and slow growth. A seed treatment is highly recommended. Successive plantings of bush beans at two- to three-week intervals can be made until August 15.

Seeding rate is partly determined by variety. Small-seeded varieties require fewer pounds of seed per acre than large-seeded varieties. The average amount of seed to plant is about 80 pounds per acre.

There are no known detrimental effects on plant growth associated with inoculating seed with *Rhizobium* prior to planting. However, there are many different strains of *Rhizobium*, and many factors are involved in determining if it will increase nitrogen fixation and help your crop. There will be no effect if the field has a recent history of being planted with beans, because a large population of *Rhizobium* will already be present in the field.

### Production with Plasticulture

Some Kentucky growers producing for roadside stands or farmers' markets have obtained extremely high yields and a cleaner harvest of bush beans and half runners using trellises and black plastic on raised beds with drip irrigation. Holes are punched in the plastic by hand or with a waterwheel setter, and two to three seeds are planted in each hole. Two rows about 15 inches apart are planted on each

### FERTILIZER: Beans

Soil Test Results (lb/A)		Fertilizer Needed (lb/A)
Phosphorus		Phosphate (P <sub>2</sub> O <sub>5</sub> )
Low	<31	51-95
Medium	31-60	1-50
High	>60	0
Potassium		Potash (K <sub>2</sub> O)
Low	<201	51-150
Medium	201-300	1-50
High	>300	0
Nitrogen		N
Poor soils		50
Heavily fertilized soils		20-30

bed with a spacing of 12 inches between planting holes in the row. A simple trellis can be constructed by stringing horizontal rows of twine between tomato stakes spaced about 8 to 10 feet apart. Horizontal stringing is followed by weaving twine vertically between the top and bottom horizontal lines.

Pole beans require sturdier trellises. High-tensile wires are strung at 6 inches and at 5 feet above the ground. Jute twine is then woven vertically between these two wires.

### Fertilizing and Pollination

Snap-bean fertilizer trials in Kentucky indicate that 50 pounds of actual nitrogen per acre and a pH of 6.2 to 6.5 is adequate for good yields. For beans grown on plastic with

**VARIETIES:** Beans

Variety	Use			Seed Color	Maturity (days)	Comments
	Fresh Market	Canning	Shipping			
<b>SNAP BEANS, BUSH PLANT TYPE</b>						
Jade	X	X	X	LGr	53	High quality, high yielding bean
Bronco	X	X	X	W	53	Round, 5.5 inches long, dark green pods, high yield potential, resistance to mosaic and seed transmission of bean common mosaic virus.
Pony Express	X	X	X	W	53	Very high yields, upright plant, resistant to bean common mosaic and bean curly top viruses.
Hialeah	X	X	X	W	53	Round; high yield and recovery for machine harvested, fresh market beans.
Tema	X	X		DBr	53	Round pods, resistance to mosaic and seed transmission of bean common mosaic virus.
Tenderette	X	X	X	W	53	Round pods; concentrated set; tolerant to bean mosaic.
Hickok	X	X			54	Upright plant; high quality and straight pods; has grown well in both northern and southern U.S. Some resistance to Bean Common Mosaic Virus, Rust, and Bean Curly Top Virus.
Magnum	X		X	LBr	55	Flat, medium light green, 6.9 inches long pods, resistance to mosaic and seed transmission of bean common mosaic virus.
Lewis	X	X	X	W	53	Resistant to bean common mosaic and curly top viruses rust, halo blight, bacterial brown spot.
Caprice	X		X	W	60	Round pods, 6 inches, dark green, resistant to bean common mosaic virus, anthracnose, halo blight, common blight, with some resistance to bacterial brown spot
<b>SNAP BEANS, POLE TYPE</b>						
Kentucky Blue	X	X	X	W	58	Round, medium green pod, 7 to 10 inches long, excellent flavor; resistant to bean common mosaic virus, rust.
White Kentucky Wonder 191	X	X	X	W	65	Round pod; rust resistant.
State Half Runner	X	X		W	60	Some tolerance to common bean mosaic; beans have strings, poor set in heat
Volunteer Half Runner	X	X		W	60	Resistant to common bean mosaic, intermediate resistance to rust, sets better than others in heat
<b>OTHER</b>						
Royal Burgundy	X			B	55	Deep purple snap beans on bush plants.
Roma II (snap bush Romano)	X			W	58	Resistant to common bean mosaic and NY15 mosaic. Flat pods.
Maxibel	X			T/B	60	Long, thin, stringless 7 to 8 inches "French beans."
Carson (bush)	X			W	56	Round, yellow wax bean; resistant to bean common mosaic virus, NY15 mosaic, bacterial spot, 5 to 6 inches long.
Fordhook 242 (Lima, bush)		X	X	G	78	Large pod; sets blossom under adverse weather conditions.
Capitol (Navy, dry bean)		X	X	W	92	30-inch high plants; large seeded.
<b>VEGETABLE SOYBEANS</b>						
Envy	X			Y/G	75	Earliest vegetable bean; 2 foot tall plant
BeSweet 292	X			Y/G	85	Top commercial variety; powdery mildew resistant.

<sup>1</sup> W = white, DBr = dark brown, LBr = light brown, T/B = tan/brown, Y = yellow, G = greenish

drip irrigation, 19 to 26 pounds of calcium nitrate per acre can be fertigated weekly.

Zinc deficiency has been a limiting factor in some areas of the state. Where zinc levels are known to be low, up to 20 pounds of elemental zinc or 55 pounds per acre of zinc sulfate should be broadcast prior to seeding (see Appendix B).

If air temperature rises above 90°F during the pollination period, pollen production and growth can be reduced. Unpollinated blossoms will drop off. Blossom drop can be reduced by maintaining adequate soil moisture and by keeping good leaf growth on the vines. Poor pollination also can cause pods to be misshapen. Irrigation at the time of bloom will help ensure good pod set if soils are dry.

**Harvesting and Storage**

For the best eating quality, harvest green snap beans and pole beans when the bean seed is about one-third developed. Many snap beans are mechanically harvested (once-over harvest). Varieties that produce a concentrated set of pods should be grown where mechanical harvesters are used. Green beans for the fresh wholesale market are packed in bushel baskets or cartons.

Vegetable soybeans (edamame) are picked when the pods are nearly fully grown but before they begin to turn yellow. Shelling is made easier by dropping the pods in a pot of boiling water for 15 to 20 minutes.

Navy and kidney beans should be harvested and handled at the 17 to 18 percent moisture level to prevent splitting and seed-coat damage. Pinto beans should be harvested at around 14 percent moisture.

Green beans are stored at 40° to 45°F and 90 to 95 percent relative humidity.

**Common Diseases/Management**

**Seedling disease and seed rots.** Seed planted when soil temperatures are below 65°F need a fungicide treatment. Those who buy untreated seed should apply Captan 40W. At-planting (in-furrow) application of fungicides can reduce losses to seedling disease.

**Anthracnose.** In most situations, control measures consist of rotating to non-legume crops for at least two years and planting pathogen-free seed. Deeply incorporate bean stubble promptly after harvest to limit pathogen survival. Do not work crops while foliage is wet, especially pole beans. Fungicides can be an important part of an integrated management plan.

**Bacterial blights (halo blight, common blight, and brown spot).** Plant certified, disease-free seed and rotate two to three years to non-leguminous crops. Do not work while plants are wet. Purchase seed that has been treated with streptomycin. Practice sanitation between fields. Plow under bean stubble immediately after harvest to encourage rapid decline in bacterial populations. Fixed coppers may prevent spread of these diseases.

**Nematodes.** Root-knot, soybean cyst, and lesion nematodes are common to Kentucky. Rotate at least two to three years with grasses (corn, fescue, small grains), and control weeds. Do not rotate with alfalfa, soybeans, tomatoes, tobacco, or other hosts of any of these nematodes. Nematicides are available, but thresholds for their use have not been established in Kentucky. See "Soil Fumigants for Control of Nematodes and Soilborne Diseases" on page 16.

**Root rots.** Several fungi, including *Pythium*, *Fusarium*, *Rhizoctonia*, and *Thielaviopsis*, cause root diseases in Kentucky. Seed treatments reduce losses, but at-planting applications of fungicide may be warranted in some situations. A band or furrow fungicide treatment at seeding time can be helpful. Sod and/or cover crops should be incorporated early to promote thorough decomposition before planting. Soil temperatures at planting should be at least 65°F.

**Rust.** Rust-resistant varieties are available, including 'Dade,' 'Kentucky Wonder,' 'Opus,' 'Roma,' and 'Spurt.' Fungicide sprays can be especially valuable with fall plantings.

**Viruses (Mosaic).** Avoid planting near weedy borders, clover, or other legumes, including older bean plantings, and control weeds in the field. Use certified disease-free seed. Staggered seeding dates increase the chances that some plantings will escape high aphid activity; however, sequential plantings can also harbor viruses. Increasing the seeding rate can help sustain yields

when a high incidence of viruses occurs early. Reflective mulches may disturb aphid flights and reduce virus transmission. Use varieties resistant to bean common mosaic and bean yellow mosaic. Bush varieties include 'Bronco,' 'Bush Blue Lake 274,' 'Embassy,' 'Provider,' and 'Valentino.' In general, half runner and pole beans are highly sensitive to some of these viruses.

**White mold, gray mold.** Avoid fields with a history of white mold in any vegetable crop. Deep-turning infested fields will encourage decomposition of survival structures (sclerotia). Rotate two to three years with grass crops; avoid canola, potatoes, tomatoes, and cabbage. No-till beans have increased potential for white and gray mold. Fungicides are available.

**PESTICIDE SAFETY: Beans**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>INSECTICIDES</b>			
Acramite 4SC	C	12	3
Admire Pro	C	12	7/21 <sup>3</sup>
Assail 30 SG	C	12	7
Belt 4 SC	C	12	1/14 <sup>3</sup>
Blackhawk 36 WG	C	4	3/28
Bt products	C	12	0
Coragen 1.67 SC	-	4	1
Courier 40 SC	C	12	14
Dibrom 8	D	24	1
Dimethoate 4 E	W	48	0
Intrepid 2F	C	4	7
Kanemite 15 SC	C	12	7
Knack 0.83 EC	C	12	7
Malathion 8	C	12	1
Miteus 0.42 EC	W	21	1
Movento 2 SC	C	24	1
Orthene 75 S	C	24	1/14 <sup>3</sup>
Radiant SC	C	4	3/28 <sup>3</sup>
Rimon 0.83 EC	W	12	1
Sevin XLR	C	12	3
Sivanto 1.67 SL	C	12	7/21 <sup>3</sup>
Trigard 75 WP	C	12	7

**PESTICIDE SAFETY: Beans**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>Restricted Use</b>			
Agri-Mek 0.15 EC	W	12	7 <sup>3</sup>
Asana XL	W	12	3/21 <sup>3</sup>
Baythroid XL	W	12	3/7 <sup>3</sup>
Brigade 2 EC	W	12	3
Diazinon 50 W	C	24	7
Hero 1.24 EC	C	12	3
Lannate 90 SP	DP	48	1/14 <sup>3</sup>
Leverage 2.7	W	12	71
Mustang Max	W	12	1/21 <sup>3</sup>
Proaxis 0.5 EC	C	24	7/21 <sup>3</sup>
Renounce 20 WP	C	12	7
Thimet 20 G	DP	48	60
Warrior II	W	24	7/21 <sup>3</sup>
<b>FUNGICIDES<sup>3</sup></b>			
Approach	C	12	14
Blocker 10G	C	12	45
Cannonball WP	C	12	7
Chlorothalonil <sup>2</sup>	W	12	7/14 <sup>3</sup>
Endura	W	12	7/21 <sup>3</sup>
Fixed coppers <sup>2</sup>	W	24/48	0
Fontelis	C	12	0
Headline	W	12	7/30 <sup>3</sup>
Iprodione 4L AG	C	24	0
MetaStar 2EC AG	W	48	0

**PESTICIDE SAFETY: Beans**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
Nevado 4F	C	24	0
Omega 500F	W	12	30
PCNB <sup>2</sup>	W	12	0
Priaxor	C	12	7/21 <sup>3</sup>
Quadris	C	4	0
Quadris Opti	W	12	14
Quilt	W	12	7/14 <sup>3</sup>
Quilt Xcel	W	12	7/14 <sup>3</sup>
Ridomil Gold SL	C	48	0
Ridomil Gold PC GR	W	48	0
Rovral 4 Flowable	C	24	0
Sulfur <sup>2</sup>	C	24	0
Switch	C	12	7
Tebuconazole <sup>2</sup>	C	12	7/14 <sup>3</sup>
Thiophanate-methyl <sup>2</sup>	C	12	14/28 <sup>3</sup>
Tilt	W	12	7
<b>Snap beans only</b>			
Botran 75 W	C	12	2
Botran 5F	C	12	2
Rally 40 WSP	W	24	0
<b>Dry beans only</b>			
Quadris Opti	W	12	14
Proline 480 SC	C	48	7

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison  
<sup>2</sup> Several formulations are marketed. See the general introduction for more details on fungicides.  
<sup>3</sup> Dependent on formulation, type of bean, and application rate; there are specific restrictions on feeding and grazing, so see label.

**INSECT CONTROL: Beans<sup>1</sup>**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>PREPLANT INCORPORATED</b>			
<b>Cutworms:</b> Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites.			
Diazinon AG 500	2 to 4 qt		Incorporate immediately.
<b>AT PLANTING</b>			
<b>Aphids, Leafhoppers, Seedcorn Maggots:</b> Seedcorn maggots damage newly planted seeds by feeding on seed contents. Shallow planting in well-prepared seedbeds and adequate soil temperature to promote rapid germination will aid in reducing problems. Heavy cover crops or manure should be plowed early to render fields less attractive for egg laying.			
Admire Pro	7 to 10.5 fl oz	10.5 fl oz	See label for application methods.
Thimet 20 G	4.5 to 7 oz/ 1,000 row-feet	-	Place band on each side of furrow.
<b>FOLIAR TREATMENTS</b>			
<b>Grasshoppers</b>			
Asana XL	5.8 to 9.6 fl oz	38.4 fl oz	Do not feed to livestock. Not for use on Lima beans.
Baythroid XL	2.4 to 3.2 fl oz	6.4 fl oz	Limit 3.2 fl oz per 14-day period. For shelled beans only.
Brigade 2 EC	1.6 to 6.4 fl oz	19.2 fl oz	Allow 7 days between applications. Dried beans only.
Dimethoate 4 E	8 to 16 fl oz	32 fl oz	Allow 14 days between applications.
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 5 days between applications.
<b>Aphids, Leafhoppers</b>			
Admire Pro	1.2 fl oz	3.7 fl oz	Allow 7 days between applications.
Asana XL	2.9 to 9.6 fl oz	38.4 fl oz	Do not feed to livestock. Not for use on Lima beans. For leafhoppers only.
Assail 30 SG	2.5 to 5.3 oz	16 oz	Limit 3 applications. Allow 7 days between applications. Not for dried beans.
Baythroid XL	0.8 to 1.6 fl oz	6.4 fl oz	Limit 3.2 fl oz per 14-day period. For shelled beans only.
Brigade 2 EC	1.6 to 6.4 fl oz	19.2 fl oz	Allow 7 days between applications. Dried beans only.
Dimethoate 4 E	8 to 16 fl oz	32 fl oz	Do not spray during bloom. Allow 14 days between applications.
Lannate 90 SP	0.5 to 1 lb	5 lb	Limit 10 applications.

(continued on next page)

**INSECT CONTROL: Beans<sup>1</sup> (continued)**

<b>Insecticide</b>	<b>Product Amt/A</b>	<b>Seasonal Limit/A</b>	<b>Comments and Other Restrictions</b>
Malathion 8	1.5 pt	-	-
Movento 2 SC	4 to 5 fl oz	10 fl oz	Allow 7 days between applications.
Mustang Max	2.72 to 4 fl oz	24 fl oz	Allow 5 days between applications.
Orthene 75 S	0.67 to 1.33 lb	2.67 lb	-
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	Allow 5 days between applications.
Sevin XLR	1 qt	6 qt	Leafhoppers only. Limit 4 applications, allow 7 days between sprays.
Sivanto 1.67 SL	7 to 10.5 fl oz	28 fl oz	Allow 10 days between applications.
Warrior II	1.28 to 1.92 fl oz	7.68 fl oz	Allow 5 days between applications.
<b>Corn Earworms</b>			
Asana XL	5.8 to 9.6 fl oz	38.4 fl oz	Do not feed to livestock. Not for use on Lima beans.
Baythroid XL	2.4 to 3.2 fl oz	6.4 fl oz	Limit 3.2 fl oz per 14-day period. For shelled beans only.
Belt 4 SC	2 to 3 fl oz	6 fl oz	Allow 5 days between applications.
Blackhawk 36 WG	2.2 to 3.3 oz	20 oz	Allow 5 days between applications.
Brigade 2 EC	2.1 to 6.4 fl oz	19.2 fl oz	Allow 7 days between applications. Dried beans only.
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Allow 3 days between applications.
Intrepid 2 F	10 to 16 fl oz	64 fl oz	Allow 7 days between applications.
Mustang Max	2.72 to 4 fl oz	24 fl oz	Allow 5 days between applications.
Orthene 75 S	1 to 1.33 lb	2.67 lb	-
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	Allow 5 days between applications.
Radiant SC	4 to 8 fl oz	12 fl oz	Allow 4 days between applications.
Sevin XLR	0.5 to 1.5 qt	6 qt	Limit 4 applications. Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	7.68 fl oz	Allow 5 days between applications.
<b>Cutworms</b>			
Baythroid XL	0.8 to 1.6 fl oz	6.4 fl oz	Limit 3.2 fl oz per 14-day period. For shelled beans only.
Belt 4 SC	2 to 3 fl oz	6 fl oz	Allow 5 days between applications.
Mustang Max	1.28 to 4 fl oz	24 fl oz	Allow 5 days between applications.
Orthene 75 S	0.67 to 1.33 lb	2.67 lb	-
Proaxis 0.5 EC	1.92 to 3.2 fl oz	15.36 fl oz	Allow 5 days between applications.
Warrior II	0.96 to 1.6 fl oz	7.68 fl oz	Allow 5 days between applications.
<b>Japanese Beetles</b>			
Baythroid XL	2.4 to 3.2 fl oz	6.4 fl oz	Limit 3.2 fl oz per 14-day period. For shelled beans only.
Brigade 2 EC	2.1 to 6.4 fl oz	19.2 fl oz	Allow 7 days between applications. Dried beans only.
Mustang Max	2.72 to 4 fl oz	24 fl oz	Allow 5 days between applications.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	Allow 5 days between applications.
Sevin XLR	0.5 to 1 qt	6 qt	Blister beetles and flea beetles also. Limit 4 applications. Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	7.68 fl oz	Allow 5 days between applications.
<b>Mexican Bean Beetles, Bean Leaf Beetles:</b> Treat for Mexican bean beetle if populations exceed 0.5 adults per plant or if egg mass number is greater than 1 per foot of row.			
Asana XL	2.9 to 5.8 fl oz	38.4 fl oz	Do not feed to livestock. Not for use on Lima beans. Bean leaf beetle only.
Assail 30 SG	2.5 to 5.3 oz	16 fl oz	Limit 3 applications. Allow 7 days between applications. Not for dried beans.
Baythroid XL	2.4 to 3.2 fl oz	6.4 fl oz	Limit 3.2 fl oz per 14-day period. For shelled beans only.
Brigade 2 EC	2.1 to 6.4 fl oz	19.2 fl oz	Bean leaf beetle only. Allow 7 days between applications. Dried beans only.
Dimethoate 4 E	8 to 16 fl oz	2 pt	Allow 14 days between applications.
Malathion 8	1.5 pt	-	-
Mustang Max	2.72 to 4 fl oz	24 fl oz	Allow 5 days between applications.
Orthene 75 S	0.67 to 1.33 lb	2.67 lb	-
Proaxis 0.5 EC	1.92 to 3.2 fl oz	15.36 fl oz	Allow 5 days between applications.
Rimon 0.83 EC	9 to 12 fl oz	36 fl oz	Allow 7 days between applications.
Warrior II	0.96 to 1.92 fl oz	7.68 fl oz	Allow 5 days between applications.
<b>Spider Mites</b>			
Acramite 4 SC	12 to 16 fl oz	2 applications	Allow 14 days between applications.
Agri-Mek 0.15 EC	8 to 16 fl oz	48 fl oz	Allow 6 days between applications. Dry beans only.
Brigade 2 EC	5.12 to 6.4 fl oz	19.2 fl oz	Allow 7 days between applications. Dried beans only.
Dimethoate 4 E	8 to 16 fl oz	2 pt	Allow 14 days between applications.
Kanemite 15 SC	31 fl oz	62 fl oz	Allow 14 days between applications.
Miteus 0.42 EC	2 pt	4 pt	Allow 14 days between applications.
<b>Stink Bugs</b>			
Baythroid XL	1.6 to 2.4 fl oz	6.4 fl oz	Limit 3.2 fl oz per 14-day period. For shelled beans only.
Brigade 2 EC	2.1 to 6.4 fl oz	19.2 fl oz	Allow 7 days between applications. Dried beans only.
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 5 days between applications.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	Allow 5 days between applications.
Warrior II	1.28 to 1.92 fl oz	7.68 fl oz	Allow 5 days between applications.
<b>Thrips, Whiteflies:</b> Thrips damage to small seedlings is uncommon and plants usually recover without treatment. Although whiteflies are common in beans, they are not usually a serious problem.			
Assail 30 SG	4.5 to 5.3 oz	16 oz	Limit 3 applications. Allow 7 days between applications. Not for dried beans.
Blackhawk 36 WG	2.5 to 3.3 oz	20 oz	Allow 5 days between applications. Use an adjuvant.
Brigade 2 EC	2.1 to 6.4 fl oz	19.2 fl oz	Allow 7 days between applications. Dried beans only.
Courier 40 SC	8.7 fl oz	17.4 fl oz	Apply before bloom. Allow 5 days between applications. For whiteflies on snap beans only.
Knack 0.83 EC	8 to 10 fl oz	20 fl oz	Allow 14 days between applications. For eggs and immature stages of whiteflies only.
Movento 2 SC	4 to 5 fl oz	10 fl oz	Allow 7 days between applications. For whiteflies.
Orthene 75 S	0.67 to 1.33 lb	2.67 lb	For thrips.

*(continued on next page)*

**INSECT CONTROL: Beans<sup>1</sup> (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Miteus 0.42 EC	2 pt	4 pt	Allow 14 days between applications. For whiteflies.
Sivanto 1.67 SL	10.5 to 14 fl oz	28 fl oz	Allow 10 days between applications. For whiteflies.

<sup>1</sup> Generic products available (Appendix E).

**WEED CONTROL: Beans**

Product Amt/A	Lb A.I./A	Comments
<b>Lima, Snap Beans</b>		
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
1-2 pt Basagran 4S	0.5-1 bentazon	Use post-emergence for control of annual broadleaves and suppression of yellow nutsedge. Do not apply until the first trifoliolate bean leaf is fully expanded. Some injury may occur but plants will grow out of it. Do not apply more than 4 pt/A per year. PHI = 30 days.
0.4-0.67 pt Command 3ME	0.15-0.25 clomazone	Use pre-emergence for suppression of annual grasses and broadleaf weeds. Apply once in min. 10 gal water/A. PHI = 45 days.
1.3-1.7 pt Dual II Magnum	1.3-1.6 s-metolachlor	For control of most annual grasses and certain broadleaves. Apply preplant surface or incorporated or pre-emergence. Small grains may be planted 4½ months following this treatment. See label for other rotational crops.
2-4 pt Gramoxone Inteon	0.69-1.38 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds.
2.5-3 qt Micro-Tech 4 E	2.5-3 alachlor	Lima (green) beans only. For control of annual grasses and broadleaf weeds and yellow nutsedge. Max. 1 application/year or 3 qt/A. Apply preplant incorporated within 7 days before planting or surface application before or after planting.
0.5-2.5 pt Poast	0.09-0.49 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 15 days. Max. rate of 2.5 pt/application and 4 pt/season.
1.8-3.6 pt Prowl 3.3 EC	0.74-1.49 pendimethalin	For control of annual grasses and broadleaf weeds. Apply before planting and incorporate 1 to 2 inches up to 60 days before planting and incorporate within 7 days of application. Do not apply surface pre-emergence or serious crop injury can result.
1.5- 3.0 pt Prowl H2O		Broadcast and incorporate. Not effective on soils with high organic matter
0.75-1.5 pt Reflex 2 EC	0.18-0.36 fomesafen	For post-emergence control of broadleaves and suppression of grasses, apply broadcast to actively growing weeds. Use COC as adjuvant 0.5-1% v/v. Max rate is 1.5 pt/A per season. Do not use hay or straw for animal feed or bedding. Check label for plantback restrictions. Timely cultivation 1 to 3 weeks after applying Reflex may assist weed control. PHI = 45 days.
16-22 fl oz Roundup WeatherMax	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
0.5-1 oz Sanda 75 DF	0.023-0.047 halosulfuron	For control of broadleaf weeds and yellow nutsedge. Apply after planting but before cracking in min. 15 gal water/A. PHI = 30 days. Max. 1 oz/A/crop and 2 oz/A per season.
0.5-1 oz Sanda DF + 3.5-4.5 pt Eptam 7 E	0.023-0.047 halosulfuron + 3-4 EPTC	For control of broadleaf weeds, grasses, and yellow nutsedge. Apply and incorporate to a depth of ½ to 2 inches just before planting. Max. rate 1 oz Sandea/season and 7 pt Eptam/season. Do not use Eptam on flat-podded beans except Romano.
9-16 fl oz Select Max	0.07-0.13 clethodim	For selected post-emergent control of some grasses. For use on succulent shelled beans only. PHI = 21 days. Use a NIS 0.25% v/v for added control. Limit one application per season.
2.5 -5.0 fl oz Targa		Maximum rate 14 oz per season. 7 day interval minimum. PHI = 15 days.
1-1.5 pt Treflan HFP 4 E	0.5-0.75 trifluralin	For control of annual grasses and broadleaf weeds. Apply and incorporate in spring before planting or in fall in advance of spring planting.
<b>Dry Beans</b>		
5-12 fl oz Assure II 0.88L	0.033-0.08 quizalofop	For selective post-emergence control of annual grasses and suppression of perennial grasses. Apply to actively growing grasses in 10 to 15 gal water/A. Include 1% v/v crop oil concentrate or 0.25% v/v non-ionic surfactant. Snap beans: 15-day pre-harvest interval and maximum of 14 oz/A per season. Dry beans: 30-day pre-harvest interval and maximum of 28 oz/A per season.
1-2 pt Basagran	0.5-1 bentazon	Use post-emergence for control of annual broadleaves and suppression of yellow nutsedge. Do not apply until the first trifoliolate bean leaf is fully expanded. Some injury may occur but plants will grow out of it. Do not apply more than 4 pt/A per year.
3.5 pt Eptam 7 E	3 EPTC	For control of annual grasses and broadleaf weeds and suppression of yellow nutsedge. Apply before planting and incorporate into soil 2 to 4 inches immediately. Can be applied as a directed lay-by application to soil at the base of the plants before pods start to form. Gives good nutsedge suppression. Do not use on flat podded beans except for Romano beans.
1.2-2.0 pt Gramoxone Inteon	0.4-0.67 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply as a leaf desiccant in min. 20 gal water/A. Apply when crop is mature or at least 80% pods are yellowing and mostly ripe. Use with non-ionic surfactant 0.25% v/v. Max. 2 applications/season. PHI = 7 days.
14-18 fl oz Outlook 6 E	0.65-0.84 dimethenamid-P	For control of annual grasses and broadleaf weeds and suppression of seedling Johnson grass. Can be applied pre-plant surface or incorporated, pre-emergence or post-emergence to dry beans at 1-3 trifoliolate stage. PHI = 70 days.
0.5-2.5 pt Poast	0.09-0.49 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 30 days. Max. rate of 2.5 pt/application and 4 pt/season.
1.8-3.6 pt Prowl 3.3 EC	1-2 pendimethalin	For control of annual grasses and broadleaf weeds. Apply before planting and incorporate 1 to 2 inches up to 60 days before planting and incorporate within 7 days of application. Do not apply surface pre-emergence, or serious crop injury can result.
1.5- 3.0 pt Prowl H2O		Broadcast and incorporate. Not effective on soils with high organic matter
4 fl oz Raptor 1EC	0.031 imazamox	For control of annual grasses and broadleaf weeds. Some varieties are sensitive and injury can occur. Apply post-emergence to actively growing dry beans with at least 1 fully expanded trifoliolate leaf. Max. 1 application/season.
0.75-1.5 pt Reflex 2 EC	0.18-0.36 fomesafen	For post-emergence control of broadleaves and suppression of grasses, apply broadcast to actively growing weeds. Use COC as adjuvant 0.5-1% v/v. Max rate is 1.5 pt/A per season. Do not use hay or straw for animal feed or bedding. Check label for plantback restrictions. Timely cultivation 1 to 3 weeks after applying Reflex may assist weed control. PHI = 45 days.

(continued on next page)

**WEED CONTROL:** *Beans (continued)*

Product Amt/A	Lb A.I./A	Comments
16-22 fl oz Roundup Weather-Max 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
0.5-0.66 oz Permit 75 DF	0.023-0.031 halosulfuron	For control of broadleaf weeds and yellow nutsedge. Apply broadcast after planting but before cracking in min. 15 gal water/A. PHI = 30 days. Max. of 0.66 oz/A per crop and 2 oz/A per season.
0.5-0.66 oz Permit DF + 3.5-4.5 pt Eptam 7 E	0.023-0.03 halosulfuron + 3-4 EPTC	For control of broadleaf weeds, grasses, and yellow nutsedge. Apply and incorporate to a depth of ½ to 2 inches just before planting. Max. rate 2/3 oz Permit/season and 7 pt Eptam/season. Do not use Eptam on flat-podded beans except Romano.
9-32 fl oz Select Max	0.07-0.24 clethodim	For selected post-emergent control of some grasses. For use on succulent shelled beans only. PHI = 30 days. Use a NIS 0.25% v/v for added control. Limit 64 fl oz per season.
7.5-11.5 lb Sonalan 10G	0.75-1.15 ethalfuralin	For pre-emergence control of annual grasses and broadleaves. Apply and incorporate before planting.
2.5-5.0 fl oz Targa		Maximum rate 28 oz per season. 7 day interval minimum. PHI = 30 days.
1-2 pt Treflan HFP 4 E	0.5-1 trifluralin	For control of annual grasses and broadleaf weeds. Apply and incorporate in spring before planting or in fall in advance of spring planting.

**DISEASE CONTROL:** *Beans*

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Anthraxnose</b>					
Aproach	11	14	6 to 12 fl oz <sup>5</sup>	24 fl oz	Dry beans only. Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxy 25C	11	0	6 to 15.5 fl oz <sup>5</sup>	4 foliar apps	
AzoxyStar	11	0	6 to 15.5 fl oz <sup>5</sup>	4 foliar apps	
Quadris	11	0	6 to 15.5 fl oz <sup>5</sup>	4 foliar apps	
Satori	11	0	6 to 15.5 fl oz <sup>5</sup>	4 foliar apps	
<b>Chlorothalonil<sup>4</sup></b>					
Bravo Ultrex	M	7	1.25 to 1.8 lb	7.3 lb	Dry beans only. Apply at disease onset, repeat every 7 to 10 days. PHI is 14 days.
Bravo WeatherStik	M	7	1.375 to 2 pt	8 pt	
<b>Fixed coppers</b>					
					Apply every 5 to 10 or 7 to 14 days, depending on product and conditions. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1 to 2 pt		-
Badge X2	M	0	0.5 to 1.25 lb		OMRI-listed.
Basic Copper 53	M	0	1.5 lb		OMRI-listed.
C-O-C-S WDG	M	0	2 to 4 lb		-
COC DF	M	0	2 to 4 lb		-
COC WP	M	0	2 to 4 lb		OMRI-listed.
Cueva	M	0	0.2 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Kentan DF	M	0	1 to 2 lb		-
Nordox 75 WG	M	0	0.66 to 2.5 lb		OMRI-listed.
Fontelis	7	0	14 to 30 fl oz <sup>5</sup>	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Headline	11	7/30 <sup>3</sup>	6 to 9 fl oz <sup>5</sup>	2 apps	Apply before disease onset, continue every 7 to 14 days.
Priaxor	7/11	7/21 <sup>3</sup>	4 to 8 fl oz <sup>5</sup>	2 apps	Apply every 7 to 14 days.
Quadris Opti	11/M	14	1.6 to 2.4 pt	see comments	Dry beans only. Apply before disease onset, continue every 7 to 14 days.
Quilt	3/11	7/14	14 fl oz	42 fl oz	Apply before disease onset and continue every 7 to 14 days. Some leaf crinkling may occur as a result of application, but yields should not be affected.
Quilt Xcel	11/3	7/14	10.5 to 14 fl oz	42 fl oz	
<b>Thiophanate-methyl<sup>4</sup></b>					
Topsin 4.5 FL	1	14/28	20 to 40 fl oz	80 fl oz	Apply when 10 to 30% of plants have at least one open bloom OR when conditions favor disease, continue every 4 to 7 days (no later than peak bloom).
Topsin M 70 WP	1	14/28	1 to 2 lb	4 lb	
Topsin M WSB	1	14/28	1 to 2 lb	4 lb	
Tilt	3	7	4 fl oz	12 fl oz	Make up to three applications every 7 to 14 days. May cause leaf crinkling or increased greening of leaves.

**Bacterial Blights (i.e. Halo Blight, Common Blight, Brown Spot)**

<b>Fixed coppers</b>					
					Apply every 5 to 10 or 7 to 14 days, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1 to 2 pt		-
Badge X2	M	0	0.5 to 1.25 lb		OMRI-listed.
Basic Copper 53	M	0	1.5 lb		OMRI-listed.
C-O-C-S WDG	M	0	2 to 4 lb		-
Champ DP	M	0	0.67 to 2 lb		-
Champ Formula 2 FL	M	0	0.67 to 2 pt		-
Champ WG	M	0	1 to 3 lb		OMRI-listed.
COC DF	M	0	2 to 4 lb		-
COC WP	M	0	2 to 4 lb		OMRI-listed.
Copper-Count-N	M	0	2 to 6 pt		-
Cueva	M	0	0.2 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	0.75 to 2 lb		-
Kentan DF	M	0	1 to 2 lb		-
Kocide 2000	M	0	0.75 to 2.25 lb		-
Kocide 3000	M	0	0.5 to 1.25 lb		-
Kocide DF	M	0	1 to 3 lb		-
Nordox 75 WG	M	0	0.66 to 2.5 lb		OMRI-listed.

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**DISEASE CONTROL: Beans (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Nu-Cop HB	M	0	0.5 to 1.5 lb		-
Nu-Cop 50 WP	M	0	1 to 3 lb		OMRI-listed.
Nu-Cop 3 L	M	0	0.66 to 4 pt		-
Nu-Cop 50 DF	M	0	1 to 3 lb		OMRI-listed.
<b>Gray Mold, White Mold</b>					
Aproach	11	14	8 to 12 fl oz <sup>5</sup>	24 fl oz	Dry beans only. Apply before disease onset, continue every 7 to 14 days.
Botran 75 W	14	2	2.25 to 4 lb	n/a	Snap beans only for control of white mold. Use low rate for bush varieties, high rate for pole varieties. Apply when conditions favor disease and continue every 7 days during favorable periods.
Botran 5F	14	2	1.33 to 1.6 qt	5.2 qt	
Cannonball WP	12	7	7 oz	28 oz	For white mold, make first application at 10-20% bloom.
Chlorothalonil <sup>4</sup>					Snap beans only. Apply at early bloom or when conditions favor disease. PHI is 7 days.
Bravo Ultrex	M	7	2.7 lb	10.9 lb	
Bravo WeatherStik	M	7	3 pt	12 pt	
Cueva	M	0	0.5 to 2 gal	n/a	OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution. Apply before 25% bloom for white mold.
Endura	7	7/21	8 to 11 oz	2 apps	Apply at the beginning of flowering or before disease onset. PHI is 7 days for snap (succulent) beans, 21 days for dry beans.
Fontelis	7	0	14 to 30 fl oz <sup>5</sup>	72 fl oz	Apply at beginning bloom and 7 to 10 days later at full bloom.
Iprodione <sup>4</sup>					Apply when 1 to 10% of plants have at least one bloom; make a second application (if necessary) 5 to 7 days later, but no later than full bloom.
Rovral 4 Flowable	2	0	1.5 to 2 pt	2 apps	
Omega 500F	29	30	0.5 to 0.85 pt	1.75 pt	Make first application at 10-30% bloom, make a second application 7 to 10 days later if needed.
Priaxor	7/11	7/21	6 to 8 fl oz <sup>5</sup>	2 apps	Apply every 7 to 14 days.
Proline 480 SC	3	7	4.3 to 5.7 fl oz	3 apps	Dry beans only for control of white mold. Apply at the first sign of disease, continue every 5 to 14 days if conditions remain favorable for disease. Use the highest rate for severe disease pressure.
Switch 62.5WG	9/12	7	11 to 14 oz	56 oz	Apply prior to or at the onset of disease, repeat applications every 7 days if needed. For white mold, beginning at 10-20% bloom.
<b>Thiophanate-methyl<sup>4</sup></b>					
Topsin 4.5 FL	1	14/28	20 to 40 fl oz	80 fl oz	Apply when 10 to 30% of plants have at least one open bloom OR when conditions favor disease, continue every 4 to 7 days (no later than peak bloom).
Topsin M 70 WP	1	14/28	1 to 2 lb	4 lb	
Topsin M WSB	1	14/28	1 to 2 lb	4 lb	
<b>Rhizoctonia Web Blight, Pod Rot</b>					
<b>Azoxystrobin<sup>4</sup></b>					
Apply before disease onset, continue every 7 to 14 days.					
Azoxy 2SC	11	0	6 to 15.5 fl oz <sup>5</sup>	4 foliar apps	
AzoxyStar	11	0	6 to 15.5 fl oz <sup>5</sup>	4 foliar apps	
Quadris	11	0	6 to 15.5 fl oz <sup>5</sup>	4 foliar apps	
Satori	11	0	6 to 15.5 fl oz <sup>5</sup>	4 foliar apps	
Quadris Opti	11/M	14	1.6 to 2.4 pt	see comments	Dry beans.
Rally 40 WSP	3	0	4 to 5 oz	1.25 lb	Snap beans only, Rhizoctonia pod rot. Apply as pods begin to develop; continue every 7 to 10 days.
Tilt	3	7	4 fl oz	12 fl oz	Make up to three applications every 7 to 14 days. May cause leaf crinkling or increased greening of leaves.
<b>Rust</b>					
<b>Azoxystrobin<sup>4</sup></b>					
Apply before disease onset, continue every 7 to 14 days.					
Aproach	11	14	6 to 12 fl oz <sup>5</sup>	24 fl oz	Dry beans only. Apply before disease onset, continue every 7 to 14 days.
<b>Chlorothalonil<sup>4</sup></b>					
May be used on snap or dry beans for rust. Apply at early bloom or when conditions favor disease.					
<b>Dry beans.</b>					
Bravo Ultrex	M	7	1.25 to 1.8 lb	4 apps	
Bravo WeatherStik	M	7	1.375 to 2 pt	8 pt	
Bravo Ultrex	M	7	1.25 to 2.7 lb	10.9 lb	Snap beans.
Bravo WeatherStik	M	7	1.375 to 3 pt	12 pt	
Fontelis	7	0	14 to 30 fl oz <sup>5</sup>	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Headline	11	7/30	6 to 9 fl oz <sup>5</sup>	2 apps	Use 5.5 to 8 fl oz for dry beans. Apply before disease onset, continue every 7 to 14 days as needed.
Priaxor	7/11	7/21	4 to 8 fl oz <sup>5</sup>	2 apps	Apply every 7 to 14 days.
Proline 480 SC	3	7	5.7 fl oz	3 apps	Dry beans only. Apply at the first sign of disease, continue every 5 to 14 days if conditions remain favorable for disease.
Quadris Opti	11/M	14	1.6 to 2.4 pt	see comments	Dry beans.
Rally 40 WSP	3	0	4 to 5 oz	1.25 lb	Apply when rust is first observed; continue every 7 to 10 days as needed.
Sulfur <sup>4</sup>	M	0			Apply when rust is first observed; continue every 7 to 14 days as needed. Phytotoxicity may occur if applications are made when temperatures exceed 90°F.
<b>Tebuconazole<sup>4</sup></b>					
Apply preventively when conditions favor disease; continue every 14 days as needed.					
Tilt	3	7	4 fl oz	12 fl oz	Make up to three applications every 7 to 14 days. May cause leaf crinkling or increased greening of leaves.
<b>Pythium Damping-off, Seedling Diseases, Root Rot</b>					
Ridomil Gold SL	4	0	0.5 to 1 pt	1 app	Apply pre- or post-planting as a broadcast or banded spray (7-inch band) in sufficient water to provide uniform coverage. Incorporate into the upper 2 inches of soil mechanically or by rainfall/irrigation. Can be tank-mixed with azoxystrobin or Blocker to provide additional protection against Rhizoctonia.
MetaStar 2E AG	4	0	2 to 4 pt		
Ultra Flourish	4	0	1 to 2 pt		
Ridomil Gold PC GR	4/M	0	12 oz <sup>3</sup>	1 app	For preplant application only. Adjust equipment so that granules are mixed with soil before covering seed. Also provides control of Rhizoctonia.

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**DISEASE CONTROL:** Beans (continued)

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Rhizoctonia Damping-off, Seedling Diseases, Stem/Root Rot</b>					
Azoxystrobin <sup>4</sup>					
Azoxystrobin 25C	11	0	0.4 to 0.8 fl oz	1 app	Use as an In-furrow spray at planting, or postemergence; see label for directions.
Azoxystrobin Star	11	0	0.4 to 0.8 fl oz	1 app	
Quadris	11	0	0.4 to 0.8 fl oz	1 app	
Satori	11	0	0.4 to 0.8 fl oz	1 app	
Blocker 4F/10G	14	45	2.2 to 3.3 fl oz <sup>3</sup>	1 app	
Use as an In-furrow spray at planting. Actual rate is dependent on row spacing; see label for directions.					
Headline	11	7/30	0.1 to 0.8 fl oz <sup>3</sup>	1 app	Use as an In-furrow spray at planting; see label for directions.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Per 1,000 row-feet.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>5</sup> Use higher rate when pressure is severe.

## Cole Crops

Mustard family (Brassicaceae): *Brassica* (broccoli, Brussels sprouts, cabbage, cauliflower, Chinese cabbage, kohlrabi)

### Planting and Culture

The ground for spring cole crops should be plowed in the fall in order to have crops ready for the early market. Cabbage should be transplanted to the field by mid-March in most parts of Kentucky; broccoli and Brussels sprouts should be in the field by the middle of April for the spring crop (see Appendix J). Avoid poorly drained fields. A good firm seedbed should be prepared by disking. Cole crops do well on ground that has been in tobacco. Fescue sod ground is also good if plowed early in the fall and allowed to decompose.

### FERTILIZER: Cole Crops

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
Phosphorus	Phosphate (P <sub>2</sub> O <sub>5</sub> )	
Low	<31	121-180
Medium	31-60	61-120
High	61-80	31-60
Very High	>80	0-30
Potassium	Potash (K <sub>2</sub> O)	
Low	<201	101-150
Medium	201-300	51-100
High	301-450	1-50
Very High	>450	0

**Nitrogen N**  
Broadcast and plow under 50 lb N. Sidedress with 50 lb N when heads begin forming. A second sidedressing of 50 lb of N two weeks later should also be applied. Alternatively begin fertigrating when heads begin forming with 10 to 15 lb of nitrogen per acre weekly using a total of 100 lb of nitrogen. Delaying N application may cause cabbage heads to burst. Too high levels of N may result in greater internal tipburn of cabbage. Calcium nitrate should be used where tipburn has been a problem. High nitrogen levels cause hollow stem in broccoli. Usually 100 lb total nitrogen is sufficient for broccoli.

Cauliflower does not do well as a spring crop in Kentucky. Cabbage, broccoli, and cauliflower all do well as fall crops. Cabbage and cauliflower should be transplanted by early August at the latest, whereas broccoli can be transplanted as late as mid-August. Growers may want to select shorter maturing varieties for late summer plantings. Be aware that days-to-maturity for most cole crops is based on days from transplant. Cauliflower does well when transplanted around July 15 to 20 for a fall crop. Irrigation is often critical for establishing the fall crop.

Use transplants for early market. Sort plants by size to have uniformity in the field. This is helpful at harvest time. A tobacco setter can be used to transplant. Space cabbage plants 12 to 14 inches in the row with rows spaced 36 inches apart. A plant population of 14,000 plants per acre is desirable. Brussels sprouts and cauliflower should be spaced 18 to 20 inches apart in the row with rows 36 inches apart. Broccoli should be spaced 12 to 14 inches apart to keep heads from becoming too large. A 10-inch spacing and double rows 20 inches apart are used for smaller, bunching-size broccoli heads.

A starter fertilizer dissolved in water and applied around the root system during transplanting is recommended. Use 3 pounds of starter in 50 gallons of water, and apply half a pint per plant. Some insecticides can be added to starter solution to control soil insects (see "Insect Control" table).

### Fertilizing

Get a soil test and follow the recommendations. Lime should be applied if needed to bring the pH to around 6.5. Cole crops are heavy users of sulfur; soils prone to deficiencies can be amended by using one of the many sulfur-containing fertilizers to supply 10 to 20 pounds actual sulfur per

acre. Boron deficiencies have appeared in cabbage in several Kentucky counties. The addition of 2 pounds per acre of actual boron is recommended where cabbage is to be planted (see Appendix B).

### Cold Tolerance, Harvesting, and Storage

The cold tolerance of cole crops varies somewhat with the weather conditions preceding the cold period. These minimum temperatures are usually tolerated by cole crops in the fall:

Broccoli*	22-23°F
Brussels Sprouts	20°F
Cabbage	17-18°F
Cauliflower	22-24°F
*Sometimes damaged at 25°F	

Broccoli heads should be cut before any yellow petals show. Cut the heads with 6 to 8 inches of the stem attached. Later maturing lateral stalks should be cut in a similar manner. Broccoli is sold to the wholesale fresh market in cartons holding 14 bunches with two to three heads to the bunch.

Brussels sprouts should be harvested when they are 1 to 1 ¼ inches in diameter. The lower leaves of the plant should first be broken away and the sprouts cut off close to the stem with a sharp knife.

Fresh market cabbage should be cut when heads are firm. Cut 2 ½- to 3 ½-pound heads low enough to leave two to three loose wrapper leaves. Cabbage is usually marketed in 50-pound boxes or bags with 16 to 18 heads per bag. Allow 3 to 4 extra pounds for shrinkage. For the slaw market cabbage, cut 4- to 8-pound heads, remove wrapper leaves, and put in 20-bushel bins.

Cauliflower should have the leaves pulled around the developing curd when the curd is about the size of a quarter. The head will then be ready to harvest in about

a week to 10 days. When tying the curds, use rubber bands of different colors to represent different tying dates. Tie high enough so there is adequate air circulation around the heads, which will help reduce “riciness” and molding of the head. Tying the leaves up around the developing curd results in a white head. Heads should be cut before they become “ricy” in appearance. High temperatures may cause riciness to the head, with very poor quality.

Cauliflower is packed in cartons containing nine to 12 firmly wrapped heads.

Store cole crops at 32°F and 90 to 95 percent relative humidity.

### Common Diseases/Management

**Alternaria, Cercospora, and Cercospora leaf spots.** To avoid introduction of these pathogens, use hot-water seed treatments. To reduce severity, avoid cruciferous (cabbage-related) crops in two- to four-year (or longer) rotations. Apply protective fungicides, starting in seedbeds or shortly after transplanting in wet seasons.

**Black leg.** Control focuses on using disease-free seed/transplants and crop rotation. Hot-water seed treatment (see Appendix H) will improve control but will reduce seed germination and vigor. Purchase transplants from certified, disease-free sources, or produce them from clean seed. A crop rotation period of four years or more away from all cruciferous crops and related weeds is recommended for sites with a history of black leg. Read product labels carefully as some products may not be labeled for all cole crops.

**Black rot.** The causal agent is seed-borne, so start with certified, disease-free seed and transplants. Hot-water seed treatment can reduce severity in infested seed lots. Plant into land that has been away from cole crops for three to four years, and avoid planting late crops in fields adjacent to earlier plantings of cole crops. Some cabbage and broccoli varieties have partial resistance to black rot that can greatly reduce losses. Spread of disease within the field can be slowed by removing infected plants and applications of fixed coppers (begin at first sign of disease and continue on a regular schedule).

**Club root.** Avoid poorly drained fields and those with a history of club root; be sure to have suspected cases confirmed through your county Extension office. Avoid introduction onto the farm by using only disease-free transplants. Maintain a high soil pH of 7.2 to 7.5, and use a seven-year rotation away from related crops. Fungicides are also available to manage club root.

### VARIETIES: Broccoli, Brussels Sprouts, Cauliflower

Note: see “Greens” chapter for broccoli raab varieties.

Variety (all are hybrids)	Maturity (days) <sup>4</sup>	Comments
<b>BROCCOLI<sup>1</sup></b>		
Packman	48	Early, production, good for spring and early fall.
Everest	51	Good for bunching, refined head with good extension; downy mildew resistant.
Windsor	53	Large heads for crown cuts; large stems; downy mildew resistant.
Gypsy	59	Large, medium green heads; downy mildew resistant.
Green Magic	60	Large, blue-green heads; downy mildew tolerant.
Premium Crop	65	Medium head, tight bead, for farmers market sales.
GreenBelt	67	For fall crop, large head, shorter stalk, slow maturing; small bead size, good for bunching.
Arcadia	70	Spring or fall crop; large, blue-green tight-beaded heads; downy mildew tolerant.
Marathon	75	Large blue-green heads; excellent for bunching or crown cuts; downy mildew tolerant.
<b>BRUSSELS SPROUTS<sup>2</sup></b>		
Jade Cross, E Strain	85	Plants grow to about 2 feet tall; medium sized sprouts.
<b>CAULIFLOWER<sup>3</sup></b>		
Majestic	55	Early maturing, medium-compact plants, attractive heads.
Snow Crown	55	Early maturing; very uniform head development; Up to 8 inch diameter heads.
Freedom	67	Heat tolerant, wrapper leaves, self blanching
White Sails	75	Excellent fall crop, attractive.
Candid Charm	75	Excellent fall crop, OK in spring, heat tolerant; large wrapper leaves. Heads up to 3 lb.
Graffiti	74	Purple heads, used fresh, will turn a deep green when cooked.

<sup>1</sup> *Italica* group

<sup>2</sup> *Gemmifera* group

<sup>3</sup> *Botrytis* group

<sup>4</sup> Days to maturity when transplanted.

### VARIETIES: Cabbage<sup>1</sup>

	Maturity (days) <sup>2</sup>	Head Size (lb)	Yellows Resistant	Black Rot Tolerant	Tipburn Tolerant
<b>GREEN</b>					
Artost	68	4	X		
Blue Vantage	72	4	X	X	X
Atlantis	72	4	X	X	
Blue Dynasty	75	4	X	X	X
Bronco	78	4	X		X
Cecile	80	3.5	X	X	X
Ramada	83	4	X	X	X
Cheers	85	5	X	X	
<b>RED</b>					
Scarlet King	70	4			
Rio Grande Red	73	4.5			
Rondale	75	4	X		X
Super Red 80	83	3.5			X
<b>SAVOY</b>					
Savoy Ace Improved	73	3.5	X		
Savoy King	80	4.5			X

<sup>1</sup> *Capitata* group (all are hybrids)

<sup>2</sup> When transplanted

**Downy mildew.** Crop rotation with non-cruciferous plants and control of cruciferous weeds is recommended. Spring plantings of cole crops should be destroyed promptly to prevent them from serving as inoculum sources for fall crops. Resistant varieties are an option for some cole crops. Regular applications of fungicides should provide adequate control.

### VARIETIES: Pak Choi, Chinese Cabbage, Kohlrabi

	Maturity (days) <sup>4</sup>	Comments
<b>PAK CHOI<sup>1</sup></b>		
Joi-choi (hybrid)	47	Slow bolting, very uniform.
<b>CHINESE CABBAGE<sup>2</sup></b>		
Blues	57	Excellent for spring or fall, tolerant to virus, downy mildew, white spot, Alternaria leaf spot and bacterial soft rot—Napa type.
Yuki	62	Early slow bolting similar to China Express—Napa type.
Jade Pagoda (hybrid)	65	Excellent for spring crop—Michili type. Slow bolting.
<b>KOHLRABI<sup>3</sup></b>		
Winner (hybrid)	45	Early maturing; slow to lose fine texture.
Kossak	80	Large, excellent taste, no fiber development, stores well.
Kolibri	45	Excellent purple color and taste

<sup>1</sup> *B. rapa*, *Chinensis* group

<sup>2</sup> *B. rapa*, *Pekinensis* group

<sup>3</sup> *B. oleracea*, *Gongylodes* group

<sup>4</sup> Days to maturity from seeding.

**Fusarium yellows (wilt).** Resistant varieties should be planted in sites with a history of Fusarium yellows, or follow a long-term rotation (7-plus years). Avoid introduction of the disease with transplants. Preplant fumigation of other crops in the rotation (staked tomatoes, for example) can aid greatly in controlling this disease.

**PESTICIDE SAFETY: Cole Crops**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>INSECTICIDES</b>			
Actara 25 WP	C	12	0
Admire Pro	C	12	7/21 <sup>5</sup>
Assail 30 SG	C	12	7
Avaunt 30 DG	C	12	3
Belay 2.13 SC	C	12	7/21 <sup>5</sup>
Beleaf 50 SG	C	12	0
Belt 2 SC	C	12	8
Bt products	C	12	0
Closer 2 SC	C	12	3
Confirm 2 F	C	4	7/10 <sup>5</sup>
Coragen 1.67 SC	-	4	3
Courier 40 SC	W	12	1
Dimethoate 4 E	W	48	7
Durivo 1.67 SC	-	12	30
Exirel 0.83 SE	C	4	1
Fulfill 50 WDG	C	12	7
Intrepid 2 F	C	4	1
Larvin 3.2 F	W	12	7
Lorsban 15 G	C	12	AP <sup>2</sup>
Malathion 8	C	12	3/7 <sup>5</sup>
Movement 2 SC	C	24	1
Oberon 2 SC	C	12	7
Platinum 2 SC	C	12	30
Radiant SC	C	4	1
Requiem 25 EC	C	4	0
Rimov 0.83 EC	W	12	7
Scorpion 3.5 SL	C	12	1/21 <sup>5</sup>
Sevin XLR	W	12	3/14 <sup>5</sup>
Venom 70 SG	C	12	1/21 <sup>5</sup>

**Bacterial soft rot and bacterial head rot.**

Horticultural characteristics and production methods that lead to a tight head with a dome are important considerations in reducing losses. Broccoli varieties such as 'Green Defender,' 'Pirate,' and 'Shogun' have tight and domed heads and generally have less disease. Reducing injuries and controlling insects, downy mildews, and foliage diseases are very important. Avoid working fields when plants are wet, and limit irrigation prior to harvest. A two-year rotation away from cole crops should be used in fields with a history of bacterial head rot. Fixed coppers applied for control of black rot may also reduce incidence of head rots.

**Nonpathogenic physiological disorders.**

Cole crops suffer from non-pathogenic disorders that can be confused with infectious diseases, including the following:

- **Tipburn** in cabbage is caused by inadequate supply of calcium at the time of leaf formation. Maintain uniform soil moisture so that calcium is supplied continuously to the plant.
- **Black petiole/stem** in cabbage is associated with poor fertility management, occurring in soils with very high phosphorus levels and low potassium levels.

**PESTICIDE SAFETY: Cole Crops**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>Restricted Use</b>			
Asana XL	W	12	3
Baythroid XL	W	12	0
Brigade 2 EC	W	12	7
Capture LFR	W	12	AP <sup>2</sup>
Danitrol 2.4 EC	W	24	7
Diazinon AG500	C	24	7/10/21 <sup>5</sup>
Diazinon 50 W	C	24	7/10/21 <sup>5</sup>
Hero 1.24 EC	C	12	7
Lannate 90 SP	DP	48	1/3/10 <sup>5</sup>
Lorsban 4 E	W	48	AP <sup>2</sup>
Mustang Max	W	12	1
Permethrin 3.2 EC	C	12	1
Proaxis 0.5 EC	C	24	1
Proclaim 5 WDG	C	48	7
Renounce 75 WP	C	12	0
Warrior II	W	24	1
<b>FUNGICIDES<sup>3</sup></b>			
Actigard 50 WG	C	12	7
Aliette WDG <sup>6</sup>	C	12	3
Blocker 10G/4F	C	12	0
Cabrio EG	C	12	0
Chlorothalonil <sup>4</sup>	D	48	7
Endura	W	12	0
Fixed coppers <sup>4</sup>	D	24/48	0
Fontelis	C	12	0
Forum SC	C	12	7
Inspire Super	C	12	7
Iprodione 4L AG	W	12	0
Koverall	C	24	7
ManKocide	D	48	7

- **Black speck/pepper spot** appears to be caused by excessive fertilization, especially during temperature swings. Infectious diseases such as bacterial soft rot and *Alternaria* often occur on tissues damaged by these physiological disorders.
- **Bolting** is the development of flower stalks, which can occur in most cole crops if they are exposed to long periods of warm weather early in their development. Transplant management is critical.

**Phytophthora root rot and basal stem rot.**

Phytophthora root rot is a newly reported problem in Kentucky and has caused significant losses under conditions that are ideal for the pathogen (warm, saturated soils). Control efforts should focus on managing soil moisture to avoid a saturated environment. Improve drainage where possible, and plant into raised beds. Crop rotation and burial of crop residues at season's end can be effective management tools; avoid planting cole crops in fields with a history of Phytophthora root rot. Suppression of this disease can be obtained by applying mefenoxam (Ridomil Gold or Ultra Flourish) or Presidio prior to or at planting.

**PESTICIDE SAFETY: Cole Crops**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
Manzate Pro-Stick	C	24	7
MetaStar 2E AG	W	48	0
Meteor	W	12	0
Nevado 4F	W	12	0
Omega 500F	W	48	50
Presidio	C	12	2
Procure 480 SC	C	12	1
Quadris	C	4	0
Quadris Top	C	12	1
Ranman	C	12	0
Reason 500 SC	C	12	2
Revus	C	4	1
Ridomil Gold Bravo SC	W	48	7
Ridomil Gold SL	C	48	0
Rovral 4 Flowable	W	12	0
Sulfur <sup>4</sup>	C	24	0
Switch 62.5 WG	C	12	7
Terraclor	W	12	0
UltraFlourish	W	48	0
Zampro	C	12	0

<sup>1</sup> W: Warning, C: Caution, D: Danger; P: Poison  
<sup>2</sup> AP: At planting.  
<sup>3</sup> None of these fungicides is labeled on all cole crops, so check labels carefully.  
<sup>4</sup> Several formulations are marketed. See the general introduction for more details on fungicides.  
<sup>5</sup> PHI depends on crop type and application method.  
<sup>6</sup> The use of Aliette in the following Kentucky counties has certain restrictions to protect endangered freshwater mollusks and their habitat, so read labels carefully: Campbell, Green, Hart, Kenton, Logan, Marshall, Rockcastle, Todd, Warren, and Wayne.

**Sclerotinia stem rot, white mold (raisin head).** Rotate with grass or grain crops for three years (control broadleaf weeds during the rotation); avoid canola, green beans, tomatoes, and potatoes; and deep plow to bury fungal sclerotia. Chemical control options are limited.

**Seedling damping-off.** Always start plants in beds or trays that have been sterilized with either steam or fumigation, and practice good sanitation around the beds and greenhouses. At transplanting, application of fungicides can reduce post-transplant damping-off and stem rots caused by *Pythium* and *Rhizoctonia*.

**Wire stem and bottom rot (*Rhizoctonia solani*).** Raise seedlings in fumigated soils and use fungicides in the field as recommended in the "Disease Control" table. Cover crops and sod should be plowed early enough to ensure they are well rotted before transplanting. Shallow setting of plants has been shown to reduce the incidence of this disease.

**Virus diseases.** Timely destruction of old crops and weeds is recommended. Maintain a weed-free border around fields. In cases where plants have been infected prior to transplanting, aphid control in transplant production is also important.

**INSECT CONTROL: Cole Crops<sup>1,2,3</sup>**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
To prevent or reduce insect problems, destroy crop remnants immediately after harvest. When growing both spring and fall cole crops, allow for a 2- to 3-week period during midsummer without a cole crop. Always use a spreader/sticker to increase coverage on cole crops.			
<b>PREPLANT INCORPORATED</b>			
<b>Cutworms, Root Maggots:</b> Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites.			
Capture LFR	3.4 to 6.8 fl oz	-	Apply as a band over the furrow or in-furrow.
Diazinon 50 W	4 to 6 lb	-	Incorporate immediately.
Lorsban 15 G	4.6 to 9.2 oz/ 1,000 row-feet	-	Root maggots.
Lorsban 4 E	1.6 to 2.4 oz/ 1,000 row-feet	-	Root maggots.
<b>TRANSPLANT WATER</b>			
<b>Root Maggots</b>			
Diazinon AG 500	0.25 to 0.5 pt/50 gal	-	-
<b>SOIL APPLICATION</b>			
<b>Aphids:</b> Do not use a foliar spray of Actara, Belay, Venom, Provado, or Assail following a soil application of Admire, Belay, Platinum, or Venom.			
Admire Pro	4.4 to 10.5 fl oz	10.5 fl oz	Use as a 2 inch band during bedding, an in-furrow spray, a post-seeding drench, or a side-dress after plants are established.
Belay 2.13 SC	9 to 12 fl oz	12 fl oz	-
Platinum 2 SC	5 to 11 fl oz	11 fl oz	See label for soil application methods.
Vemon 70 SG	5 to 6 oz	12 fl oz	-
<b>FOLIAR TREATMENTS</b>			
<b>Aphids, Harlequin Bugs, Stink Bugs, Flea Beetles</b>			
Actara 25 W	1.5 to 3 oz	11 oz	Allow 7 days between applications.
Admire Pro	1.3 fl oz	2.7 fl oz	Allow 5 days between applications. For aphids and flea beetles.
Assail 30 SG	2 to 3 oz	20 oz	Limit 5 applications. Allow 7 days between applications.
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications.
Beleaf 50 SG	2 to 2.8 oz	8.4 oz	Allow 7 days between applications. For aphids only.
Brigade 2 EC	2.1 to 6.4 fl oz	32 fl oz	Allow 7 days between applications.
Closer 2 SC	1.5 to 2 fl oz	17 fl oz	Allow 7 days between applications. For aphids only.
Danitol 2.4 EC	10.67 to 16 fl oz	42.6 fl oz	Allow 7 days between applications. For stink bugs.
Dimethoate 4 E	0.5 to 1 pt	3 pt	Aphids only. Not for use on Chinese cabbage or Brussels sprouts.
Exirel 0.83 SE	13.5 to 20.5 fl oz	61.5 fl oz	Allow 5 days between applications. For aphids only.
Fulfill 50 WDG	2.75 oz	5.5 oz	Aphids only. Allow 7 days between applications.
Malathion 8	1.25 pt	2 applications	Aphids and flea beetles only. Allow 7 days between applications.
Movento 2 SC	4 to 5 fl oz	10 fl oz	Allow 7 days between applications. For aphids only.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Sevin XLR	0.5 to 1 qt	4 applications	Not for aphids. Allow 7 days between applications. Use within 30 days of transplanting.
Vemon 70 SG	1 to 4 oz	6 oz	Allow 7 days between sprays. Flea beetle only.
Warrior II	1.28 to 1.92 fl oz	15.36 fl oz	Stink bugs and flea beetles only.
<b>Beet Armyworms:</b> These are infrequent but serious pests of cole crops in Kentucky.			
Belt 4 SC	2 to 2.4 fl oz	7.2 fl oz	Allow 5 days between applications.
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Soil and foliar applications possible, see label for limitations.
Exirel 0.83 SE	7 to 13.5 fl oz	61.5 fl oz	Allow 5 days between applications.
Intrepid 2 F	4 to 10 fl oz	64 fl oz	-
Larvin 3.2 F	16 to 32 fl oz	6 applications	For broccoli, cabbage, and cauliflower only.
Proclaim 5 WDG	2.4 to 4.8 oz	28.8 oz	Allow 7 days between applications.
Rimon 0.83 EC	6 to 12 fl oz	24 fl oz	Target small larvae.
Vetiva 2.66	11 to 13 fl oz	26 fl oz	Allow 7 days between applications.
<b>Cabbage Loopers:</b> Treat when 20% of the plants are infested with looper larvae during the cotyledon stage, when 15% of the plants are infested up to the cupping stage, and when 5% of the plants are infested from cupping until harvest.			
Asana XL	5.8 to 9.6 fl oz	76.8 fl oz	Not for use on Brussels sprouts.
Avaunt 30 DG	2.5 to 3.5 oz	14 oz	Allow 3 days between applications.
Baythroid XL	1.6 to 2.4 fl oz	12.8 fl oz	Limit 3.2 fl oz per 7-day period.
Belt 4 SC	2 to 2.4 fl oz	7.2 fl oz	Allow 5 days between applications.
Brigade 2 EC	2.1 to 6.4 fl oz	32 fl oz	Allow 7 days between applications.
Bt products	See labels	-	-
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Soil and foliar applications possible, see label for limitations.
Danitol 2.4 EC	10.67 to 16 fl oz	42.6 fl oz	Allow 7 days between applications.
Exirel 0.83 SE	10 to 17 fl oz	61.5 fl oz	Allow 5 days between applications.
Intrepid 2 F	4 to 10 fl oz	64 fl oz	-
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	2 to 4 fl oz	32 fl oz	For broccoli, cauliflower, Brussels sprouts, and Chinese broccoli.
	2 to 8 fl oz	40 fl oz	For cabbage and Chinese cabbage only.
Proclaim 5 WDG	3.2 to 4.8 oz	28.8 oz	Allow 7 days between applications.
Radiant SC	5 to 10 fl oz	34 fl oz	-
Rimon 0.83 EC	6 to 12 fl oz	24 fl oz	Target small larvae.
Vetiva 2.66	11 to 13 fl oz	26 fl oz	Allow 7 days between applications.
Warrior II	0.96 to 1.6 fl oz	15.36 fl oz	-
<b>Cross-Striped Cabbageworms, Imported Cabbageworms:</b> Treat when 20% of the plants are infested with any of these larvae during the cotyledon stage, when 15% of the plants are infested up to the cupping stage, and when 5% of the plants are infested from cupping until harvest.			
Asana XL	2.9 to 5.8 fl oz	76.8 fl oz	Not for use on Brussels sprouts.
Avaunt 30 DG	2.5 to 3.5 oz	14 oz	Allow 3 days between applications.
Baythroid XL	1.6 to 2.4 fl oz	12.8 fl oz	Limit 3.2 fl oz per 7-day period.

(continued on next page)

**INSECT CONTROL: Cole Crops<sup>1,2,3</sup> (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Belt 4 SC	2 to 2.4 fl oz	7.2 fl oz	Allow 5 days between applications.
Brigade 2 EC	2.1 to 6.4 fl oz	32 fl oz	Allow 7 days between applications.
Bt products	See labels	-	-
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Soil and foliar applications possible, see label for limitations.
Danitol 2.4 EC	10.67 to 16 fl oz	42.6 fl oz	Allow 7 days between applications.
Exirel 0.83 SE	7 to 13.5 fl oz	61.5 fl oz	Allow 5 days between applications.
Intrepid 2 F	4 to 10 fl oz	64 fl oz	-
Malathion 8	1.25 pt	2 applications	Allow 7 days between applications.
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	2 to 4 fl oz	32 fl oz	For broccoli, cauliflower, Brussels sprouts, and Chinese broccoli.
	2 to 8 fl oz	40 fl oz	For cabbage and Chinese cabbage only.
Proaxis 0.5 EC	1.92 to 3.2 fl oz	30.72 fl oz	-
Proclaim 5 WDG	2.4 to 4.8 oz	28.8 oz	Allow 7 days between applications.
Radiant SC	5 to 10 fl oz	34 fl oz	-
Rimon 0.83 EC	6 to 12 fl oz	24 fl oz	Target small larvae.
Sevin XLR	1 to 2 qt	4 applications	Allow 7 days between applications. Use within 30 days of transplanting.
Vetiva 2.66	11 to 13 fl oz	26 fl oz	Allow 7 days between applications.
Warrior II	0.96 to 1.6 fl oz	15.36 fl oz	-

**Cutworms:** Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites.

Asana XL	5.8 to 9.6 fl oz	76.8 fl oz	Not for use on Brussels sprouts.
Baythroid XL	0.8 to 1.6 fl oz	12.8 fl oz	Limit 3.2 fl oz per 7-day period.
Belt 4 SC	2 to 2.4 fl oz	7.2 fl oz	Allow 5 days between applications.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Proaxis 0.5 EC	1.92 to 3.2 fl oz	30.72 fl oz	-
Vetiva 2.66	11 to 13 fl oz	26 fl oz	Allow 7 days between applications.
Warrior II	0.96 to 1.6 fl oz	15.36 fl oz	-

**Diamondback Moth Larvae:** Diamondback moth larvae are able to rapidly develop resistance to most major classes of insecticides. Do not tank-mix insecticides with the same mode of action and frequently rotate among insecticides with different modes of action to discourage resistance. Treat when 20% of the plants are infested with diamondback larvae during the cotyledon stage, when 15% of the plants are infested up to the cupping stage, and when 5% of the plants are infested from cupping until harvest. IRAC Codes: Insecticides followed by the same number share the same mode of action.

Avaunt 30 DG (22)	2.5 to 3.5 oz	14 oz	Allow 3 days between applications.
Baythroid XL (3)	2.4 to 3.2 fl oz	12.8 fl oz	Limit 3.2 fl oz per 7-day period.
Belt 4 SC	2 to 2.4 fl oz	7.2 fl oz	Allow 5 days between applications.
Brigade 2 EC (3)	2.1 to 6.4 fl oz	32 fl oz	Allow 7 days between applications.
Bt products (11B2)	See labels	-	-
Coragen 1.67 SC (28)	3.5 to 5 fl oz	15.4 fl oz	Soil and foliar applications possible, see label for limitations.
Mustang Max (3)	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC (3)	2 to 4 fl oz	32 fl oz	For broccoli, cauliflower, Brussels sprouts, and Chinese broccoli.
	2 to 8 fl oz	40 fl oz	For cabbage and Chinese cabbage only.
Proaxis 0.5 EC (3)	2.56 to 3.84 fl oz	30.72 fl oz	-
Proclaim 5 WDG (6)	2.4 to 4.8 oz	28.8 oz	Allow 7 days between applications.
Radiant SC (5)	5 to 10 fl oz	34 fl oz	-
Rimon 0.83 EC (15)	6 to 12 fl oz	24 fl oz	Target small larvae.
Sevin XLR (1A)	1 to 2 qt	4 applications	Allow 7 days between applications. Use within 30 days of transplanting.
Vetiva 2.66	11 to 13 fl oz	26 fl oz	Allow 7 days between applications.
Warrior II (3)	1.28 to 1.92 fl oz	15.36 fl oz	-

**Root Maggots**

Diazinon 50 W	1 to 1.5 lb per 200 to 300 gal water	-	Direct spray at base of plants. May result in stand reduction due to stress at transplanting.
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<sup>1</sup> See *Kentucky Cabbage Insect Pest Management Scout Manual (IPM-11)* for additional information on cabbage pests and their control.

<sup>2</sup> See *An IPM Scouting Guide for Common Problems of Cole Crops in Kentucky (ID-216)* for photos of pests.

<sup>3</sup> Generic products available (Appendix E).

**WEED CONTROL: Cole Crops**

Product Amt/A	Lb A.1./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
0.67-1.3 pt Command 3ME	0.25-0.5 clomazone	Cabbage only—not labeled on chinese vegetables. Apply before transplanting and incorporate to a depth of 1 inch. Use a min. 10 gal water/A. Do not replant treated field with any crops inconsistent with rotational guidelines. PHI = 45 days.
6-14 lb Dacthal W-75	4.5-10.5 DCPA	For pre-emergence control of annual grasses and broadleaves. Apply at seeding or transplanting. Can be broadcast over transplants. Can be preplant incorporated.
2-4 lb Devrinol 50 DF	1-2 napropamide	Not labeled on chinese vegetables. For control of annual grasses and broadleaf weeds. Apply to weed-free soil and incorporate 1 inch before seeding or transplanting or irrigate within 24 hours of application to soak soil to a depth of 2 to 4 inches. Do not plant rotational crops that are not specified on the label until 12 months after last Devrinol application. Most effective in combination with Goal.
0.5-1.3 pt Dual Magnum	0.48-1.27 s-metolachlor	24(C) Special Local Need Label see label for use and restrictions. Grower assumes all risk of crop injury, yield reductions, and crop loss.
1-2 pt Goal 2XL	0.25-0.5 oxyfluorfen	For pre-emergence and post-emergence control of certain annual grasses and most broadleaves. Apply to soil after final tillage but before transplanting. Do not use on direct seeded cole crops. If plants contact treated soil, some foliar burn may occur but plants generally outgrow symptoms. Do not use post-transplant. Do not use on Brussels sprouts. Max. rate is 2 pt/A.
2.0-4.0 pt Gramoxone Inteon	0.69-1.38 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply preplant, pre-emergence, or before transplanting in min. 10 gal water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v.

(continued on next page)

**WEED CONTROL: Cole Crops (continued)**

Product Amt/A	Lb A.I./A	Comments
5-6 qt Prefar 4 E	5-6 bensulide	For control of grasses and broadleaf weeds. Apply preplant and incorporate to 1 to 2 inch depth. Apply pre-emergence only if it can be watered in within 36 hours. Max. rate of 6 qt/season.
0.5-1.5 pt Poast	0.09-0.28 sethoxydim	For control of actively growing grasses only. Rate for Chinese Brassica vegetables is 0.5 to 1.5 pt. Use higher rate on Johnson grass. PHI = 30 days. Max. rate of 1.5 pt/application and 3 pt/season.
16-22 fl oz Roundup Weather- Max 5.5L	0.69-0.94 glyphosate-salt v/v.	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
9-16 fl oz Select Max	0.07-0.12 clethodim	For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. Max. 16 fl oz/application. Min. 14 days between applications. PHI = 30 days.
3-12 fl oz Spartan 4F	0.09-0.38 sulfentrazone	Processing and transplanted cabbage only. Apply 60 days prior to transplanting and allow rain to move into soil for early preplant application. For preplant incorporation apply as a broadcast and incorporate to depths no greater than 2 inches. May be applied in row middles only of transplanted cabbage up to 72 hours after transplant.
1.25-2 pt Treflan HFP 4 E	0.6-1 trifluralin	For control of annual grasses and broadleaf weeds. Apply and incorporate in spring before transplanting. Check label for direct seeded cole crops. Rate for Chinese Brassica vegetables is 1 to 1.5 pt.

**DISEASE CONTROL: Cole Crops**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Alternaria Leaf Spot</b>					
Azoxystrobin <sup>4</sup>					
Azoxystrobin <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxy 2SC	11	0	6 to 15.5 fl oz <sup>5</sup>	3 foliar apps	
AzoxyStar	11	0	6 to 15.5 fl oz <sup>5</sup>	3 foliar apps	
Quadris	11	0	6 to 15.5 fl oz <sup>5</sup>	3 foliar apps	
Satori	11	0	6 to 15.5 fl oz <sup>5</sup>	3 foliar apps	
Cabrio	11	0	12 to 16 oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
Chlorothalonil <sup>4</sup>					
Bravo Ultrex	M	7	1.4 lb	14.5 lb	Apply after transplanting or when conditions favor disease.
Bravo WeatherStik	M	7	1.5 pt	11.7 pt	
Endura	7	0	6 to 9 oz	2 apps	Apply before disease onset, continue every 7 to 14 days.
Fixed coppers					
Badge SC	M	0	1 to 1.8 pt		-
Badge X2	M	0	0.5 to 1.8 lb		OMRI-listed.
Basic Copper 53	M	0	1 lb		OMRI-listed.
Champ DP	M	0	0.33 to 0.67		-
Champ Formula 2 FL	M	0	0.33 to 0.67 pt		-
Champ WG	M	0	1 to 2 lb		OMRI-listed.
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	0.75 to 1.25 lb		-
Kentan DF	M	0	1 to 1.3 lb		-
Kocide 2000	M	0	0.75 to 1.5 lb		-
Kocide 3000	M	0	0.5 to 0.75 lb		-
Kocide DF	M	0	1 to 2 lb		-
Mastercop	M	0	0.5 to 1 pt		May cause flecking of cabbage wrapper leaves and reddening of older leaves on broccoli.
Nordox 75 WG	M	0	0.66 to 2 lb		OMRI-listed.
Nu-Cop 3L	M	0	0.66 to 1.33 pt		-
Nu-Cop 50 WP	M	0	2 lb		OMRI-listed.
Nu-Cop 50 DF	M	0	1 to 2 lb		OMRI-listed.
Nu-Cop HB	M	0	0.5 to 1 lb		-
Fontelis	7	0	14 to 30 fl oz <sup>5</sup>	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Inspire Super	3/9	7	16 to 20 fl oz	80 fl oz	Apply every 7 to 10 days.
Koverall	M	7	1.6 to 2.1 lb	12.8 lb	Apply every 7 to 10 days when conditions favor disease.
ManKocide	M	7	1 to 3 lb	8.8 lb	Broccoli & cabbage only. Apply every 7 to 10 days when conditions favor disease.
Manzate Pro-Stick	M	7	1.6 to 2.1 lb	12.8 lb	Apply every 7 to 10 days when conditions favor disease.
Procure 480 SC	3	1	6 to 8 fl oz <sup>5</sup>	18 fl oz	Apply every 14 days.
Quadris Top	11/3	1	12 to 14 fl oz <sup>5</sup>	56 fl oz	Apply before disease onset, continue every 7 to 14 days.
Reason 500 SC	11	2	8.2 fl oz	24.6 fl oz	Apply before disease onset, continue every 5 to 10 days.
Switch 62.5 WG	9/12	7	11 to 14 oz	56 oz	Apply every 7 to 10 days.
<b>Black Leg</b>					
Cabrio	11	0	12 to 16 oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
Iprodione <sup>4</sup>					
Rovral 4 Flowable	2	0	2 pt	2 apps	Broccoli only. Apply after thinning (2-4 leaf stage) as a directed spray targeting the base of the plant and adjacent soil surface; make a 2nd application (if necessary) no later than the day of harvest.
<b>Black Rot</b>					
Actigard	21	7	0.5 to 1 oz	4 apps	Suppression only. Apply 7 to 10 days after thinning and make up to three additional applications every 7 days. Apply in a minimum of 20 gal/A of water. May be applied through drip irrigation. May cause phytotoxicity and yield reduction. Do not apply to stressed or injured plants.
Fixed coppers					
Badge SC	M	0	1 to 1.8 pt		-
Badge X2	M	0	0.5 to 1.8 lb		OMRI-listed.
Basic Copper 53	M	0	1 lb		OMRI-listed.

(continued on next page)

**DISEASE CONTROL: Cole Crops (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
C-O-C-S WDG	M	0	3 to 4 lb		-
Champ DP	M	0	0.33 to 0.67 lb		-
Champ Formula 2 FL	M	0	0.33 to 0.67 pt		-
Champ WG	M	0	1 to 2 lb		OMRI-listed.
Copper-Count-N	M	0	2 to 6 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	0.75 to 1.25 lb		-
Kentan DF	M	0	1 to 1.3 lb		-
Kocide 2000	M	0	0.75 to 1.5 lb		-
Kocide 3000	M	0	0.5 to 0.75 lb		-
Kocide DF	M	0	1 to 2 lb		-
Mastercop	M	0	0.5 to 1 pt		May cause flecking of cabbage wrapper leaves and reddening of older leaves on broccoli.
Nordox 75 WG	M	0	0.33 to 2 lb		OMRI-listed.
Nu-Cop 3L	M	0	0.66 to 1.33 pt		-
Nu-Cop 50 WP	M	0	2 lb		OMRI-listed.
Nu-Cop 50 DF	M	0	1 to 2 lb		OMRI-listed.
Nu-Cop HB	M	0	0.5 to 1		-
<b>Clubroot</b>					
Blocker (Flowable & 4F)	14	0	3 pt <sup>3</sup>	1 app	Apply 0.5 pt of solution/plant at transplanting. Agitate continuously to keep material in suspension.
			5.6 gal		
			7.5 gal		
Omega 500F	29	50	6.45 oz <sup>3</sup> 2.6 pt	1 app	Apply 3.4 fl oz per plant in transplant water.
Ranman	21	0	12.9 to 25.75 fl oz <sup>3</sup>	1 app	Drench seedlings after transplanting with 1.7 fl oz of solution.
			20 fl oz		
<b>Damping-off (Rhizoctonia), Wirestem</b>					
Blocker 4F	14	0	2.8 to 3.8 gal	1 app	May be applied as a plant drench or banded spray. See label for specific applications instructions.
Blocker 10G	14	0			
<b>Damping-off (Pythium)</b>					
MetaStar 2E AG	4	0	1 to 2 pt 2 to 4 pt	1 app	Preplant. See Ridomil Gold. At planting. See Ridomil Gold.
Presidio	43	2	3 to 4 fl oz	12 fl oz	Can be applied as a drench or through drip irrigation at planting; soil-directed applications can be made during the season.
Ranman	21	0	2.75 fl oz	1 app	Prior to planting, apply as a banded spray followed by incorporation. Can be applied as a drench at planting or in transplant water; see label for instructions.
Ridomil Gold SL	4	0	0.25 to 0.5 pt	1 app	Preplant. Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil. Can be applied by drip irrigation. At-planting. Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil with irrigation/rainfall. Can be applied by drip irrigation.
			1 to 2 pt		
Ultra Flourish	4	0	0.5 to 1 pt 2 to 4 pt	1 app	Preplant. See Ridomil Gold. At planting. See Ridomil Gold.
<b>Downy Mildew</b>					
Actigard	21	7	0.5 to 1 oz	4 apps	Apply 7 to 10 days after thinning and make up to three additional applications every 7 days. Apply in a minimum of 20 gal/A of water. May be applied through drip irrigation. May cause phytotoxicity and yield reduction. Do not apply to stressed or injured plants.
Aliette WDG <sup>6</sup>	33	3	2 to 5 lb	7 apps	Apply when conditions favor disease and continue every 7 to 21 days. Do not tank-mix with copper compounds.
<b>Azoxystrobin<sup>4</sup></b>					
Azoxystrobin <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin <sup>4</sup>	11	0	6 to 15.5 fl oz <sup>5</sup>	3 foliar apps	
Azoxystrobin <sup>4</sup>	11	0	6 to 15.5 fl oz <sup>5</sup>	3 foliar apps	
Azoxystrobin <sup>4</sup>	11	0	6 to 15.5 fl oz <sup>5</sup>	3 foliar apps	
Azoxystrobin <sup>4</sup>	11	0	6 to 15.5 fl oz <sup>5</sup>	3 foliar apps	
Cabrio	11	0	12 to 16 oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
<b>Chlorothalonil<sup>4</sup></b>					
Bravo Ultrex	M	7	1.4 lb	14.5 lb	Apply after transplanting or when conditions favor disease.
Bravo WeatherStik	M	7	1.5 pt	16 pt	
<b>Fixed coppers</b>					
Apply every 7 to 10 days after transplanting or when conditions favor disease. See label for mixing instructions and tank-mix precautions.					
Badge SC	M	0	1 to 1.8 pt		-
Badge X2	M	0	0.5 to 1.8 lb		OMRI-listed.
Basic Copper 53	M	0	1.0 lb		OMRI-listed.
C-O-C-S WDG	M	0	3 to 4 lb		-
Champ DP	M	0	0.33 to 0.67 lb		-
Champ WG	M	0	0.5 to 1 lb		OMRI-listed.
Champ Formula 2 FL	M	0	0.33 to 0.67 pt		-
Copper-Count-N	M	0	1 to 2 pt		-

(continued on next page)

**DISEASE CONTROL: Cole Crops (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprox Ultra 40 Disperss	M	0	0.75 to 1.25 lb		-
Kentan DF	M	0	1 to 1.3 lb		-
Kocide 2000	M	0	0.75 to 1.5 lb		-
Kocide 3000	M	0	0.5 to 0.75 lb		-
Kocide DF	M	0	1 to 2 lb		-
Mastercop	M	0	0.5 to 1 pt		May cause flecking of cabbage wrapper leaves and reddening of older leaves on broccoli.
Nordox 75 WG	M	0	0.33 to 0.66 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	0.5 to 1 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	0.5 to 1 lb		-
Nu-Cop 3 L	M	0	0.33 to 1.33 pt		-
Nu-Cop 50 DF	M	0	1 to 2 lb		OMRI-listed.
Forum SC	40	7	6 fl oz	30 fl oz	Tank-mix with another fungicide NOT in FRAC Group 40.
Koverall	M	7	1.6 to 2.1 lb	12.8 lb	Apply every 7 to 10 days when conditions favor disease.
Manzate Pro-Stick	M	7	1.6 to 2.1 lb	12.8 lb	Broccoli and cabbage only. Apply when disease threatens and continue every 7 to 10 days.
Presidio	43	2	3 to 4 fl oz	4 apps	Apply every 7 to 14 days. Tank-mix with another fungicide NOT in FRAC Group 43.
Ranman	21	0	2.75 fl oz	5 apps	Treat every 7 to 10 days. Tank-mix with an organosilicone surfactant.
Reason 500 SC	11	2	5.5 to 8.2 fl oz	24.6 fl oz	Apply before disease onset, continue every 5 to 10 days.
Revus	40	1	8 fl oz	32 fl oz	Apply every 7 to 10 days. Use a spreader/penetrant surfactant. Tank-mix with another fungicide NOT in FRAC Group 40.
Ridomil Gold Bravo SC	4/M	7	1.5 pt	4 apps	Apply before disease onset, continue every 14 days. Do not apply to loosehead Chinese cabbage. Observe seasonal limits for choroethalonil.
Ridomil Gold SL	4	0	0.25 to 0.5 pt	1 pt	Apply before disease onset, continue every 14 days. Tank-mix Ridomil Gold EC or SL with another fungicide labeled for downy mildew.
Zampro	40/45	0	14 fl oz	3 apps	Apply before disease onset, treat every 7 days.
<b>Phytophthora Root Rot, Basal Stem Rot</b>					
MetaStar 2E AG	4	0	4 to 8 pt	1 app	Preplant. Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil. Can be applied by drip irrigation. Do not use in transplanter water. At-planting. Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil with irrigation/rain-fall. Can be applied by drip irrigation. Do not use in transplanter water.
Ridomil Gold SL	4	0	1 to 2 pt		
Ultra Flourish	4	0	2 to 4 pt		
Presidio	43	2	3 to 4 fl oz	12 fl oz	Can be applied as a drench or through drip irrigation at planting; soil-directed applications can be made during the season.
<b>Sclerotinia Stem Rot</b>					
Cueva	M	0	0.5 to 2 gal	n/a	OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Endura	7	0	6 to 9 oz	2 apps	Apply before disease onset, continue every 7 to 14 days.
Fontelis	7	0	16 to 30 fl oz <sup>5</sup>	72 fl oz	Apply before disease onset, continue every 7 to 14 days.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Per 100 gal of water.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>5</sup> Use higher rate when pressure is severe.

<sup>6</sup> Restricted in some Kentucky counties. See fungicide safety table on page 20.

## Sweet Corn

Grass family (Poaceae): *Zea mays* subsp. *mays*

### Types and Isolation Requirements

An array of high-sugar sweet corn types are found in the most recent seed company catalogs. Varieties are often grouped under abbreviations for the types of genes they carry for sweetness (*su*, *se*, *sh2*, etc.) or under various trade names (TripleSweet™, Xtra Tender™, Sweet Generation™, etc.) that contribute to the confusion. Various types of sweet corn are strikingly different in terms of sweetness, eating quality, and suitability for mechanical harvest and shipping. Consider carefully which types are best suited to your marketing situation. Different types also have different isolation requirements.

Regardless of the type, the variety should have a tight husk cover over the

ear tip to help keep out birds, sap beetles, and corn earworms.

**Traditional or standard sweet corn** (*su*) varieties are characterized by their creamy corn flavor and mild sugars; these sugars quickly convert to starch so these varieties are best consumed soon after harvest. Obviously, they are most suitable for local sales.

**Sugary enhanced** (*se*) varieties have tender kernels and a creamy texture like standard varieties but have up to twice as much sugar. Consequently, they will remain sweet longer than standard sweet corn. Sugary enhanced varieties are very popular at farmers' markets and for local sales.

**Supersweet or shrunken-2** varieties (*sh* or *sh2*) all have shrunken, wrinkled/shriveled seeds. They have a high sugar content as well as slower conversion of

sugar to starch. This means they will remain sweeter much longer than other corn types. Supersweets also have kernels that hold up much better when mechanically harvested; however, these tougher kernels do not have the creamy texture and flavor of standard or sugary enhanced corn varieties. Most sweet corn varieties sold for processing and through wholesale market channels are supersweets.

**Augmented supersweets** are new and improved supersweet varieties that have tender kernels like *se* varieties while retaining the added sweetness and longer shelf life of supersweets. Ears of these varieties contain only a single type of kernel. These varieties are sold under several trade names ('Xtra Tender™', 'Gourmet Sweet™', 'MultiSweet™', 'HQ', 'shQ,' etc.).

**Synergistic** varieties are sold under several trade names, including 'TripleSweet™',

'Sweet Generation™', 'Sweet Breed™', 'Table Sweet™', and 'seQ.' Ideally, they have the seed vigor of standard varieties, the flavor and eating quality of *se* varieties, and the high sugar and long shelf life of *sh2* varieties. Most synergistics combine the best characteristics of sugary enhanced and supersweet varieties with seed vigor that is most similar to *se* types. What distinguishes this group is that *different types of kernels occur on the same ear*; that is, most of these varieties have ears with 3/4 sugary enhanced (*se*) type kernels and 1/4 supersweet (*sh2*) kernels. These varieties may not have as long a shelf life as true supersweets and may not be suitable for mechanical harvest. The genetic combinations in these varieties differ widely, and growers should try them on a small scale prior to growing large acreages.

**Genetically modified or transgenic** sweet corn varieties are available that express a toxin from the insect-killing bacteria *Bacillus thuringiensis* (Bt). Bt toxins help control worms feeding on sweet corn and can result in considerable reductions in pesticide usage, especially late in the season. Any of the previously described sweet corn types can be modified in this way. Current transgenic sweet corn varieties are sold under the trade name 'Attribute™'. While Bt toxins are harmless to humans, some wholesale and retail buyers will not accept transgenic products. *Transgenic varieties also are not allowed in organic production.*

### Isolation Requirements

All sweet corn types must be isolated from field corn or popcorn to prevent cross pollination and loss of sweetness. A separation (isolation) distance of 700 feet will give complete isolation of white, yellow, or high-sugar varieties but may be impractical. A distance of 250 feet will result in some contamination but not enough to affect quality. Isolation can also be maintained by a 10- to 14-day difference in maturities of different types, although isolation by distance is more effective.

The different types of sweet corn described in the "Varieties" table can be placed in either of two major groups in terms of their isolation requirements. While each type within one of these groups may benefit from isolation from other types in the same group, the resulting cross pollination will not produce field corn kernels. *Cross pollination between the two groups, however, will produce a percentage of unacceptable kernels.* These lists may not include all the trade names currently available.

### VARIETIES: Sweet Corn and Ornamental Corn

Variety	Maturity (days)	Color <sup>1</sup>	Comments
<b>STANDARD SWEET CORN (su)</b>			
Merit	80	Y	Rust and northern corn leaf blight resistance, long ears.
Silver Queen	95	W	Rust resistant, one of the most popular sweet corn varieties.
<b>SUGAR ENHANCED (se) AND SYNERGISTICS (seq)</b>			
Temptation	72	BC	Good for early spring plantings, good yields.
Kristine	75	BC	Resistance to rust and southern corn leaf blight
Synergy	76	BC	Uniform, good resistance to rust and Stewart's wilt
Montauk	79	BC	Resistance to Stewart's wilt and northern corn leaf blight
Providence	80	BC	Good strong mid-season variety, rust resistant
Lancelot	80	BC	Rust, Stewart's wilt, and northern corn leaf blight resistance, good tip fill, and appearance.
Bodacious RM	72	Y	Resistance to rust and Stewart's wilt, early type with good flavor.
Honey Select	79	Y	Resistance to Stewart's wilt, AAS winner, high sugars, good for farmers market
Incredible RM	85	Y	Resistant to Stewart's wilt, rust, northern corn leaf blight, and maize dwarf mosaic virus, good husk coverage, excellent flavor.
Whiteout	74	W	Stewart's wilt and northern corn leaf blight resistance.
Sweet Ice	74	W	Attractive ear, good flavor, husk snaps off easily.
Argent RM	83	W	Resistance to rust, Stewart's wilt, maize dwarf mosaic virus, and northern corn leaf blight.
<b>SUPERSWEETS (sh2 and augmented supersweets)</b>			
Mirai 308 BC	71	BC	Good early maturing type, plant in warm soil, 1.25 inches deep).
Triumph	75	BC	Good main season type, tall plant with 7 to 8 inch ears.
Awesome	76	BC	Resistance to Stewart's wilt, good early type for shipping and farmers markets.
Obsession	79	BC	Resistance to rust, Stewart's wilt, and northern corn leaf blight, excellent husk cover, tip fill, and yield.
Vision Xtra-Tender	75	Y	Resistance to Stewart's wilt, good eating quality, average yields, excellent tip fill.
Garrison	79	Y	Resistance to rust, Stewart's wilt and northern and southern corn leaf blight.
Sentinel	83	Y	Resistance to rust, Stewart's wilt, southern corn leaf blight and Maize dwarf mosaic virus.
Xtra-tender 3272	72	W	Resistance to Stewart's wilt and southern corn leaf blight, good emergence and tip fill, early white variety, slightly larger than Xtra-Tender 372A.
Munition	78	W	Good disease resistance and yield.
<b>GENETICALLY MODIFIED<sup>2</sup></b>			
BC 0805 (se)	83	BC	Resistance to rust, Attribute® insect protection.
BC 0822 (se)	77	BC	Resistance to Stewart's wilt, rust, northern and southern corn leaf blights, Attribute® insect protection.
WH 0809 (se)	80	W	Resistance to rust and southern corn leaf blight, Attribute® insect protection.
Obsession II (sh2)	79	BC	Resistance to rust, Stewart's wilt, and northern corn leaf blight, excellent husk cover, tip fill, and yield, Performance Series hybrid tolerant to Roundup brand herbicides with above and below ground insect control.
BSS 0977 (sh2)	79	BC	Resistance to rust, Stewart's wilt and northern corn leaf blight, Attribute® insect protection.
GSS 0966 (sh2)	79	Y	
Passion II (sh2)	80	Y	Resistance to rust, Stewart's wilt and northern corn leaf blight, Performance Series hybrid tolerant to Roundup brand herbicides with above and below ground insect control.
WSS 0987 (sh2)	78	W	Resistance to rust and northern corn leaf blight Attribute® insect protection.
<b>ORNAMENTAL CORN<sup>3</sup></b>			
Earth Tones Dent	90		Colors are soft earth tones, 8 to 10 inch ears.
Green and Gold Dent	95-100		Bright yellow and green kernels, 8 to 10 inch ears.
Miniature Blue, Little Boy Blue, Cutie Blues	100		Shiny blue kernels, 2 to 4 inch ears, good stalks, popcorn.
Miniature Pink, Little Bow Peep, Cutie Pink, Little Miss Muffet	100		Shiny pink kernels, 2 to 4 inch ears, good stalks, popcorn.
Autumn Explosion	102		Multicolored flint corn, 8 to 9 inch ears, 25% red husks.
Indian Fingers	110		Multicolored, 3 1/2 inch ears, small shiny kernels.
Pod Corn	110		Highly ornamental and variable with husks around each kernel.

<sup>1</sup> Y = yellow; W = white; BC = bicolor

<sup>2</sup> Growers should check current regulations for marketing and labeling of transgenic or "genetically modified" crops before planting; "Attribute" sweet corn seed may also have minimum purchase requirements.

<sup>3</sup> See HO-81, Ornamental Corn Production in Kentucky, for production and more detailed variety information.

## SWEET CORN ISOLATION GROUPS

Group 1	Standard varieties (su) Sugary enhanced (se) Synergistics Sweet Breed Table Sweet TripleSweet seQ, HQ
Group 2	Supersweets (sh-2) Augmented supersweets Crisp N Sweet Gourmet Sweet MultiSweet SummerSweet Xtra Tender shQ

## Planting and Culture

Sweet corn will do well in all areas of Kentucky, but well-drained soils are essential for good results. Fescue sod is ideal prior to sweet corn production. Sweet corn makes a good rotational crop for other vegetable crops. A well-prepared seedbed is critical for successful seed germination and good stands. Disking the soil three to four times before planting will help in preparing a good seedbed. Plowing should be done several weeks in advance of planting to allow the ground to settle and the grass to decompose. Ten to 15 pounds of seed will usually be required to plant an acre. Plant seed in rows 30 to 40 inches apart with plants spaced 8 to 10 inches apart in the row. If plants are spaced closer, thin to 8 inches within row spacing. Ears will be smaller if planted too close together.

For best results, sweet corn seed should be planted after the soil temperature has reached 60°F. In most parts of Kentucky, the earliest plantings can be made from April 20 to May 1 (see Appendix J). The harvest period for sweet corn can be extended by planting early, midseason, and late-maturing varieties or by making successive plantings at weekly intervals. Late-planted sweet corn will have more insect and disease problems. Cultivars with tolerance or resistance to leaf blights and viruses should be selected when planting in June, especially in river bottoms and humid areas in the state (see "Varieties" table).

Seed-germination percentages of some supersweet varieties (or other varieties with shrunken seed) can be poor to fair, particularly under cold soil conditions. Make sure the soil is warmer than 60°F before planting these varieties. The germination of sugary enhanced corn is much better than that of shrunken types but not quite as good as standard sweet corn. At present, use standard varieties for very early plantings intended for early markets. Most high sugar corn varieties

are also more attractive to insects, birds, groundhogs, and raccoons and more susceptible to heat and drought stresses than standard sweet corn.

Irrigation is usually required to ensure high quality in both standard and high-sugar corn types. While solid set sprinkler systems and traveling guns are still in use, it is also relatively easy to irrigate (and fertigate) sweet corn simply by running drip irrigation lines down the rows on bare ground with lines placed no more than about 4 inches from the plants.

## Production with Plasticulture

A number of Kentucky growers have successfully grown transplanted sweet corn on plastic mulch with drip irrigation. This system enables earlier harvests, resulting in considerably higher market prices. Typically seeds are sown in 128 cell trays with two seeds per cell. Transplants should be planted between 14 and 18 days after seeding. It is critical that corn transplants not be held over too long in the greenhouse, as this results in permanent stunting of the plants in the field. Also, *do not use early-maturing varieties (earlier than 75 days) as these will tend to tassel prematurely, resulting in stunted plants with non-marketable ears.* Growers may want to consider multiple seeding times in case unfavorable weather prevents transplanting in a timely fashion. Typically seed is inexpensive compared to the cost of using the plasticulture system.

Black plastic mulch on raised beds is most often used for transplanted corn. One popular system uses double rows (two rows per bed) with 12 inches between transplants in the row and about 18 to 20 inches between the two rows. In the latter system two seeds are sown in each cell of the plug trays; therefore, each hill will contain two plants in the field. Some growers have also direct seeded sweet corn under clear plastic and then cut the plastic open after the seedlings emerged. Using clear plastic, however, has resulted in problems with weed seed germination under the plastic.

## Fertilizing

Make all lime and fertilizer applications based on soil test results. Sweet corn tolerates some soil acidity and can be grown in soils ranging in pH from 5.5 to 6.8; however, lime should be applied to bring the pH to 6.5 for best results. Where sweet corn is planted on sod ground, apply at least half of the fertilizer broadcast and plow down. The remaining fertilizer can be applied broadcast just before planting and disked in. If banding equipment is available, fertilizer may be banded 2 to 3 inches to the side

## PESTICIDE SAFETY: Sweet Corn

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days) <sup>2</sup>
<b>INSECTICIDES</b>			
Avaunt 30 DG	C	12	3
Belt SC	C	12	1
Blackhawk 36 WG	C	4	1/7/28
Bt products	C	12	0
Coragen 1.67 SC	-	4	1
Intrepid 2 F	C	4	3
Larvin 3.2 F	W	12	0
Lorsban 15 G	C	24	35
Lorsban 75 WP	W	48	35
Malathion 8	C	12	5
Oberon 2 SC	C	12	5
Radiant SC	C	4	1
Sevin XLR	W	12	2
<b>Restricted Use</b>			
Asana XL	W	12	1
Aztec 4.67 G	W	48	AP
Battalion 1.5 EC	DP	12	1
Baythroid XL	W	12	0
Brigade 2 EC	W	12	1/30 <sup>4</sup>
Counter 15 G	DP	48	AP
Diazinon AG500	C	24	7
Force 3 G	C	0	AP
Fortress 5 G	DP	48	AP
Hero 1.24 EC	C	12	3
Lannate 90 SP	DP	48	0
Lorsban 4 E	W	24	35
Mocap 15 G	W	48	AP
Mustang Max	W	12	3
Permethrin 3.2 EC	C	12	1
Pounce 1.5 G	C	12	1
Proaxis 0.5 EC	C	24	1
Renounce 20 WP	C	12	0
Thimet 20 G	DP	48	AP
Warrior II	W	24	1
<b>FUNGICIDES</b>			
Aftershock	C	12	7
Aproach	C	12	7
Avaris	W	12	14
Evito 480/Evito T	C	12	7
Fixed coppers <sup>3</sup>	D	24/48	0
Headline	W	12	7
Headline SC	W	12	7
Headline AMP	W	12	7
Mancozeb <sup>3</sup>	C	24	7
Priaxor	C	12	7
Propiconazole <sup>3</sup>	W	24	14
Prosaro	C	12	7
Quadris	C	4	7
Quilt	C	24	14
Quilt Xcel	W	12	14
Stratego	W	12	14
Stratego YLD	C	48	0
Tebuconazole <sup>3</sup>	W	19 days	7
Vertisan	W	12	7
<b>Fresh market only</b>			
Chlorothalonil <sup>3</sup>	D	48	14

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> AP: At planting, ST: Seed treatment.

<sup>3</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

<sup>4</sup> Dependent on application type, see label.

<sup>5</sup> Re-entry period varies by product. See label for more information.

of seed and 2 to 3 inches deeper than the seed. The total amount of fertilizer that is banded should not exceed 45 pounds per acre (total of N and K, to avoid root burn from salts). Sidedress with 50 pounds of actual nitrogen (N) when plants are about

**FERTILIZER:** *Sweet Corn*

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
<b>Phosphorus</b>	<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>	
Low	<31	121-180
Medium	31-60	61-120
High	61-80	1-60
Very High	>80	0
<b>Potassium</b>	<b>Potash (K<sub>2</sub>O)</b>	
Low	<201	151-200
Medium	201-300	101-150
High	>300	100
<b>Nitrogen</b>	<b>N</b>	
Apply 80 to 100 lb actual nitrogen (N)/A preplant; apply at least 40 to 50 lb N/A as sidedressing when plants are knee high.		

knee high. High-sugar varieties (super-sweets, sugary enhanced, and others) benefit from an additional late sidedressing of nitrogen to keep the husks dark green.

With plasticulture systems, apply all P and K and half to two-thirds of the nitrogen prior to planting. The remaining nitrogen requirement can be divided up into equal doses and fertigated weekly.

Sweet corn grown on high pH soils that are also very high in available phosphorus may show zinc deficiency in some years. However, many other factors, including weather conditions and cool soil temperatures, affect availability of soil zinc, making it difficult to predict a response to added zinc for a specific growing season. Zinc should be broadcast at 30 pounds per acre (90 pounds of zinc sulfate) or banded at 6 pounds per acre (17 pounds of zinc sulfate).

A broadcast application should last from four to six years, whereas a band application should be made annually for six to eight years (see Appendix B).

**Harvesting and Handling**

Corn should be harvested at the milk stage of maturity for best quality. Sweet corn is usually marketed as five dozen ear units in bags or crates. Harvest in the early morning while the air is still cool. If the temperature of the ears is high when harvested, field heat should be removed by plunging them in ice water. To maintain top quality, sweet corn must be cooled to as near to 32°F as possible. This prevents sugars from changing to starch. Crated corn can be cooled in ice water from about 86°F to around 41°F in about 80 minutes. Hydrocoolers are often used by larger producers for this purpose. Vacuum cooling is a much faster procedure but involves more expensive equipment. Store sweet corn at 32°F and 90 to 95 percent relative humidity. The type of sweet corn grown also has a great impact on sweetness and shelf life.

**Common Diseases/Management**

**Stewart's wilt, bacterial wilt.** The causal agent (a bacterium) overwinters in and is spread by adult flea beetles. *Control is based on using either tolerant plants or management of the adult flea beetles with insecticides* (see "Insect Control" table). Where possible, use wilt-resistant hybrids (see "Varieties" table).

**Damping-off, seed rot.** Plant seed that has been commercially treated with fungicides, or apply Captan 50 W at 1 teaspoon per pound of seed if you purchase untreated seed. Plant at a shallow depth in warm, well-drained soils; raised beds improve drainage and help reduce losses. Avoid using float systems, if possible, in the production of transplants.

**Leaf blights (gray leaf spot, *Helminthosporium*, and Anthracnose), rust.** Crop rotation on a two- to three-year schedule, along with clean tillage, helps to reduce pathogen levels. Fungicide treatments may be necessary during rainy seasons, in foggy sites, and in late plantings (especially with corn following corn or in small plantings near older corn). Rust fungicides may be warranted when the disease is active before the whorl stage of plant development; labeled materials are listed in the "Disease Control" table. Several rust-resistant cultivars are available. Consider planting resistant cultivars for fall crops.

**Smut.** No fungicides are available, and there are only a few tolerant hybrids. Rotation is the recommended control practice.

**Virus complex.** Maize Dwarf Mosaic Virus and Maize Chlorotic Dwarf Virus are the most common viruses of sweet corn in Kentucky. Infected corn crops and grassy weeds serve as hosts of the viruses/mycoplasmas. Control Johnson grass within and adjacent to sweet corn fields. Partial resistance to virus diseases is available in some cultivars; see list.

**INSECT CONTROL:** *Sweet Corn*<sup>1,2,3</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>PREPLANT INCORPORATED</b>			
<b>Wireworms:</b> Wireworms can be a potential problem where sweet corn follows grass or grass-legume sod.			
Lorsban 15 G	13.5 lb	-	-
<b>Cutworms:</b> Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites.			
Lorsban 15 G	6.75 to 13.7 lb	-	-
<b>PLANTING TIME</b>			
<b>Seedcorn Maggots, Rootworms, Seedcorn Beetles:</b> Corn rootworms are a potential pest where corn is grown year after year in the same field.			
Aztec 2.1 G	6.7 oz/ 1,000 row-feet		Band, T-band or furrow.
Aztec 4.67 G	3 oz/1,000 row-feet		Band, T-band or furrow.
Brigade 2 EC	0.3 fl oz/ 1,000 row-feet		Spray as T-band over open furrow.
Counter 15 G	8 oz/1,000 row-feet		Band or furrow.
Force 3 G	4 to 5 oz/ 1,000 row-feet		T-band controls cutworms as well.
Fortress 5 G	3 oz/1,000 row-feet		T-band or furrow.
Lorsban 15 G	8 oz/1,000 row-feet		Band or furrow.
Mocap 10 G	12 oz/ 1,000 row-feet		Band only. Rootworm control.
Thimet 20 G	6 oz/1,000 row-feet		Band only. Rootworm control.
<b>FOLIAR TREATMENTS</b>			
<b>Armyworms</b>			
Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Battalion 1.5 EC	1.5 to 2.4 fl oz	38.4 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	28 fl oz	Limit 2.8 fl oz per 2-day interval.
Belt SC	2 to 3 fl oz	12 fl oz	Limit 3 fl oz per 3-day interval. Limit 4 applications.
Blackhawk 36 WG	1.67 to 3.3 oz	20 oz	-
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Do not graze livestock for 1 day.
Intrepid 2 F	4 to 8 fl oz	64 fl oz	-

(continued on next page)

**INSECT CONTROL: Sweet Corn<sup>1,2,3</sup> (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Lannate 90 SP	0.25 to 0.5 lb	8 lb	-
Mustang Max	2.8 to 4 fl oz	24 fl oz	Allow 3 to 5 days between applications.
Radiant SC	3 to 6 fl oz	36 fl oz	Allow 2 days between applications.
Sevin XLR	1 to 2 qt	8 applications	Allow 3 days between applications.
Warrior II	1.28 to 1.92 fl oz	30.7 fl oz	-

**Corn Earworms:** Corn earworm is often the key insect pest attacking sweet corn. Egg laying occurs only while silks are still green, and sprays need to be repeated at 2- to 7-day intervals while silks are green. Time of planting, intensity of moth flight, and temperature will affect spray intervals. Pheromone traps are available for monitoring this pest and determining spray intervals. Pyrethroid insecticides are not as effective as in the past when used later in the sweet corn season.

Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Battalion 1.5 EC	1.5 to 2.4 fl oz	38.4 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	28 fl oz	Limit 2.8 fl oz per 2-day interval.
Belt SC	2 to 3 fl oz	12 fl oz	Limit 3 fl oz per 3-day interval. Limit 4 applications.
Blackhawk 36 WG	2.2 to 3.3 oz	20 oz	-
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Do not graze livestock for 1 day.
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Limit 4 applications.
Lannate 90 SP	0.25 to 0.5 lb	8 lb	-
Mustang Max	2.8 to 4 fl oz	24 fl oz	Allow 3 to 5 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	48 fl oz	-
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	-
Radiant SC	3 to 6 fl oz	36 fl oz	Allow 4 days between applications.
Warrior II	1.28 to 1.92 fl oz	30.7 fl oz	-

**Corn Leaf Aphids**

Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Malathion 8	1 pt	2 applications	Allow 5 days between applications.

**Cutworms:** Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites.

Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Battalion 1.5 EC	1 to 2.4 fl oz	38.4 fl oz	-
Baythroid XL	0.8 to 1.6 fl oz	28 fl oz	Limit 2.8 fl oz per 2-day interval.
Belt SC	2 to 3 fl oz	12 fl oz	Limit 3 fl oz per 3-day interval. Limit 4 applications.
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Do not graze livestock for 1 day.
Lorsban 4 E	2 to 3 pt	6 pt	Limit 3 applications. Allow 10 days between applications.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 3 to 5 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	48 fl oz	-
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	-
Warrior II	1.28 to 1.92 fl oz	30.7 fl oz	-

**European Corn Borer, Southwestern Corn Borer:** Treat if more than 15% of the whorls are infested with live larvae. Pheromone traps are available to monitor this pest. Corn borer control is frequently necessary when tassels begin to emerge from the whorl.

Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Avaunt 30 DG	2.5 to 3.5 oz	14 oz	Allow 3 days between applications. Until tassel push only.
Battalion 1.5 EC	1.5 to 2.4 fl oz	38.4 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	28 fl oz	Limit 2.8 fl oz per 2-day interval.
Belt SC	2 to 3 fl oz	12 fl oz	Limit 3 fl oz per 3-day interval. Limit 4 applications.
Blackhawk 36 WG	1.67 to 3.3 oz	20 oz	-
Bt products	See labels	-	-
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Do not graze livestock for 1 day.
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Limit 4 applications.
Intrepid 2 F	4 to 8 fl oz	64 fl oz	-
Lannate 90 SP	0.25 to 0.5 lb	8 lb	-
Mustang Max	2.8 to 4 fl oz	24 fl oz	Allow 3 to 5 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	48 fl oz	-
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	-
Radiant SC	3 to 6 fl oz	36 fl oz	Allow 4 days between applications.
Warrior II	1.28 to 1.92 fl oz	30.7 fl oz	-

**Fall Armyworms:** Usually a serious pest only of sweet corn planted after June 1. Treat if more than 10% of the whorls are infested with live larvae. Pheromone traps are available to monitor this pest.

Avaunt 30 DG	2.5 to 3.5 oz	14 oz	Allow 3 days between applications. Until tassel push only.
Belt SC	2 to 3 fl oz	12 fl oz	Limit 3 fl oz per 3-day interval. Limit 4 applications.
Blackhawk 36 WG	1.67 to 3.3 oz	20 oz	-
Bt products	See labels	-	-
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Limit 4 applications.
Lannate 90 SP	0.25 to 0.5 lb	8 lb	-
Radiant SC	3 to 6 fl oz	36 fl oz	Allow 4 days between applications.

**Flea Beetles**

Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Battalion 1.5 EC	1 to 2.4 fl oz	38.4 fl oz	-
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Do not graze livestock for 1 day.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 3 to 5 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	48 fl oz	-
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	-
Sevin XLR	1 to 2 qt	8 applications	Allow 3 days between applications.
Warrior II	1.28 to 1.92 fl oz	30.7 fl oz	-

**Grasshoppers**

(continued on next page)

**INSECT CONTROL:** Sweet Corn<sup>1,2,3</sup> (continued)

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Battalion 1.5 EC	1 to 2.4 fl oz	38.4 fl oz	-
Baythroid XL	2 to 2.8 fl oz	28 fl oz	Limit 2.8 fl oz per 2-day interval.
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Do not graze livestock for 1 day.
Lorsban 4 E	0.5 to 1 pt	6 pt	Limit 3 applications. Allow 10 days between applications.
Mustang Max	2.8 to 4 fl oz	24 fl oz	Allow 3 to 5 days between applications.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	-
Sevin XLR	0.5 to 1.5 qt	8 applications	Allow 3 days between applications.
Warrior II	1.28 to 1.92 fl oz	30.7 fl oz	-

**Corn Rootworm Beetles, Japanese Beetle, Sap Beetle:** Select sweet corn cultivars with good tip coverage. Treat when necessary.

Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Battalion 1.5 EC	1.5 to 2.4 fl oz	38.4 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	28 fl oz	Limit 2.8 fl oz per 2-day interval.
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Do not graze livestock for 1 day.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 3 to 5 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	48 fl oz	-
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	-
Sevin XLR	1 to 2 qt	8 applications	Allow 3 days between applications.
Warrior II	1.28 to 1.92 fl oz	30.7 fl oz	-

**Stink bugs**

Baythroid XL	1.6 to 2.8 fl oz	28 fl oz	Limit 2.8 fl oz per 2-day interval.
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Do not graze livestock for 1 day.

<sup>1</sup> See also Kentucky Insect Integrated Pest Management Scout Manual (IPM-10) for more information on sweet corn pests and their control.

<sup>2</sup> See An IPM Scouting Guide for Common Problems of Sweet Corn in Kentucky (ID-184) for photos of pests.

<sup>3</sup> Generic products available (Appendix E).

**WEED CONTROL:** Sweet Corn

Product Amt/A	Lb A.I./A	Comments
2-4 pt Aatrex 4L	1-2 atrazine	For control of annual grasses and broadleaf weeds. Apply after planting but before weeds are 1 inch tall. Best in combination with alachlor or s-metolachlor. Do not plant any crop but corn for 18 months if using 1 lb or more atrazine because of residual injury. Do not use atrazine exclusively because resistance has occurred in certain weed species. Restricted use pesticide.
0.33-1.33 oz Accent 75 DF	0.015-0.06 nicosulfuron	For post-emergence control of grasses and broadleaves. Apply broadcast or with drop nozzles (post-direct) when corn up to 12 inches tall or V5 leaf stage. For corn 12 to 18 inches tall, apply only as post-direct. Max. 1 application/season.
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows to corn with 8 to 14 leaf collars stage. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 2 fl oz/A.
1-2 pt Basagran	0.5-1 bentazon	Use post-emergence for control of annual broadleaves and suppression of yellow nutsedge. Use 2 applications for nutsedge control. Best if tank-mixed with other corn herbicides. Do not graze treated corn before 12 days after application.
2.1-2.58 qt Bicep II Magnum	1.6-2 atrazine + 1.2-1.56 s-metolachlor	Apply preplant or pre-emergence for control of most annual grasses and broadleaves. Do not use if small grains are to be planted the same year or if vegetable crops or tobacco are to be planted the following year. Conduct a soil test analysis for atrazine residue before the second year planting. May be applied at 1.3 to 2.58 qt/A in min. 15 gal water as a post-emergence directed treatment on weeds < 2 leaf stage.
3-3.75 qt Bullet 4 F or Lariat 4 F	3-3.75 alachlor + atrazine	For control of many annual grasses and broadleaves. Apply to soil surface immediately after planting. See label for further directions and restrictions. Max. rate is 6.4 qt/A per year or 2 applications/year.
3-7.7 fl oz Callisto 4L	0.09-0.24 mesotrione	For pre-emergence (6 to 7.7 fl oz/A) and post-emergence (3 fl oz/A) control of annual broadleaves. Rainfall within 7 to 10 days is needed for activation. If no rain, a rotary hoe is suggested. Do not cultivate 7 days before or after application. Do not tank-mix with organophosphate or carbamate insecticide or with a grass herbicide.
4 pt Camix 3.67 E	1.84 s-metolachlor + mesotrione	For pre-emergence control of annual grasses and broadleaves. Camix may be applied up to 14 days before planting or as a broadcast application before corn emerges.
12-20 oz Define DF	0.45-0.75 Flufenacet	For pre-emergent control of many annual grasses and some broadleaf weeds. May be applied preplant surface or incorporated or early post-emergence.
1.3-1.7 pt Dual II Magnum 7.6 E	1.3-1.6 s-metolachlor	For control of most annual grasses and certain broadleaf weeds and suppression of yellow nutsedge. Apply pre-plant surface or incorporated, pre-emergence, post-emergence, or lay-by. See label for specific rates. Better control of seedling Johnson grass with higher rates. Small grains may be planted 4½ months following treatment. See label for other rotational crop restrictions.
6-7.5 pt Expert 9.45 E	6-10 atrazine + s-metolachlor + glyphosate	For pre-emergence control of grasses and broadleaves. Good coverage is essential for best results. Sprinkler irrigate a minimum of 2 hours after, but within 2 days of application. Apply ½ to 1 inch of water. If irrigation is not possible and rain does not occur within 2 days after application, weed control may be decreased.
5.4-6.6 pt Fultime 4 E	2.7-3.3 acetochlor + atrazine	For pre-emergence control of grasses and broadleaves. Apply preplant, pre-emergence incorporated or non-incorporated. Max. 1 application/season. 0.5 inch water can be used to incorporate the herbicide.
2.0-4.0 pt Gramoxone Inteon	0.69-1.38 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply before, during, or after planting but before crop emergence banded or broadcast. Use higher rate for heavy weed infestations. Add non-ionic surfactant 0.25% v/v. Can be applied post-emergence as a directed spray at 1.0 to 2.0 pt/A on corn at least 10 inches tall with nozzles arranged to spray the bottom 3 inches of the stalk. Shorter corn plants may be injured.
3-4 pt Guardman Max 5 EC	1.24-1.65 atrazine + 0.64-0.84 dimethenamid-P	Apply preplant surface or incorporated, pre-emergence, or post-emergence for control of most annual grasses and many broadleaf weeds and suppression of nutsedge. Preplant applications for use in min. tillage or no-tillage (15 to 45 days). If incorporated, apply min. 2 weeks before planting. For pre-emergence, rainfall or irrigation is needed for activation. For early post-emergence, apply to corn up to 12 inches tall.

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**WEED CONTROL: Sweet Corn (continued)**

Product Amt/A	Lb A.I./A	Comments
1.5-3 pt Harness	1.3-2.6 acetochlor	For pre-emergence control of some grasses and broadleaves. Tank-mix with other herbicides for adequate weed control.
0.75 fl oz Impact 2.8 E	0.016 topramezone	For post-emergence control of broadleaves and grasses. Use MSO at 1 to 1.5% v/v. Max. 1 application/season. PHI = 45 days.
6 pt Lexar 3.7 E	2.7 atrazine + s-metolachlor + mesotrione	For pre-emergence control of broadleaves and grasses. Apply preplant or pre-emergence without incorporation. May be applied up to 14 days before planting. Max. 3.5 qt/season. Irrigation or rainfall is needed within 7 days for best results. PHI = 60 days.
2.5-3 qt Micro-Tech 4ME or 3.8-4.5 lb Partner 65 WDG	2.3-4 alachlor	For control of many annual grasses and broadleaves. Apply as preplant or pre-emergence. Use higher rate for control of lambsquarters, black nightshade, nutsedge, and seedling Johnson grass. Restricted use pesticide. Max. 1 application/year and 4 qt/A per year.
14-18 fl oz Outlook 6 E	0.65-0.84 dimethenamid-P	For control of annual grasses and broadleaf weeds and suppression of seedling Johnson grass. Can be applied preplant surface or incorporated, pre-emergence or post-emergence to corn up to 12 inches tall. Outlook can be applied through chemigation or mixed with bulk dry fertilizer. Check label for exact rate for your soil type. PHI = 50 days. Max. rate is 21 fl oz/season.
0.67 oz Permit 75 WG or 0.66-1 oz Sanda 75 DF	0.031-0.046 halosulfuron	For annual broadleaves and yellow nutsedge control. Apply post-emergence broadcast from the spike to lay-by stage. Avoid cultivation within 7 days of application. Apply again as directed spray if needed and avoid spraying the plant whorl. Include 0.5% v/v non-ionic surfactant. Not all corn varieties are tested, so use Permit with caution on newly released varieties. Do not apply to Jubilee sweet corn or any corn under stress. Do not use with soil-applied organophosphate insecticides and do not apply any organophosphate insecticide within 7 days before or 3 days after Permit application.
1 oz Priority 62W	0.04 carfentrazone + halosulfuron	For pre-emergence and post-emergence control of broadleaves. Apply post-emergence to actively growing weeds. Multiple applications are allowed, with no time restrictions between applications.
4 pt Princep 4 L	2 simazine	For pre-emergence control of broadleaves and grasses. Apply preplant or pre-emergence with or without incorporation. Read label for rotation restrictions. Max. 1 application/season.
2.4-3.6 pt Prowl 3.3 E	1-1.49 pendimethalin	For control of annual grasses and broadleaf weeds. For use in conventional tillage only. Plant corn at least 1.5 inches deep. Apply pre-emergence after planting but before crop or weeds emerge. Apply post-emergence to corn 20 to 24 inches tall or when it has 8 visible collars (V8). Max. 1 application/season.
16-22 fl oz Roundup Weather- Max 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Corn must be at least 12 inches tall. Application with hooded sprayers is allowed. Min. 30 days before planting any non-labeled crop. With Roundup Ready varieties only, post emergence applications may be made over the top of corn through the 8 leaf-collar stage (V8) or until corn is 30 inches tall. Drop nozzles are recommended if corn is more than 24 inches tall, and must be used if corn is more than 30 inches tall to prevent spraying into whorls. Do not apply to corn more than 30 inches tall if it has reached the reproductive stage. Do not exceed 3.3 qts. per acre prior to crop emergence. Do not exceed 44 fl. oz. per acre in a single application in the crop. Do not exceed 4.1 qts. per acre per growing season from emergence through crop height of 48 inches. Do not exceed 5.3 qts. per acre for all applications.
0.6-1.3 pt Starane 1.5L	0.11-0.22 fluroxypyr	For post-emergence control of broadleaf weeds. Apply broadcast or band to corn up to 4 leaf collars (V4). After V4 stage, apply only as a directed treatment with drop nozzles. Max. 2 applications or 1.3 pt/A per season. PHI = 31 days. See label for control of volunteer potato vine.
1.5-2.5 pt Surpass 6.4 E	1.2-2 acetochlor	For pre-emergence control of broadleaves and grasses and yellow nutsedge. Apply and incorporate up to 2 weeks preplant or anytime from 14 to 30 days prior to planting or after planting but prior to corn emergence.
1.6-4.0 oz TriCor DF	0.075-0.19 metribuzin	Pre-emergent control of grasses and broadleaves, tank-mix with other herbicides for adequate weed control. See label for mix options.
1-3 pt Weedar 64 4L	0.5-1.5 2,4-D amine salt	For selective post-emergence control of broadleaf weeds. Apply 7 to 14 days preplant at 1 to 2 pt/A. Apply 3 to 5 days after planting but before corn emerges at 2 to 3 pt/A. Apply on small weeds when corn is 8 inches tall using drop nozzle at 0.5 to 1.5 pt/A. Avoid drift to other crops. 2,4-D may injure some supersweet (sh2, SE) cultivars.

**DISEASE CONTROL: Sweet Corn**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Leaf Blights, Gray Leaf Spot, Rust</b>					
Aftershock	11	7	2 to 3.8 fl oz	4 apps	Apply every 7 to 14 days.
Aproach	11	7	3 to 12 fl oz <sup>4</sup>	36 fl oz	Apply before disease onset, continue every 7 to 14 days.
Avaris	11/3	14	7 to 14 fl oz	56 fl oz	Premix of azoxystrobin and propiconazole. Use higher rates for rust and gray leaf spot. Apply before disease onset; continue every 7 to 14 days. Do not rotate with azoxystrobin or propiconazole.
Chlorothalonil <sup>3</sup>					Not for processing sweet corn. Apply when conditions favor disease; continue every 7 days as needed. Limit 9 lb ai/A per season.
Bravo Ultrex	M	14	0.7 to 1.8 lb	10.9 lb	
Bravo WeatherStik	M	14	0.75 to 2 pt	12 pt	
Copper-Count-N		0	4 pt	n/a	Leaf blights only. Apply when conditions favor disease and repeat every 7 days as needed.
Cueva	M	0	0.5 to 2 gal	n/a	OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Evito 480 SC	11	7	2 to 3.8 fl oz	15.2 fl oz	Apply every 14 days.
Evito T	11/3	7	4 to 9 fl oz	2 apps	Apply every 14 days.
Headline	11	7	6 to 12 fl oz	72 fl oz	Apply before disease onset, continue every 7 to 14 days as needed. Use lower rates for rust and gray leaf spot.
Headline SC	11	7	6 to 12 fl oz	72 fl oz	Apply before disease onset, continue every 7 to 14 days as needed. Use lower rates for rust and gray leaf spot.
Headline AMP	11/3	7	10 to 14.4 fl oz	57.6 fl oz	Apply before disease onset, continue every 7 to 14 days as needed.
Mancozeb <sup>3</sup>					Products include Dithane, Koverall, Manzate, Penncozeb.
Dry formulations	M	7	1 to 1.5 lb	22.5-24 lb	Apply when disease appears and continue every 4 to 7 days as needed. Limit 18 lb ai/A per season.
Liquid formulations	M	7	1.6 to 2.4 pt	36 pt	
Propiconazole <sup>3</sup>		14			Use higher rates for rust. Apply before disease onset, continue every 7 to 14 days.
Tilt	3	14	2 to 4 fl oz	16 fl oz	
Priaxor	7/11	7	4 to 8 fl oz	16 fl oz	Apply prior to development of disease, continue every 7 to 10 days.
Prostar 421SC	3	7	6.5 fl oz	26 fl oz	Apply when disease appears and continue every 5 to 14 days while conditions favor disease.

(continued on next page)

**DISEASE CONTROL:** *Sweet Corn (continued)*

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Azoxystrobin <sup>4</sup>					Use lower rates for rust. Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin	11	7	6 to 15.5 fl oz <sup>4</sup>	6 apps	
Azoxystrobin	11	7	6 to 15.5 fl oz <sup>4</sup>	6 apps	
Quadris	11	7	6 to 15.5 fl oz <sup>4</sup>	6 apps	
Satori	11	7	6 to 15.5 fl oz <sup>4</sup>	6 apps	
Quilt	11/3	14	7 to 14 fl oz	56 fl oz	Apply before disease onset and continue every 7 to 14 days.
Quilt Xcel	11/3	14	10.5 to 14 fl oz	56 fl oz	
Stratego	11/3	14	10 fl oz	30 fl oz	Apply when disease appears and continue every 7 to 14 days as needed.
Stratego YLD	11/3	14	4 to 5 fl oz	20 fl oz	
Tebuconazole <sup>3</sup>	3	7		0.675 lb ai	Apply every 7 to 14 days; tank-mix with the lowest labeled rate of a surfactant.
Vertisan	7	7	10 to 24 fl oz	48 fl oz	Apply every 7 to 14 days.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>4</sup> Use higher rate when pressure is severe.

## Eggplant

Nightshade family (Solanaceae): *Solanum melongena*

### Planting and Culture

Eggplants need warm soil and warm air temperatures to yield well. After the danger of frost is past (see Appendix J), transplant into rows 36 to 42 inches apart with plants 18 to 24 inches apart in the rows. Plant on a well-drained loam soil for best results. Apply ½ pint of starter fertilizer solution to each plant when transplanting. Prepare the starter fertilizer by mixing 3 pounds of 10-52-17 or similar analysis water-soluble fertilizer in 50 gallons of water. Immediately following transplanting, flea beetles must be carefully monitored and treated if necessary. Yields of large-fruited varieties are in the range of 12 to 15 tons per acre of marketable fruit. Eggplant benefits from irrigation at flowering and fruit set if soil moisture is low.

Eggplants are most productive on black plastic with trickle irrigation. Mulched beds are usually spaced 5 to 6 feet apart with individual plants spaced 18 to 24 inches apart within the row. The recommendations in the “Fertigation” table are based on a plant population of 4,356 plants per acre (beds on 5-foot centers and 24 inches between plants within rows). Fertigation should begin about two weeks after transplanting and continue throughout the season. Growers may need to modify these guidelines slightly depending on soil type, previous crop, etc. Eggplants may benefit from staking similar to that used in tomatoes. Staking helps prevent late-forming fruit from pulling the branches over to the ground.

### VARIETIES: Eggplant

Variety	Maturity (days)	Comments
<b>TRADITIONAL ITALIAN</b>		
Nadia	62	Medium, teardrop shaped fruit, deep purple-black skin, soft spines; will set fruit in cool weather.
Epic	64	Good yield, strong upright plant; medium teardrop shaped fruit, deep purple/black, few spines.
Irene	65	Large broad fruit, high yield, purple/black, sharp spines.
Night Shadow	68	Medium sized, teardrop shaped, glossy purple/black, few soft spines.
Belen	70	Oval, medium sized purple/black, spineless.
Santana	80	Elongated oval shape, glossy purple/black, high yielding, green calyx, fewer spines.
<b>ASIAN TYPE</b>		
Orient Express	58	Elongated Oriental eggplant, sets fruit in cool and hot weather.
Dairyu	60	Long slim, purple/black fruit, few soft spines, Ichiban replacement.
<b>SPECIALTY</b>		
Fairy Tale	55	Mini purple fruit with white strips, AAS winner.
Tango	60	White skinned, small, cylindrical, few spines.
Megal	60	Long tapered purple/black attractive fruit, few soft spines
Kermit	60	Small, round eggplant, green skinned
Nubia	64	Medium size, broad teardrop shape, dark wine streaks over cream background, sharp spines, very attractive
Little Fingers	66	Mini slender purple/black 6-inch long fruit; borne in clusters of 4 to 6 fruits.
Ghostbuster	80	White skinned, excellent flavor.

### Fertilizing

Lime the soil if needed to obtain a soil pH of 6.0 to 6.8. Too much early nitrogen results in large plants, delayed maturity, and stem breakage. For eggplants grown using plastic mulch and drip irrigation, apply all phosphorus and potassium and a portion of the total nitrogen requirement prior to laying plastic. The remaining N requirement can be fertigated in weekly doses (see “Fertigation” table).

### Harvesting

The time required from flowering to marketable fruit size is about three weeks. Large fruit should weigh in the range of three quarters to 1 pound. Oriental type fruit should weigh one third to of half of a pound. The principal market container is a 1 ½ bushel fiberboard carton, 18 to 21 fruit per box.

Harvest fruit when they reach a dark, glossy, uniform, purple-black color. They

### FERTILIZER: Eggplant

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
<b>Phosphorus</b>	<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>	
Low	<31	181-240
Medium	31-60	121-180
High	61-80	61-120
Very High	>80	0-60
<b>Potassium</b>	<b>Potash (K<sub>2</sub>O)</b>	
Low	<201	101-150
Medium	201-300	51-100
High	301-450	1-50
Very High	>450	0

**Nitrogen** **N**  
Apply 75 lb nitrogen (N)/A before transplanting. Broadcast and disk well with other fertilizer. Sidedress plants with 35 to 40 lb of nitrogen (N) when first fruit appear. Too much N can delay fruiting and lead to large plants that fall over. See “Fertigation” table for N recommendations using plastic mulch and drip irrigation.

should be firm (non-wrinkled). Wipe fruit clean or wash. Frequent pickings will result in higher yields.

Cut the stem from the plant. The calyx and stem should be fresh green in color. For transit and storage, hold eggplants at a temperature of 45° to 50°F and 90 to 95 percent relative humidity. Handle fruit carefully, as they bruise easily.

### Common Diseases/Management

#### Damping-off and seed-borne diseases.

Hot-water seed treatment at 122° F for 25 minutes is helpful in reducing seed-borne diseases (see Appendix H). Treat seed with Captan WP at 1 teaspoon per pound of seed. Transplant into raised beds. Ridomil Gold and Ultra Flourish applied preplant incorporated are effective.

**Fruit rots, leaf spots (Anthracnose, Alternaria early blight, Cercospora, and Phomopsis).** Use crop rotations of three years to grasses or crops not related to the nightshade family (tomatoes, peppers, potatoes, tobacco) to help control these diseases. Practice good weed control both during crop rotation and during crops of eggplant. Fungicides applied on a seven- to 14-day schedule can be effective.

**Phytophthora blight.** Phytophthora blight affects stems and fruit of eggplant. See the "Phytophthora Blight" section in the "Peppers" chapter for information on control. Fungicide options are limited.

**Powdery mildew.** Powdery mildew has generally been a minor problem in Kentucky, mainly found very late in the season. Several fungicides are registered.

**Tomato spotted wilt.** The key control is prevention. Use virus-free transplants. Do not produce transplants in greenhouses containing ornamental plants. Control thrips in the greenhouse.

**Verticillium and Fusarium wilts.** Use hot-water seed treatment to reduce seed-borne introduction (see Appendix H). Tolerance to Verticillium wilt has been reported in the following varieties: 'Black Pride,' 'Epic,' 'Classic,' 'Early Bird,' 'Elondo,' 'Irene,' 'Vernal,' and 'Viserba.' Avoid fields with a history of the disease, or use a general soil fumigant. Rotate with small grains or other grasses to prevent rapid buildup of the pathogen in soil. Crop rotation does not significantly reduce populations of this

### FERTIGATION: Eggplant<sup>1</sup>

Actual N/week:	6 lb/A
Calcium Nitrate	38 lb 11 oz/A 8 lb 14 oz/1,000 plants

Total amount/season:	120 lb/A
Preplant amount:	60 lb/A
Fertigated amount:	60 lb/A
Growing season:	10 weeks

Fertigation can begin 10 to 14 days after transplanting.

The doses listed for 1,000 plants are based on a plant population of 4,356 plants/A (i.e., rows on 5 foot centers and plants 24 inches apart).

For seasons extending beyond 10 weeks from transplanting, a maintenance dose of 1 to 1.5 lb N/week (6.5 to 9.7 lb calcium nitrate) is adequate.

<sup>1</sup> All recommendations assume starter fertilizer was used.

### PESTICIDE SAFETY: Eggplant

INSECTICIDES	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
Acramite 50 WS	C	12	3
Actara 25 W	C	12	0
Admire Pro	C	12	0/21 <sup>3</sup>
Assail 30 SG	C	12	7
Avant 30 DG	C	12	3
Belay 2.13 SC	C	12	7/21 <sup>3</sup>
Beleaf 50 SG	C	12	0
Belt SC	C	12	1
Closer 2 SC	C	12	1
Confirm 2 F	C	4	7
Coragen 1.67 SC	-	4	1
Courier 40 SC	W	12	1
Exirel 0.83 SE	C	12	1
Fulfill 50 WDG	C	12	0
Intrepid 2 F	C	4	1
Kanemite 15 SC	C	12	1
Knack 0.86 EC	C	12	14
Malathion 8	C	12	3
Movento 2 SC	C	24	1
Oberon 2 SC	C	12	7
Platinum 2 SC	C	12	30
Portal 0.4 EC	W	12	1
Radiant SC	C	4	1
Requiem 25 EC	C	4	0
Rimon 0.83 EC	W	12	1
Scorpion 3.5 SL	C	12	1/21 <sup>3</sup>
Sevin XLR	W	12	3
Venom 70 SG	C	12	1/21 <sup>3</sup>
Zeal 72 WDG	C	12	7
Restricted Use			
Agri-Mek 0.15 EC	W	12	7
Asana XL	W	12	7
Battalion 1.5 EC	DP	21	1
Baythroid XL	W	12	7
Brigade 2 EC	W	12	7

### PESTICIDE SAFETY: Eggplant

FUNGICIDES	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
Danitol 2.4 EC	W	24	3
Hero 1.24 EC	C	12	7
Lannate 90 SP	DP	48	5
Mustang Max	W	12	1
Permethrin 3.2 EC	C	12	3
Proaxis 0.5 EC	C	24	5
Proclaim 5 WDG	W	48	7
Renounce 20 WP	C	12	0
Vydate L	DP	48	1/7 <sup>3</sup>
Warrior II	W	24	5
FUNGICIDES			
Aftershock	C	12	3
Ariston	C	12	3
Cabrio EG	C	12	0
Endura	W	12	0
Evito 480 SC	C	12	3
Fixed coppers <sup>2</sup>	D	24/48	0
Flint	C	12	3
Fontelis	C	12	0
Forum SC	C	12	0
Inspire Super	C	12	0
MetaStar 2EC AG	W	48	7
Presidio	C	12	2
Priaxor	C	12	7
Quadris	C	4	0
Quadris Top	C	12	0
Rally 40 WSP	W	24	0
Ranman	C	12	0
Reason 500 SC	C	12	14
Ridomil Gold SL	W	12	7
Ultra Flourish	W	12	7
Vivando	C	12	0
Zapro	C	12	4

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

<sup>3</sup> PHI varies by type of application.

<sup>4</sup> Varies by formulation, so check label carefully.

fungus after it has become established. Once a significant population exists, soil fumigation under plastic is needed to re-

duce the population. See "Soil Fumigants for Control of Nematodes and Soilborne Diseases" on page 16 for details.

### INSECT CONTROL: Eggplant<sup>1,2</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>AT PLANTING</b>			
<b>Aphids, Flea Beetles, Whiteflies, Colorado Potato Beetle:</b> Do not use a foliar spray of Actara, Assail, Belay, Provado, or Venom following a soil application of Admire, Belay, Platinum, or Venom.			
Admire Pro	7 to 10.5 fl oz	10.5 fl oz	Systemic control. See label for applications methods.
Belay 2.13 SC	9 to 12 fl oz	12 fl oz	Allow 7 days between applications. At planting only.
Platinum 2 SC	5 to 8 fl oz	8 fl oz	Systemic control. See label for applications methods.
Scorpion 35 SL	9 to 10.5 oz	21 oz	For soil applications.
Venom 70 SG	5 to 6 lb	12 oz	For soil applications.

(continued on next page)

**INSECT CONTROL: Eggplant (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>FOLIAR TREATMENTS</b>			
<b>Aphids, Whiteflies</b>			
Admire Pro	1.3 to 2.2 fl oz	6.7 fl oz	Allow 5 days between applications. Not during bloom.
Actara 25 W	2 to 5.5 oz	11 oz	Allow 5 days between applications.
Assail 30 SG	2 to 4 oz	16 oz	Limit 4 applications. Allow 7 days between applications.
Beleaf 50 SG	2 to 2.8 oz	8.4 oz	Allow 7 days between applications. Use high rate for whiteflies.
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Closer 2 SC	1.5 to 2 fl oz	17 fl oz	Allow 7 days between applications.
Courier 40 SC	9 to 13.6 fl oz	2 applications	Allow 5 days between applications. For whiteflies only.
Exirel 0.83 SE	13.5 to 20.5 fl oz	61.5 fl oz	Allow 5 days between applications. Use an adjuvant. Whiteflies only.
Fulfill 50 WDG	2.75 oz	5.5 oz	Allow 7 days between applications.
Knack 0.83 EC	8 to 10 fl oz	20 fl oz	Allow 14 days between applications. Whiteflies only.
Lannate 90 SP	0.25 to 1 lb	5 lb	-
Movento SC	4 to 5 fl oz	10 fl oz	Allow 7 days between applications.
Malathion 8	0.75 to 3.5 pt	4 applications	Aphids only. Allow 5 days between treatments.
Requiem 25 EC	2 to 3 qt	-	-
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications. Whitefly only.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications. Whitefly only.
<b>Colorado Potato Beetle:</b> This is the key insect pest of eggplant. This pest has the ability to develop resistance to all major classes of insecticides. Do not tank mix insecticides with the same mode of action and frequently rotate among insecticides with different modes of action to discourage resistance. Treat when an average of more than 1 larva/adult is found per plant on plants less than 6 inches tall or when 2 or more larvae/adults are found on larger plants. IRAC Codes: Insecticides followed by the same number share the same mode of action.			
Actara 25 W (4A)	2 to 3 oz	11 oz	Allow 5 days between applications. Not during bloom.
Agri-Mek 0.15 EC (6)	8 to 16 fl oz	48 fl oz	Allow 7 days between applications.
Assail 30 SG (4A)	1.5 to 2.5 oz	16 oz	Limit 4 applications. Allow 7 days between applications.
Asana XL (3)	5.8 to 9.6 fl oz	67.2 fl oz	-
Battalion 1.5 EC (3)	1.5 to 2.4 fl oz	14.4 fl oz	-
Belay 2.13 SC (4A)	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Brigade 2 EC (3)	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Coragen 1.67 SC (28)	3.5 to 5 fl oz	15.4 fl oz	Drip and foliar application possible. See label for limitations.
Exirel 0.83 SE	7 to 13.5 fl oz	61.5 fl oz	Allow 5 days between applications.
Mustang Max (3)	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC (3)	8 fl oz	80 fl oz	-
Proaxis 0.5 EC (3)	2.56 to 3.84 fl oz	46 fl oz	-
Radiant SC (5)	5 to 10 fl oz	34 fl oz	Allow 4 days between applications.
Rimon 0.83 EC (15)	9 to 12 fl oz	36 fl oz	Allow 7 days between applications. For immature stages only.
Sevin XLR (1A)	1 to 2 qt	8 qt	Limit 7 applications. Allow 7 days between applications.
Venom 70 SG (4A)	1 to 4 oz	6 oz	Allow 7 days between applications.
Warrior II (3)	1.28 to 1.92 fl oz	23 fl oz	-
<b>Cutworms:</b> Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites.			
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Belt 4 SC	1.5 fl oz	4.5 fl oz	Allow 3 days between applications.
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Proaxis 0.5 EC	1.92 to 3.2 fl oz	46 fl oz	-
Sevin 80 S	2.5 lb	7 applications	Allow 7 days between applications.
Vetiva 2.66	12 to 17 fl oz	38 fl oz	Allow 5 days between applications.
Warrior II	0.96 to 1.6 fl oz	23 fl oz	-
<b>Flea Beetles:</b> Monitor for flea beetles after setting plants. Treat when an average of 2 or more beetles are found on plants less than 3 inches, 4 or more beetles on plants that are 3 to 6 inches tall, or 8 or more beetles on plants larger than 6 inches.			
Actara 25 W	2 to 3 oz	11 oz	Allow 5 days between applications. Not during bloom.
Asana XL	5.8 to 9.6 fl oz	67.2 fl oz	-
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Baythroid XL	2.8 fl oz	16.8 fl oz	Allow 7 days between applications.
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	80 fl oz	-
Proaxis 0.5 EC	2.56 to 3.84 fl oz	46 fl oz	-
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Sevin XLR	0.5 to 1 qt	8 qt	Limit 7 applications. Allow 7 days between applications.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	23 fl oz	-
<b>Mites</b>			
Acramite 50 WS	0.75 to 1 lb	1 application	-
Agri-Mek 0.15 EC	8 to 16 fl oz	48 fl oz	Allow 7 days between applications.
Brigade 2 EC	5.12 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications. For end of season control.
Danitol 2.4 EC	10.67 fl oz	42.67 fl oz	Allow 7 days between applications. For end of season control.
Kanemite 15 SC	31 fl oz	62 fl oz	Allow 21 days between applications.
Oberon 2 SC	7.0 to 8.5 fl oz	25.5 fl oz	Allow 7 days between applications.
Portal 0.4 EC	2 pt	4 pt	Limit 2 applications.
Zeal 72 WP	2 to 3 oz	3 oz	Limit 1 application.

(continued on next page)

**INSECT CONTROL: Eggplant (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>Stink bugs</b>			
Actara 25 W	3 to 5.5 oz	11 oz	Allow 5 days between applications. Not during bloom.
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	16.8 fl oz	Allow 7 days between applications.
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	46 fl oz	-
Rimon 0.83 EC	12 fl oz	36 fl oz	For immatures only. Allow 7 days between applications.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	23 fl oz	-

<sup>1</sup> See An IPM Scouting Guide for Common Problems of Solanaceous Crops in Kentucky (ID-172) for photos of pests.

<sup>2</sup> Generic products available (Appendix E).

**WEED CONTROL: Eggplant**

Product Amt/Alb A.1./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a pre-plant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
6-14 lb Dacthal W-75	4.5-10.5 DCPA For pre-emergence control of annual grasses and small-seeded broadleaves. Over-the-top application 4 to 6 weeks after transplanting is safe to plants. Plants should be well established.
2-4 qt Devrinol 2-XT	1-2 napropamide For control of annual grasses and broadleaf weeds. For use with transplants only. Apply before transplanting. To avoid injury to crops not specified on the label, do not replant within 12 months if using the 4-lb rate. The low rate is for coarse sandy soil and the high rate for heavy clay soil.
2.0-4.0 pt Gramoxone Inteon	0.69-1.38 paraquat salt For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply preplant, pre-emergence, or before transplanting in min. 10 gal water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v.
0.5-1.5 pt Poast	0.09-0.28 sethoxydim For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 20 days. Max. rate of 1.5 pt/application and 4.5 pt/season.
5-6 qt Prefar 4 E	5-6 bensulide For control of grasses and broadleaf weeds. Apply preplant and incorporate to 1 to 2 inch depth. Apply pre-emergence only if it can be watered in within 36 hours. Max. rate of 6 qt/season.
16-22 fl oz Roundup WeatherMax 5.5L	0.69-0.94 glyphosate-salt For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 3 days before seeding and min. 30 days before planting any non-labeled crop.
0.5-1 oz Sandea 75 DF	0.023-0.047 halosulfuron For control of annual broadleaf weeds and yellow nutsedge. Can be applied in row middles of direct-seeded or transplanted eggplant. Avoid contact with the crop or with plastic if plastic mulch is used. Max. 2 applications/crop and 2 oz/A per season.
9-16 fl oz Select Max	0.06-0.12 clethodim For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. Max. 16 fl oz/application. Min. 14 days between applications. PHI = 20 days.
1-1.5 pt Treflan HFP 4 E	0.5-0.75 trifluralin For pre-emergence control of annual grasses and broadleaf weeds. Apply and incorporate before transplanting. Can also be applied post-transplant as a directed spray between rows and beneath plants and incorporate. Eggplant tolerance is marginal.

**DISEASE CONTROL: Eggplant**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Alternaria, Anthracnose, Leaf Blights, Powdery Mildew, Phomopsis Fruit Rot</b>					
Aftershock	11	3	2.0 to 5.7 oz	4 apps	Early blight. Apply before disease onset. Alternate with a different FRAC code.
Ariston	M/27	3	2.0 - 2.4 pt	17.5 pt	Anthracnose, leaf blights, and powdery mildew. Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin <sup>3</sup>					Anthracnose, powdery mildew. Apply before disease onset, continue every 7 to 14 days.
Azoxy 25C	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
AzoxyStar	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	-
Satori	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	-
Cabrio	11	0	8 to 12 oz	6 apps	Anthracnose, early blight, leaf blights. Apply before disease onset, continue every 7 to 14 days.
Endura	7	0	2.5 to 3.5 oz	6 apps	Early blight. Apply before disease onset, continue every 7 to 14 days.
Evito 480 SC	11	3	3.8 to 5.7 fl oz	4 apps	Early blight. Apply before disease onset and continue every 7 to 10 days.
Fixed coppers					Apply before disease onset, continue every 5 to 10 days, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1.5 pt		-
Badge X2	M	0	0.75 to 1.5 lb		OMRI-listed.
Basic Copper 53	M	0	1.5 lb		OMRI-listed.
C-O-C-S WDG	M	0	2 to 4 lb		-
Champ DP	M	0	1.33 lb		-
Champ Formula 2 FL	M	0	1.33 pt		-
Champ WG	M	0	2 lb		OMRI-listed.
COC DF	M	0	3 to 4 lb		-
COC WP	M	0	3 to 4 lb		-

(continued on next page)

**DISEASE CONTROL: Eggplant (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Copper-Count-N	M	0	4 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 lb		-
Kentan DF	M	0	2 lb		-
Kocide 2000	M	0	1.5 lb		-
Kocide 3000	M	0	0.75 lb		-
Kocide DF	M	0	2 lb		-
Mastercop	M	0	0.5 to 1.5 pt		-
Nordox 75 WG	M	0	1.25 to 2.5 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	2 lb		OMRI-listed.
Nu-Cop 3 L	M	0	1.33 pt		-
Nu-Cop 50 DF	M	0	2 lb		OMRI-listed.
Nu-Cop HB	M	0	1 lb		-
Flint	11	3	2 to 4 oz	5 apps	Anthracnose, early blight, leaf blights. Apply before disease onset, continue every 7 to 14 days.
Fontelis	7	0	16 to 24 fl oz	72 fl oz	Anthracnose, early blight, leaf blights. Apply every 7 to 14 days.
Inspire Super	3/9	0	16 to 20 fl oz	47 fl oz	Anthracnose, early blight, leaf blights. Apply every 7 to 10 days.
Priaxor	7/11	7	4 to 8 fl oz	24 fl oz	Anthracnose, early blight, leaf blights. Apply every 7 to 10 days.
Quadris Top	11/3	0	8 to 14 fl oz	55.3 fl oz	Anthracnose, powdery mildew. Apply before disease onset, continue every 7 to 14 days.
Rally 40 WSP	3	0	2.5 to 5 oz	4 apps	Powdery mildew. Apply every 10 to 14 days when conditions favor disease.
Reason 500 SC	11	14	5.5 to 8.2 fl oz	24.6 fl oz	Early blight. Apply before disease onset, continue every 5 to 10 days.
Sulfur <sup>3</sup>	M				Apply every 7 to 10 days, beginning when symptoms are first observed or when conditions favor disease. Phytotoxicity may occur when sulfur is applied when temperatures exceed 90°F. Some products are OMRI-listed (see labels).
Vivando	U8	0	15.4 fl oz	3 apps	Powdery mildew only. Begin applications prior to disease onset and continue every 7 to 14 days. No curative activity.
<b>Phytophthora Blight</b>					
Forum SC	40	0	6 fl oz	30 fl oz	Must be tank-mixed with another <i>Phytophthora</i> fungicide NOT in FRAC Group 40. Apply before disease onset, continue every 5 to 10 days.
MetaStar 2E AG	4	7	4 to 8 pt	12 pt	<b>Surface application (preplant or at planting):</b> Apply to soil as a broadcast spray or in a 12- to 16-inch band; incorporate mechanically before planting into the upper 2 inches of soil or at planting with 0.5 to 1 inch of irrigation if rainfall is not expected within 24 hours. Make two additional 1 pt/A applications at 30-day intervals, directing spray at the base of plants and surrounding soil. <b>Drip application:</b> Apply 1 pt/A at planting; inject into irrigation system. Make up to two additional applications at 1 pt/A at 30-day intervals after initial application.
Ridomil Gold SL	4	7	1 pt	3 pt	
Ultra Flourish	4	7	2 pt	6 pt	
Presidio	43	2	3 to 4 fl oz	12 fl oz	Apply every 7 to 14 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Ranman	21	0	2.75 fl oz	16.5 fl oz	Apply to base of plants at transplanting or in transplant water. Make additional applications every 7 to 10 days. Alternate with a fungicide with a different mode of action.
Zampro	40/45	4	14 fl oz	3 apps	Apply at planting as a drench or by drip irrigation; make supplemental applications every 5 to 7 days.
<b>Pythium Damping-off</b>					
MetaStar 2E AG	4	7	4 to 8 pt	1 app	See comments for Phytophthora blight.
Ridomil Gold SL	4	7	1 pt		
Ultra Flourish	4	7	2 pt		

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 14 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

## Greens

Collards, Kale, Lettuces, Mustards, Spinach, Swiss Chard, Turnip, and Others

Leafy greens or salad greens are consumed daily by most Americans, and nearly all types can be grown profitably in Kentucky. In fact, Kentucky was once known throughout the country for its “bibb” or “limestone” lettuce, named after Major John (Jack) Bibb, who, after fighting in the War of 1812, grew it in his garden in Frankfort. The large group of vegetable crops included under the broad term “greens” includes crops from sev-

eral families: lettuces (romaine, leaf, bibb/Boston, iceberg, etc.); mustards (mustard greens, arugula, turnip greens); crucifers (collards, kale, broccoli raab, flowering or Chinese kale); spinach (flat leaf and savoy); composites (endive, escarole, radicchio, chicory, dandelion); and others including Swiss chard and beet greens. Various mixtures of green leafy vegetables (“mesclun”) and immature “baby greens” are also very popular. Production guidelines for cole crops such as cabbage, broccoli, and some of the Asian vegetables are found in the chapter on “Cole Crops.”

Most greens are cool-season crops that do best in the spring and fall, but heat-

tolerant varieties for summer plantings are also available for some types. Many types of greens have also been successfully grown in Kentucky from September until June in unheated greenhouses or high tunnels (see Appendix J).

### Production Systems

Production systems for this group are as varied as the crops themselves. Although greens have traditionally been grown as row crops at wide spacing in Kentucky, many growers are now planting at higher densities using raised beds with multiple rows per bed. Many of the crops in this group are most productive using raised

beds with plastic mulch and drip irrigation. Greens are also grown on raised beds without plastic; however, weed control with hand/mechanical cultivation or with herbicides is critical when plastic mulch is not used. Black plastic mulch is used for spring plantings, and white mulch can be used for late summer plantings. Bed-shaping machines commonly used in Kentucky will form a 6-inch-high raised bed 30 to 32 inches wide at the top with 5 to 6 feet between centers of the beds. Depending on the crop and the between-row spacing, two to three rows can be used per bed. Growers in the Northeast make wider (4 1/2 to 5 1/2 feet), lower (4 to 5 inches high) beds on bare ground using a "meeker harrow" or roller and plant four to six rows of greens per bed, depending on the crop. This system relies heavily on the use of herbicides and overhead irrigation; similar systems are used in California but with drip irrigation.

Greens are either direct seeded and thinned or transplanted into either bare ground or plastic-mulched beds with drip irrigation. Pelleted seed is normally used for direct seeding, using a simple "Planet Jr."-type seeder or vacuum seeder. Transplanting will usually result in an earlier crop less exposed to insect damage, drought, or other early-season stresses. Some Kentucky growers have also produced leafy greens in tobacco "float beds" in the same way that tobacco transplants are grown. Keep in mind that few chemicals are available to manage diseases of greens grown in this manner. Going a step further, growers can produce high-quality bibb lettuce and other greens in traditional greenhouses using a hydroponic production system.

If transplants are used, crops are seeded in 128- to 288-cell plug trays in the greenhouse four to six weeks prior to going to the field. Harden the transplants by moving them outside the greenhouse for a few days prior to transplanting. Most greens are transplanted by hand or with a waterwheel setter onto raised beds with plastic mulch. One Kentucky grower has fabricated a three-row/bed waterwheel for this setter (8 inches within-row and 10 inches between rows) which has worked well for mustard and turnip greens. It should also be possible to use this wheel for leaf or bibb lettuce. See the table above for plant spacing used in the field for different types of greens.

### Fertilizing and Cover Crops

A soil test should be taken in the fall or early spring prior to planting. Soil pH should be in the 6.0 to 6.8 range. Lime applications should be made in the fall if necessary.

### OPTIMUM IN-ROW AND

### BETWEEN-ROW SPACINGS: Greens

Most crops can be transplanted to 2 rows/bed using a waterwheel setter, using two wheels for 9- or 12-inch spacings.

Crop	In-row (in.) <sup>1</sup>	Between-row (in.)	No. rows/bed <sup>2</sup>
Collards	12-18	15-36	1-2
Kale	9-12	12-24	2
Mustard	9-15	12-15	2
Turnip			
for roots	3-4	12-18	2
for leaves	0.5-3	12-18	2
Broccoli raab	6-12	15-18	2
Lettuce			
leaf/bibb	9-12	12-18	2
romaine	9-12	12-18	2
Endive/escarole	12-18	15-18	2
Spinach	3-6	9-18	3-4
Swiss chard	6	18-24	2

<sup>1</sup> Final spacing after thinning or transplanting.

<sup>2</sup> Raised beds formed by Rainflo or similar bed shaper.

### VARIETIES: Greens

Variety	Maturity (days) <sup>1</sup>	Comments
<b>COLLARDS<sup>2</sup></b>		
Top Bunch	70	Uniform hybrid that is 5 to 10 days earlier than Vates.
Flash	73	Vigorous uniform hybrid (Vates type); slow bolting.
Vates	75	Blue-green leaves; compact and uniform.
Champion	76	Slow bolting, good hardiness.
Georgia/Southern	80	Blue-green leaves; produces under adverse temperatures.
<b>KALE<sup>2</sup></b>		
Winterbor	50-55	Hybrid, finely curled dark green leaves; frost tolerant.
Darkibor	50-55	Hybrid, finely curled, blue-green leaves, slow bolting.
Redbor	55	For garnish not eating, hybrid, finely curled, dark red and taller version of Winterbor.
Red Russian	50	Purple stems, green, flat "oak-leaf" pattern leaves; used in salad mixes.
Blue Curled Vates	57	Dark blue-green finely curled leaves; 15 to 20 inches tall.
White Russian	55-60	Flat dissected leaves with white stems, very tender, has done well in organic trials
<b>MUSTARD<sup>2</sup></b>		
Savannah	35	Very early maturing, drought tolerant.
Tendergreen	40	Large, thick but tender leaves; cold resistant, mild flavor.
Southern Giant	45	Large plants, bright green leaves with crumpled frilled edges; for spring and fall.
Green Wave	45	Large plants, deeply frilled and finely cut leaves; heat tolerant and slow bolting.
Florida Broadleaf	50	Large plants, spreading oval, serrated dark green leaves.
<b>TURNIPS/TURNIP GREENS<sup>2</sup></b>		
Alamo	33	Broad leaved greens, short petiole, slow bolting; for greens
All Top	35	Thick tender leaves, quick regrowth, slow bolting; for greens
Southern Green	40	Hybrid, very dark green, upright leaves, slow bolting.
<b>BROCCOLI RAAB (RAPINI)<sup>2</sup></b>		
Spring Raab	42	Versatile variety for spring and summer harvests.

(continued on next page)

### FERTILIZER: Greens

Soil Test Results (lb/A)		Fertilizer Needed (lb/A)
<b>Phosphorus</b>		<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>
Low	<31	121-180
Medium	31-60	1-120
High	>60	0
<b>Potassium</b>		<b>Potash (K<sub>2</sub>O)</b>
Low	<201	101-150
Medium	201-300	51-100
High	301-450	1-50
Very High	>450	0
<b>Nitrogen</b>		<b>N</b>
Apply 100 to 150 lb of actual nitrogen (N)/A. Apply 25 to 50% broadcast with other fertilizer before seeding or transplanting and disk in well. The remainder can be divided up into one or more sidedressings.		

Soil tests are critical to making appropriate recommendations for fertilizing vegetable crops and maintaining proper soil balance. Cover crops add organic matter and reduce weed pressure. Legume cover or green manure crops can also provide significant amounts of nitrogen. Winter cover crops include winter rye, wheat, ryegrass, or a mixture of winter rye and hairy vetch. Although this practice can delay planting, hairy vetch plowed under at 50 percent flowering in the spring (mid to late

May) provides up to 80 pounds per acre of available nitrogen (140 to 160 pounds per acre total) to the following crop. Sudan grass or sorghum-Sudan grass hybrids ("Sudex") are used as summer cover crops on otherwise fallow land.

Apply all phosphorus and potassium according to soil test report recommendations prior to planting. Leafy vegetables require quick, continuous growth for best quality. Greens are high users of nitrogen, and most crops require a total of 100 to

150 pounds of nitrogen per acre. Apply 50 percent of the nitrogen together with phosphorus and potassium prior to planting. The remaining nitrogen is applied in two sidedressings on bare ground or is divided up and fertigated (injected) in equal weekly doses for plastic-mulched, drip-irrigated crops.

### Tipburn and Bolting

Tipburn is a common and serious problem in lettuce and cole crops. Symptoms are brown leaf margins on the youngest leaves (sometimes concealed within the heads). It most often occurs during periods of drought followed by abundant moisture from rain or irrigation. In these cases the supply of calcium (which moves with the flow of water in plants) cannot keep up with the needs of rapidly growing new plant tissue. The calcium-deficient tissue collapses and turns brown, resulting in an unmarketable product.

Liming according to soil test results will help reduce the risk of tipburn as will any practice which ensures a regular moisture supply to plant roots. As is the case with blossom end rot, tipburn is more the result of lack of water or adverse weather conditions than a soil calcium deficiency. Excess application of ammonium nitrate can damage roots and cause tipburn as will deep cultivation, flooding, or drought. Plastic or organic mulches with drip irrigation also help reduce the risk of tipburn. Lastly, some varieties are less susceptible to the problem (see "Varieties" table).

Bolting is the formation of a flower stalk while the plant is still small or immature. Any stresses that slow vegetative growth can cause young plants to begin flowering. Generally for cool-season crops such as lettuce, favorable cool spring temperatures followed by periods of hot weather will lead to bolting. Lettuce should be harvested as soon as possible in spring crops to avoid excess heat and subsequent bolting. Seedlings subjected to low temperatures or water stress in the greenhouse prior to transplanting also are susceptible to bolting, as are transplants which are too old. Some growers have reported difficulty producing field-grown fall lettuce in Kentucky due to bolting. The practices discussed to reduce tipburn also will help reduce the risk of premature bolting. Variety selection is also important.

### Harvesting and Handling

All fresh market leafy greens are hand harvested in Kentucky. Multiple harvests are possible from most types of greens. Baby greens are grown at closer spacings and are ready for market in a little more

### VARIETIES: Greens (continued)

Variety	Maturity <sup>1</sup> (days)	Comments
Zamboni	60	Large flower buds and uniform bud set, spring.
<b>LETTUCE<sup>3</sup></b>		
<b>Leaf/Looseleaf</b>		
Grand Rapids	43	Early, old standard open-pollinated variety; light green leaves.
Red Sails	45-55	AAS winner; ruffled and fringed red leaves with green background; slow bolting and tipburn tolerant.
Tango	45	Pointed, deeply cut leaves (like endive), used in salad mixes.
Black-seeded Simpson	46	Early, old standard open-pollinated variety; light green leaves.
Salad Bowl	46	Oak-leaf type; light green, deeply lobed leaves; heat tolerant.
New Red Fire	48	Dark red, wavy, ruffled leaf margins; slow to bolt.
Green Vision	52	Dark green, "blistered" leaf type; heat and tipburn tolerant.
Simpson Elite	53	More ruffled and slower to bolt than Black-seeded Simpson.
Royal Green	55	Medium green, broad, smooth leaves, tipburn tolerant.
<b>Bibb/Butterhead/Boston</b>		
Dancine	43	For trial for indoor tunnel production.
Buttercrunch	44	Dark green, slow bolting, commonly grown
Rex	50	For indoor hydroponic production, slow bolting, not for outdoor production
Nancy	52	Medium green leaves, large "heart;" mildew and virus resistant.
Bennett	60	Firm-headed, fast growing, slow bolting.
<b>Romaine/Cos</b>		
Coastal Star	65-70	Large heavy heads, sell as full head or heart, very heat tolerant
Parris Island	28 (58)	Commonly grown for baby romaine (28 days) or for mature heads (58), dark green, good flavor.
Green Forest	66	Dark green leaves, short core length
Ideal/Ideal Cos	73	Dark green leaves smoother and heavier than Parris Island Cos.
Green Towers	74	Dark green, lightly savoyed leaves.
<b>Endive/Escarole<sup>3</sup></b>		
Neos	45	Extra frilly, deep hearted, medium-sized heads; self blanching; for spring and fall.
Lorca	90	Large, deep, blanched heads, tipburn resistant.
Natacha	48	Replaces 'Nataly'; very large heads; slow bolting, tipburn and bottom rot tolerant.
<b>Spinach<sup>4</sup></b>		
<b>FLAT LEAF</b>		
Space	40	For trial, hybrid; smooth, dark green leaves; downy mildew resistant, slow to bolt.
<b>SAVOY</b>		
Tyee	42	Hybrid; dark green, semi-savoy type; downy mildew resistant; heat tolerant and slower bolting than 'Spinner'.
Bloomsdale Long Standing	43	Open-pollinated; very hardy; savoyed dark green leaves; slow bolting.
Samish	45	For trial, hybrid, good cold hardiness, may be good for tunnels in winter.
Melody	45	Hybrid; deep green, semi-savoy type; downy mildew and mosaic tolerant, slow to bolt.
<b>Swiss Chard<sup>4</sup></b>		
Bright Lights	55	All America Selections winner; stalks of various colors.
Fordhook Giant	55	Very tall; dark green savoyed leaves with white stems/veins; heat tolerant.
Ruby Red	55	Deep green savoyed leaves with bright red rhubarb-like stems.
Silverado	60	Compact plants; dark green, deeply savoyed leaves with broad white stems.

<sup>1</sup> From seeding. Days to maturity vary widely in seed catalog descriptions making comparisons difficult.

<sup>2</sup> (Brassicaceae)—mustard family

<sup>3</sup> (Asteraceae)—sunflower family

<sup>4</sup> (Chenopodiaceae)—goosefoot family

than half the time required to produce mature greens. Turnip, mustard, collards, and kale are harvested when stalks are fairly young and tender. Rubber bands can be used to bunch loose greens but larger wholesale buyers may require labels or bands with price-lookup (PLU) codes. Hydroponic producers routinely harvest lettuce with intact roots and market the product in clear clamshell containers.

Harvesting hydroponic lettuce with roots intact can improve shelf-life. Turnip, mustard, collards, and kale are bunched with three to five stalks per bunch. Lower leaves that are discolored or dying are removed when bunching. Lettuces and spinach are often packed in cello bags. Greens can be field packed and top iced in waxed, corrugated cardboard boxes or wooden crates. Greens have high respiration rates

and should be washed, packed, and sold as quickly as possible. Vacuum cooling to 34°F is the preferred method of pre-cooling, although forced air cooling is also possible. Greens are not usually stored for very long, although lettuce and other crops can be stored for two weeks at 32°F.

## Common Diseases/Management

### Mustard, Turnips, Collards, Kale

**Anthracnose, downy mildew, powdery mildew, leaf spots, and blights.** Cultural practices are especially important in disease control of cruciferous crops. Reduce the length of time the foliage is wet by

selecting sites for good air movement and by using open plantings (wider spacings and/or thinner stand). Maintain timely harvests. Avoid overhead irrigation late in the day or at night. Rotate away from related crops for three years. Some fungicides may not be registered for all crops in this group—read labels carefully.

#### PESTICIDE SAFETY: Greens

	Signal <sup>2</sup>	Re-entry (hrs)	Harvest Interval (days)					Turnips
			Collards	Kale	Lettuce	Mustard	Spinach	
<b>INSECTICIDES</b>								
Actara 25 WP	C	12	7	7	7	7	7	-
Admire Pro	C	12	7/21 <sup>1</sup>	7/21 <sup>1</sup>	7/21 <sup>1</sup>	7/21 <sup>1</sup>	7/21 <sup>1</sup>	7/21 <sup>1</sup>
Assail 30 SG	C	12	7	7	7	7	7	-
Avaunt 30 DG	C	12	3	3	3	3	3	3
Belay 2.13 SC	C	12	21	21	7/21	21	7/21	21
Beleaf 50 SG	C	12	0	0	0	0	0	0
Belt SC	C	12	1	1	1	1	1	1
Bt products	C	12	0	0	0	0	0	0
Closer 2 SC	C	12	-	-	7	-	7	7
Confirm 2 F	C	4	7	7	7	7	7	7
Coragen 1.67 SC	-	4	3	3	1	3	1	-
Courier 40 SC	C	12	-	-	7	-	7	-
Dimethoate 4 E	W	48	14	14	14	14	14	14
Exirel 0.83 SE	C	12	-	-	1	-	1	-
Fulfill 50 DF	C	12	7	7	7	7	7	7
Intrepid 2 F	C	4	1	1	1	1	1	1
Knack 0.86 EC	C	12	7	7	-	7	-	-
Lorsban 75 WP	W	24	21	21	-	-	-	-
Malathion 8	C	24	7	7	14	7	7	-
Movento 2 SC	C	24	1	1	3	1	3	-
Oberon 2 SC	C	12	-	7	7	7	7	-
Platinum 2 SC	C	12	30	30	30	30	30	-
Pyrethrin	C	12	0	0	0	0	0	0
Radiant SC	C	4	1	1	1	1	1	3
Requiem 25 EC	C	12	-	-	0	-	-	-
Scorpion 3.5 SL	C	12	-	-	7/21	-	7/21	-
Sevin XLR	W	12	14	14	14	14	14	-
Sivanto 1.67 SL	C	12	1	1	1	1	1	1
Torac 1.29 EC	W	12	-	-	1	-	1	-
Trigard 75 WP	C	12	7	7	7	7	7	7
Venom 70 SG	C	12	-	-	7/21 <sup>1</sup>	-	7/21 <sup>1</sup>	-
<b>Restricted Use</b>								
Agrimek 0.15 EC	W	12	-	-	7	-	7	-
Asana XL	W	12	7	-	-	7	-	-
Baythroid XL	W	12	-	-	0	0	0	0
Brigade 2 EC	W	12	7	7	7	7	40	7
Daizinin AG500	C	24	10	10	14	10	14/21	-
Diazinon 50 W	C	24	4	4	14	4	3	-
Dimilin 2L	C	12	7	7	-	7	-	7
Disyston 8 E	DP	48	-	-	60	-	-	-
Hero 1.24 EC	C	12	-	-	7	-	-	-
Lannate 90 SP	DP	48	10	10	10	10	7	10
Larvin 3.2 F	W	48	-	-	14	-	14	-
Mustang Max	W	12	1	1	5	1	1	-
Permethrin 3.2 EC	C	12	1	-	1	-	1	1
Proaxis 0.5 EC	C	24	-	-	1	-	-	-
Proclaim 5 WDG	C	48	14	14	7	14	7	14
Renounce 20 WP	C	12	0	0	0	0	0	-
Warrior II	W	24	-	-	1	-	-	-

- Indicates crop does not appear on label.

<sup>1</sup> PHI depends on the method of application.

<sup>2</sup> W: Warning, C: Caution, D: Danger, P: Poison

#### PESTICIDE SAFETY: Greens

	Signal <sup>3</sup>	Re-entry (hrs)	Harvest (days)
<b>FUNGICIDES</b>			
<b>Mustard, Turnips, Collards, Kale</b>			
Actigard 50 WG	C	12	7
Aliette WDG <sup>4</sup>	C	12	3
Cabrio EG	C	12	3
Endura	W	12	14
Fixed coppers <sup>2</sup>	D	12/24 <sup>1</sup>	0
Fontelis	C	12	0
Forum SC	C	12	0
Ridomil Gold EC/SL	C	48	0
Rovral 4 F	C	24	14
Inspire Super	C	12	7
Iprodione 4L AG	C	12	7
Meteor	C	12	7
Nevado 4F	C	12	7
PCNB <sup>2</sup>	C	12	0
Presidio	C	12	2
Procure 480 SC	C	12	1
Quadris	C	4	0
Quadris Top	C	12	1
Ranman	C	12	0
Reason 500 SC	C	12	2
Revus	C	4	1
Ridomil Gold SL	C	48	0
Sulfur <sup>2</sup>	C	12	0
Switch 62.6 WG	C	12	7
Tebuconazole <sup>2</sup>	C	12	7
Ultra Flourish	C	48	0
Zampro	C	12	0
<b>Lettuce</b>			
Actigard 50 WG	C	12	7
Aliette WDG <sup>4</sup>	C	12	3
Botran 75 W	C	12	14
Botran 5F	C	12	14
Cabrio EG	C	12	0
Cannonball WP	C	12	0
Curzate 60 DF	W	12	3
Endura	W	12	14
Fixed coppers <sup>2</sup>	D	24/48	1
Fontelis	C	12	3
Forum SC	C	12	0
Koverall	C	24	10
Mancozeb <sup>2</sup>	C	24	10

#### PESTICIDE SAFETY: Greens

	Signal <sup>3</sup>	Re-entry (hrs)	Harvest (days)
MetaStar 2EC AG	W	48	0
Meteor	C	24	14
Presidio	C	12	2
Previcur Flex	C	12	6
Quadris	C	4	0
Ranman	C	12	0
Reason 500 SC	C	12	2
Revus	C	4	1
Ridomil Gold SL/GR	C	48	0
Rovral 4 FL	C	24	14
Sulfur <sup>2</sup>	C	24	0
Switch 62.6 WG	C	12	0
Tanos	C	12	3
Zampro	C	12	0
<b>Spinach</b>			
Actigard 50 WG	C	12	7
Aliette WDG <sup>4</sup>	C	12	3
Cabrio EG	C	12	0
Fixed coppers <sup>2</sup>	D	24/48 <sup>1</sup>	0
Fontelis	C	12	3
MetaStar 2EC AG	W	48	21
Presidio	C	12	0
Quadris	C	4	0
Ranman	C	12	0
Revus	C	4	1
Ridomil Gold SL/GR	C	48	21
Ridomil Gold Copper	D	48	21
Sulfur <sup>2</sup>	C	24	0
Tanos	C	12	1
Ultra Flourish	W	48	21
Zampro	C	12	0

<sup>1</sup> Varies by formulation. Check labels carefully.

<sup>2</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

<sup>3</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>4</sup> The use of Aliette in the following Kentucky counties has certain restrictions to protect endangered freshwater mollusks and their habitat, so read labels carefully: Campbell, Green, Hart, Kenton, Logan, Marshall, Rockcastle, Todd, Warren, and Wayne.

**Botrytis gray mold.** Increase plant or row spacings to improve light penetration and aid drying. Two fungicides, Endura and Fontelis, are labeled for control of gray mold.

**Damping-off.** Purchase fungicide-treated seed or treat seed with Captan 40WP (see labels). Mefenoxam (Ridomil Gold, Ultra Flourish), metalaxyl (MetaStar 2E), and Presidio are labeled for soil treatment for control of *Pythium* damping-off on certain cole crops.

**Viruses.** Destroy earlier crops as soon as possible after harvest has been completed; control weeds and maintain a weed-free border around crops.

### Lettuce

**Bottom rot.** Cultural practices and rotation are important tools to manage this disease. Do not plant lettuce after beans, and turn under grass and other crops early to ensure thorough rotting before

planting. Avoid wet sites, and plant on well-shaped, raised beds to improve air circulation and drainage. Shallow seeding will also reduce severity of bottom rot. Fungicides are available.

**Downymildew.** Fungicides are effective for management of downy mildew.

**Drop, gray mold.** Fungicides are registered for both field and greenhouse use.

**Seed rot, damping-off.** Purchase treated seed or dust with Captan at 1 teaspoon per pound of seed. Mefenoxam, metalaxyl, and Ranman are labeled as soil treatments for damping-off due to *Pythium*.

**Virus complex, aster yellows.** Avoid transplant production in greenhouses with ornamental plants. Take steps to control aphids, leafhoppers, and thrips, especially early in the season. Do not place later plantings near older plantings. Maintain strict weed control around plantings, and destroy older plantings immediately after harvesting is complete.

### Spinach

**Damping-off, seed rot.** Treat seed with Captan at 1 teaspoon per pound of seed. For excellent control of *Pythium* in this complex, apply mefenoxam, metalaxyl, or Ranman preplant or at planting. This treatment will also aid with control of white rust.

**Downy mildew, white rust.** Resistance is available in spinach cultivars. A preplant soil application of mefenoxam or metalaxyl listed previously for damping-off control will provide early-season control for 21 to 60 days, depending on the weather.

**Leafspots.** Fungicides applied regularly are effective tools.

**Virus complex.** CMV-resistant varieties are available. If a series of plantings is used, place the first planting downwind from the later ones to reduce aphid movement from the older plantings into the others. Control broadleaf weeds within 200 feet of the planting.

### INSECT CONTROL: Greens<sup>1</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>PREPLANT INCORPORATED</b>			
<b>Cutworms, Wireworms:</b> Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites. Wireworms can be a potential problem where greens follow grass or grass-legume sod.			
Diazinon AG 500	4 to 8 pt	-	Incorporate immediately.
<b>SOIL APPLICATION</b>			
<b>Aphids, Whiteflies:</b> Do not use a foliar spray of Actara, Assail, Belay Provado or Venom following a soil application of Admire, Belay, Platinum, or Venom.			
Admire Pro	4.4 to 10.5 fl oz	10.5 fl oz	Systemic control. See label for various application methods.
Belay 2.13 SC	9 to 12 fl oz	12 fl oz	At planting only.
Platinum 2 SC	5 to 11 fl oz	11 fl oz	-
Venom 70 SG	5 to 6 oz	12 oz	-
<b>FOLIAR TREATMENTS</b>			
<b>Aphids:</b> Excessive nitrogen application favors increased aphid reproduction. Use no more nitrogen than is necessary. Eliminate remnants of fall crops to reduce numbers of overwintering eggs.			
Actara 25 W	1.5 to 3 oz	11 oz	Allow 7 days between applications. Not during bloom.
Admire Pro	1.3 fl oz	6.7 fl oz	Allow 5 days between applications. Not during bloom.
Assail 30 SG	2 to 3 oz	20 oz	Limit 5 applications. Allow 7 days between applications.
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Beleaf 50 SG	2 to 2.8 oz	8.4 oz	Allow 7 days between applications.
Closer 2 SC	1.5 to 2.0 fl oz	17 fl oz	Allow 7 days between applications.
Dimethoate 4 E	8 fl oz	8 fl oz	Allow 3 to 15 days between treatments.
Exirel 0.83 SE	13.5 to 20.5 fl oz	61.5 fl oz	Allow 5 days between applications. Use an adjuvant.
Fulfill 50 DF	2.75 oz	5.5 oz	Limit 5.5 oz/A. Allow 7 days between applications.
Lannate 90 SP	0.5 to 1 lb	4 lb	For spinach only.
		10 lb	For lettuce only.
Malathion 8	1.5 to 2.5 pt	2 applications	Allow 6 days between applications.
	2 pt	2 applications	Lettuce and spinach only.
Torac 1.29 EC	17 to 21 fl oz	42 fl oz	Limit 2 applications and allow 14 days between applications.
Venom 70 SG	1 to 3 oz	6 oz	Allow 7 days between applications.
<b>Flea Beetles</b>			
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Brigade 2 EC	2.1 to 6.4 fl oz	25.6 fl oz	Allow 7 days between applications.
		32 fl oz	For lettuce only. Allow 7 days between applications.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	38.4 fl oz	-
Scorpion 35 SL	2 to 5.25 fl oz	10.5 fl oz	Allow 7 days between applications.
Sevin XLR	0.5 to 1 qt	4 applications	Allow 7 days between applications. Apply within 30 days of planting.
Torac 1.29 EC	17 to 21 fl oz	42 fl oz	Limit 2 applications and allow 14 days between applications.
Warrior II	1.28 to 1.92 fl oz	19.2 fl oz	-
<b>Grasshoppers, Leafhoppers, Leafminers</b>			
Dimethoate 4 E	8 fl oz	8 fl oz	Allow 3 to 15 days between treatments.
Lannate 90 SP	0.5 to 1 lb	4 lb	For spinach only.
		10 lb	For lettuce only.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications. Leafhoppers only.

(continued on next page)

**INSECT CONTROL: Greens<sup>1</sup> (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Permethrin 3.2 EC	2 to 8 fl oz	40 fl oz	-
Proaxis 0.5 EC	2.56 to 3.84 fl oz	38.4 fl oz	-
Sevin XLR	0.5 to 1 qt	4 applications	Leafhoppers only. Allow 7 days between applications. Apply within 30 days of planting.
Sivanto 1.67 SL	7 to 10.5 fl oz	28 fl oz	Allow 7 days between applications. Leafhoppers only.
Torac 1.29 EC	17 to 21 fl oz	42 fl oz	Limit 2 applications and allow 14 days between applications. For leafhoppers.
Trigard 75 WP	2.66 oz	6 applications	Allow 7 days between applications. Leafminers only.
Warrior II	1.28 to 1.92 fl oz	19.2 fl oz	-
<b>Whiteflies</b>			
Actara 25 W	3 to 5.5 oz	11 oz	Allow 7 days between applications.
Assail 30 SG	3 to 4 oz	20 oz	Limit 5 applications. Allow 7 days between applications.
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications.
Beleaf 50 SG	2.8 oz	8.4 oz	Allow 7 days between applications. Greenhouse whitefly only.
Courier 40 SC	9 to 13.6 fl oz	2 applications	Allow 7 days between applications.
Exirel 0.83 SE	13.5 to 20.5 fl oz	61.5 fl oz	Allow 5 days between applications. Use an adjuvant.
Knack 0.86 EC	8 to 10 fl oz	20 fl oz	Allow 14 days between applications.
Oberon 2 SC	7 to 8.5 fl oz	25.5 fl oz	Allow 7 days between applications.
Requiem 25 EC	2 to 3 qt	-	-
Scorpion 35 SL	2 to 5.25 fl oz	10.5 fl oz	Allow 7 days between applications.
Sivanto 1.67 SL	10.5 to 14 fl oz	28 fl oz	Allow 7 days between applications.
Venom 70 SG	1 to 3 oz	6 oz	Allow 7 days between applications.

<sup>1</sup> Generic products available (Appendix E).

**WEED CONTROL: Greens<sup>1</sup>**

Product Amt/A	Lb A.I./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
6-14 lb Dacthal 75W	4.5-10.5 DCPA	For pre-emergence control of annual grasses and small-seeded broadleaves. Apply at seeding. Can be preplant incorporated.
1-2 pt Goal 2XL	0.25-0.5 oxyfluorfen	NOT LABELED ON TURNIP GREENS. For pre-emergence and post-emergence control of certain annual grasses and most broadleaves. For fallow bed preparation only. Best if used with glyphosate for control of winter annual broadleaf weeds. Min. 90 days at 1 pt/A and 120 days at 2 pt/A between application and seeding.
2-4 pt Gramoxone Inteon	0.67-1.35 paraquat salt	ONLY LABELED FOR COLLARDS, CHINESE CABBAGE AND LETTUCE. For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply preplant, pre-emergence, or before transplanting in min. 10 gal water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v.
2-4 lb Kerb 50 WP	1-2 pronamide	LABELED ON LETTUCE ONLY. For control of grasses and certain broadleaf weeds. Apply before or after seeding but before crop and weeds emerge. Moisture is necessary to activate. Label rates vary depending on variety, rainfall, and soil texture. Can be incorporated or watered in.
0.5-1.5 pt Poast	0.09-0.27 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 30 days. Max. rate of 1.5 pt/application and 3 pt/season.
5-6 qt Prefar 4 E	5-6 bensulide	NOT LABELED ON SPINACH. For control of grasses and broadleaf weeds. Apply preplant and incorporate to 1 to 2 inch depth. Apply pre-emergence only if it can be watered in within 36 hours. Max. rate of 6 qt/season.
16-22 fl oz Roundup Weather-Max 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 3 days before seeding and min. 30 days before planting any non-labeled crop.
9-16 fl oz Select Max	0.06-0.12 clethodim	For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. Max. 16 fl oz/application. Min. 14 days between applications. PHI = 14 days for leafy greens but PHI = 30 days for leaf petioles (ie. Swiss Chard)
1.5 pt Treflan HFP 4 E	0.75 trifluralin	NOT LABELED ON SPINACH AND LETTUCE. For control of annual grasses and broadleaf weeds. Use on turnip greens used for processing only. Apply as a preplant soil incorporated treatment.

<sup>1</sup> Due to the wide range of crops grown under the title "Greens" growers should carefully read labels before applying herbicides.

**DISEASE CONTROL: Greens**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>MUSTARD, TURNIP, COLLARDS, KALE</b>					
<b>Alternaria, Cercospora, Cercosporella Leaf Spots</b>					
Cabrio	11	3	8 to 12 oz	64 oz (48 oz for turnip)	Apply before disease onset, continue every 7 to 14 days.
Endura	7	14	6 to 9 oz	2 apps	Not for turnip greens. Apply before disease onset, continue every 7 to 14 days.
Fixed coppers					
Badge SC	M	0	1 to 1.8 pt	-	Products are crop-specific—check labels for list of registered crops in this subgroup. Apply every 7 to 10 days after seeding/transplanting or when conditions favor disease. See label for mixing instructions and tank-mix precautions.
Badge X2	M	0	0.75 to 1.5 lb	-	OMRI-listed.
Champ DP	M	0	0.33 to 0.67 lb	-	-
Champ Formula 2 FL	M	0	0.33 to 0.67 pt	-	-
Champ WG	M	0	1 to 2 lb	-	OMRI-listed.
Cueva	M	0	0.5 to 2 gal	-	OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	0.75 to 1.25 lb	-	-

(continued on next page)

**DISEASE CONTROL: Greens (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Kentan DF	M	0	1 to 1.3 lb		-
Kocide 2000	M	0	0.75 to 1.5 lb		-
Kocide 3000	M	0	0.5 to 0.75 lb		-
Kocide DF	M	0	1 to 2 lb		-
Mastercop	M	0	0.5 to 1 pt		-
Nordox 75 WG	M	0	0.66 to 2 lb		OMRI-listed.
Nu-Cop 50 DF	M	0	1 to 2 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	0.5 to 1 lb		-
Nu-Cop 50 WP	M	0	2 lb		OMRI-listed.
Fontelis	7	0	14 to 30 fl oz	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Inspire Super	3/9	7	16 to 20 fl oz	80 fl oz	Apply every 7 to 10 days.
Tebuconazole <sup>4</sup>	3	7			Apply preventively; can be tank-mixed with the lowest labeled rate of a surfactant.
Azoxystrobin <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days. Use higher rates for Cercospora.
Azoxy 25C	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
AzoxyStar	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Quadris Top	11/3	1	12 to 14 fl oz	56 fl oz	Apply before disease onset, continue every 7 to 14 days.
Reason 500 SC	11	2	8.2 fl oz	24.6 fl oz	Apply before disease onset, continue every 5 to 10 days.
Switch 62.5WG	9/12	7	11 to 14 oz	56 oz	Apply every 7 to 10 days.
<b>Black Rot</b>					
Actigard	21	14	0.5 to 1 oz	4 apps	Not for turnip greens, suppression only. Apply 7 to 10 days after thinning and make up to three additional applications every 7 days. Apply in a min of 20 gal/A of water. May be applied through drip irrigation. May cause phytotoxicity and yield reduction. Do not apply to stressed or injured plants.
<b>Fixed coppers</b>					
Products are crop-specific—check labels for list of registered crops in this subgroup. Apply every 7 to 10 days after seeding/transplanting or when conditions favor disease. See label for mixing instructions and tank-mix precautions.					
Badge SC	M	0	1 to 1.8 pt		-
Badge X2	M	0	0.5 to 0.75 lb		OMRI-listed.
Champ DP	M	0	0.33 to 0.67 lb		-
Champ Formula 2 FL	M	0	0.33 to 0.67 pt		-
Champ WG	M	0	1 to 2 lb		OMRI-listed.
Copper-Count-N	M	0	2 to 6 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	0.75 to 1.25 lb		-
Kentan DF	M	0	1 to 1.3 lb		-
Kocide 2000	M	0	0.75 to 1.5 lb		-
Kocide 3000	M	0	0.5 to 0.75 lb		-
Kocide DF	M	0	1 to 2 lb		-
Mastercop	M	0	0.5 to 1 pt		-
Nordox 75 WG	M	0	0.66 to 2 lb		OMRI-listed.
Nu-Cop 50 DF	M	0	1 to 2 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	0.5 to 1 lb		-
Nu-Cop 50 WP	M	0	2 lb		OMRI-listed.
<b>Basal Stem Rot, Root Rot, Wirestem (Rhizoctonia)</b>					
Azoxystrobin <sup>4</sup>					
Azoxy 25C	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 apps	Banded applications. Counts as a foliar application. Apply before disease onset, continue every 7 to 14 days. May be applied in a 7-inch band with spray directed at lower stems and surrounding soil. In-furrow. Apply in 5 to 15 gal/A, with nozzle directed to spray in-furrow just before seed are covered.
AzoxyStar	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 apps	
Quadris	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 apps	-
Satori	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 apps	-
<b>Damping-off (Pythium)</b>					
Presidio	43	2	3 to 4 fl oz	12 fl oz	Apply every 10 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43. Can be applied by drip-irrigation.
Ranman	21	0	2.75 fl oz	1 app	Prior to planting, apply as a banded spray followed by incorporation. Can be applied as a drench at planting or in transplant water; see label for instructions.
Ridomil Gold SL	4	0	0.25 to 0.5 pt	1 app	Preplant. Apply to soil as a broadcast spray or in a 7-in band; incorporate into the upper 2 inches of soil mechanically or with irrigation if rainfall is not expected within 24 hrs of treatment.
Ultra Flourish	4	0	1 to 1.5 pt		
<b>Downy Mildew</b>					
Actigard	21	14	0.5 to 1 oz	4 apps	Not for turnip greens. Make first application 7 to 10 days after thinning and make up to three additional applications every 7 days. Apply in a minimum of 20 gal/A of water. May be applied through drip irrigation. May cause phytotoxicity and yield reduction. Do not apply to stressed or injured plants.
Aliette WDG <sup>6</sup>	33	3	2 to 5 lb	7 apps	Not for turnip greens. Apply when conditions favor disease and continue every 7 to 21 days. Do not tank-mix with copper compounds.
Cabrio	11	3	12 to 16 oz	4 apps	Apply before disease onset, continue every 7 to 14 days.
<b>Fixed coppers</b>					
Products are crop-specific—check labels for list of registered crops in this sub-group. Apply every 7 to 10 days after seeding/transplanting or when conditions favor disease. See label for mixing instructions and tank-mix precautions.					
Badge SC	M	0	1 to 1.8 pt		-

(continued on next page)

**DISEASE CONTROL: Greens (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Badge X2	M	0	0.5 to 0.75 lb		OMRI-listed.
Champ DP	M	0	0.33 to 0.67 lb		-
Champ Formula 2 FL	M	0	0.33 to 0.67 pt		-
Champ WG	M	0	1 to 2 lb		OMRI-listed.
Copper-Count-N	M	0	1 to 2 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	0.75 to 1.25 lb		-
Kentan DF	M	0	1 to 1.3 lb		-
Kocide 2000	M	0	0.75 to 1.5 lb		-
Kocide 3000	M	0	0.5 to 0.75 lb		-
Kocide DF	M	0	1 to 2 lb		-
Mastercop	M	0	0.5 to 1 pt		-
Nordox 75 WG	M	0	0.66 to 2 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	0.5 to 1 lb		OMRI-listed.
Nu-Cop 3 L	M	0	0.33 to 1.33 pt		-
Nu-Cop 50 DF	M	0	1 to 2 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	2 lb		OMRI-listed.
Forum SC	40	0	6 fl oz	30 fl oz	Must be tank-mixed with another downy mildew product NOT in FRAC Group 40. Apply before disease onset, continue every 7 days.
Presidio	43	2	3 to 4 fl oz	12 fl oz	Apply every 10 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Ranman	21	0	2.75 fl oz	39.5 fl oz	Apply every 7 to 10 day schedule when conditions favor disease. Tank-mix with an organosilicone or non-ionic surfactant.
Reason 500 SC	11	2	5.5 to 8.2 fl oz	24.6 fl oz	Apply before disease onset, continue every 5 to 10 days.
Revus	40	1	8 fl oz	32 fl oz	Apply every 7 to 10 days. Use a spreader/penetrant surfactant. Must be tank-mixed with a fungicide NOT in FRAC Group 40.
Zampro	40/45	0	14 fl oz	3 apps	Apply before disease onset, treat every 7 days.
<b>Powdery Mildew</b>					
Azoxystrobin <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxy 2SC	11	0	9 to 15.5 fl oz <sup>5</sup>	3 apps	
AzoxyStar	11	0	9 to 15.5 fl oz <sup>5</sup>	3 apps	
Quadris	11	0	9 to 15.5 fl oz <sup>5</sup>	3 apps	
Satori	11	0	9 to 15.5 fl oz <sup>5</sup>	3 apps	
Cabrio	11	3	8 to 16 oz	4 apps	Apply before disease onset, continue every 7 to 14 days. Use 8 to 12 oz on turnip greens, 12 to 16 oz on other leafy Brassica greens.
Endura	7	14	6 to 9 oz	2 apps	Not for turnip greens. Apply before disease onset, continue every 7 to 14 days.
Fontelis	7	0	14 to 30 fl oz	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Inspire Super	3/9	7	16 to 20 fl oz	80 fl oz	Apply every 7 to 10 days.
Procure 480SC	3	1	6 to 8 fl oz <sup>5</sup>	18 fl oz	Apply every 14 days.
Quadris Top	11/3	1	12 to 14 fl oz	56 fl oz	Apply before disease onset, continue every 7 to 14 days.
Sulfur <sup>4</sup>	M				Apply every 14 days, beginning when symptoms are first observed or when conditions favor disease. Phytotoxicity may occur when sulfur is applied when temperatures exceed 90°F.
Switch 62.5WG	9/12	7	10 to 12 oz	56 oz	Rate is 11 to 14 oz for turnip greens. Apply every 7 to 10 days.
Tebuconazole <sup>4</sup>	3	7			Apply preventively. Use lowest listed rate of surfactant to improve coverage.
<b>Sclerotinia Stem Rot</b>					
Cabrio	11	3	12 to 16 oz	4 apps	Apply before disease onset, continue every 7 to 14 days.
Endura	7	14	6 to 9 oz	2 apps	Not for turnip greens. Apply before disease onset, continue every 7 to 14 days.
Fontelis	7	0	16 to 30 fl oz	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
<b>LETTUCE</b>					
<b>Bottom Rot (Rhizoctonia)</b>					
Azoxystrobin <sup>4</sup>					In-furrow. Apply in 5 to 15 gal/A, with nozzle directed to spray in-furrow just before seed are covered. In-furrow treatment does not count as a foliar application.
Azoxy 2SC	11	0	0.4 to 0.8 fl oz <sup>3</sup>	1 app (soil)	
AzoxyStar	11	0	0.4 to 0.8 fl oz <sup>3</sup>	1 app (soil)	
Quadris	11	0	0.4 to 0.8 fl oz <sup>3</sup>	1 app (soil)	
Satori	11	0	0.4 to 0.8 fl oz <sup>3</sup>	1 app (soil)	
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Endura	7	14	8 to 11 oz	2 apps	Apply immediately after emergence/transplanting or before disease onset.
Iprodione <sup>4</sup>					Make first application from planting to just after thinning. Repeat applications can be made every 10 days.
Rovral 4 Flowable	2	14	1.5 to 2 pt	3 apps	
<b>Damping-off (Pythium)</b>					
Previcur Flex	28	6	2 pt	8 pt	Apply after transplanting or plant emergence using nozzles directed to the lower portion of plants and surrounding soil. Previcur may be applied by drip or sprinkler irrigation. Approved for greenhouse use.
Ranman	21	0	2.75 fl oz	1 app	Prior to planting, apply as a banded spray followed by incorporation. Can be applied as a drench at planting or in transplant water; see label for instructions.
MetaStar 2EC AG	4	0	4 to 8 pt	1 app	Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil mechanically (preplant) or with irrigation (pre- and at-planting) if rainfall is not expected within 24 hours of treatment. Ridomil Gold EC or SL, MetaStar, and Ultra Flourish can be applied through drip irrigation.
Ridomil Gold SL	4	0	1 to 2 pt		
Ultra Flourish	4	0	2 to 4 pt		
Ridomil Gold GR	4	0	20 to 40 lb	1 app	Must be incorporated after application (broadcast); can also be applied at planting using in-furrow equipment. See label.

(continued on next page)

**DISEASE CONTROL: Greens (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Downy Mildew</b>					
Actigard	21	7	0.75 to 1 oz	4 apps	Apply after thinning and make up to three additional applications every 7 days. Apply in a min of 20 gal/A of water. May be applied through drip irrigation. May cause phytotoxicity—see label. Do not apply to stressed or injured plants.
Aliette WDG <sup>6</sup>	33	3	2 to 5 oz	7 apps	Apply when conditions favor disease and continue every 7 to 21 days. Do not tank-mix with copper compounds.
Azoxystrobin <sup>4</sup>					Use higher rates for downy mildew. Apply before disease onset, continue every 5 to 7 days.
Azoxy 2SC	11	0	12 to 15.5 fl oz <sup>5</sup>	4 apps	
AzoxyStar	11	0	12 to 15.5 fl oz <sup>5</sup>	4 apps	
Quadris	11	0	12 to 15.5 fl oz <sup>5</sup>	4 apps	
Satori	11	0	12 to 15.5 fl oz <sup>5</sup>	4 apps	
Cabrio	11	0	16 oz	4 apps	Apply before disease onset, continue every 7 to 14 days.
Curzate 60 DF	27	3	3.2 to 5 oz	30 oz	Head lettuce only. Apply every 5 to 7 days when conditions favor disease. Must be tank-mixed with a protectant fungicide such as mancozeb.
<b>Fixed coppers</b>					
Apply every 3 to 10 days after seeding/transplanting or when conditions favor disease. See label for mixing instructions and tank-mix precautions. Some products are approved for greenhouse use—refer to label.					
Basic Copper 53	M	0	1 to 3 lb		OMRI-listed.
Badge SC	M	0	0.75 to 1.5 pt		
Badge X2	M	0	1.75 to 3.5 lb		OMRI-listed.
C-O-C-S WDG	M	0	1 to 3 lb		-
Champ DP	M	0	0.67 to 1.33 lb		-
Champ Formula 2 FL	M	0	0.67 to 1.33 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Kentan DF	M	0	1.2 to 2.5 lb		-
Kocide 3000	M	0	0.75 to 1.5 lb		-
Nordox 75 WG	M	0	0.66 to 1.25 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	1 to 2 lb		-
Nu-Cop 3 L	M	0	0.66 to 2.66 pt		-
Nu-Cop 50 DF	M	0	1 to 2 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	0.5 to 1 lb		-
Forum SC	40	0	6 fl oz	5 apps	Must be tank-mixed with another downy mildew product. Apply before disease onset, continue every 5 to 10 days.
Koverall	M	10	2 lb	12.8 lb	Apply every 7 to 10 days when conditions favor disease.
ManKocide	M	10	1 to 2 lb	26 lb	
Manzate Flowable	M	10	2.4 to 3.4 pt	19.2 pt	
Manzate Pro-Stick	M	10	1.6 to 2.1 lb	12.8 lb	
Presidio	43	2	3 to 4 fl oz	12 fl oz	Apply every 10 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Previcur Flex	28	6	1.33 to 2 pt	8 pt	Apply when disease threatens and continue every 7 to 10 days. Approved for greenhouse use.
Reason 500 SC	11	2	5.5 to 8.2 fl oz	24.6 fl oz	Apply before disease onset, continue every 5 to 10 days.
Revus	40	1	8 fl oz	32 fl oz	Apply every 7 to 10 days. Use a spreader/penetrant surfactant. Must be tank-mixed with a fungicide NOT in FRAC Group 40.
Tanos	11/27	3	8 oz	3 apps	Tanos must be tank-mixed with a fungicide from FRAC Group M appropriate for the target disease. Apply before disease onset, continue every 5 to 7 days.
Zampro	40/45	0	14 fl oz	3 apps	Apply before disease onset, treat every 7 days.
<b>Drop, Gray Mold</b>					
Botran 75 W	14	14	2 to 5.33 lb	5.33 lb	Rates are timing dependent (pre-emergence, thinning, and post-thinning). See label for application instructions. Approved for greenhouse use.
Botran 5F	14	14	1.2 to 6.4 pt	6.4 pt	
Cannonball WP	12	0	7 oz	28 oz	Begin prior to disease onset and apply every 7 to 10 days while conditions favor disease.
Endura	7	14	8 to 11 oz	2 apps	Apply immediately after emergence/transplanting or before disease onset.
Fontelis	7	3	16 to 24 fl oz	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Iprodione <sup>4</sup>					Not labeled for gray mold. Apply from planting to just after thinning. Repeat applications can be made every 10 days.
Rovral 4 Flowable	2	14	1.5 to 2 pt	3 apps	
Switch 62.5WG	9/12	0	11 to 14 oz	56 oz	Apply every 7 to 10 days.
<b>SPINACH</b>					
<b>Damping-off (Pythium)</b>					
Ranman	21	0	2.75 fl oz	1 app	Prior to planting, apply as a banded spray followed by incorporation. Can be applied as a drench at planting or in transplant water; see label for instructions.
MetaStar 2EC AG	4	21	4 to 8 pt	1 app	Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil mechanically (preplant) or with irrigation (pre- and at-planting) if rainfall is not expected within 24 hours of treatment.
Ridomil Gold SL	4	21	1 to 2 pt		
Ultra Flourish	4	21	2 to 4 pt		
Ridomil Gold GR	4	21	20 to 40 lb	1 app	Must be incorporated after application (broadcast); can also be applied at planting using in-furrow equipment. See label.
<b>Downy Mildew, White Rust</b>					
Actigard	21	7	0.5 to 0.75 oz	3 apps	Apply after thinning and make up to two additional applications every 7 to 10 days. Apply in a minimum of 20 gal/A of water. Do not apply to stressed or injured plants. May be applied through drip irrigation.
Aliette WDG <sup>6</sup>	33	3	2 to 5 lb	7 apps	Apply when conditions favor disease and continue every 7 to 21 days. Do not tank-mix with copper compounds.

(continued on next page)

**DISEASE CONTROL: Greens (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Azoxystrobin<sup>4</sup></b>					
Azoxy 2SC	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	Use higher rates for downy mildew. Apply before disease onset, continue every 5 to 7 days (downy mildew), 7 to 14 days for white rust.
AzoxyStar	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Cabrio	11	0	8 to 16 oz	4 apps	Use highest rate for downy mildew. Apply before disease onset, continue every 7 to 14 days.
<b>Fixed coppers</b>					
Badge SC	M	0	1.8 to 2.8 pt		White rust only.
Badge X2	M	0	0.75 to 1.25 lb		OMRI-listed.
C-O-C-S WDG	M	0	1 to 3 lb		Downy mildew only.
Champ Formula 2 FL	M	0	1.33 to 2.67 pt		White rust and downy mildew.
Champ DP	M	0	1.33 to 2.66 lb		-
Champ WG	M	0	1 to 2 lb		OMRI-listed
Copper-Count-N	M	0	3 pt		Downy mildew only.
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 2 lb		White rust only.
Kentan DF	M	0	2 lb		-
Kocide 2000	M	0	1.5 to 2.25 lb		-
Kocide 3000	M	0	0.75 to 1.25 lb		-
Kocide DF	M	0	2 to 3 lb		-
Mastercop	M	0	0.5 to 1 pt		-
Nordox 75 WG	M	0	1.25 to 2 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	2 to 4 lb		OMRI-listed.
Nu-Cop 3 L	M	0	1.33 to 2.67 pt		-
Nu-Cop 50 DF	M	0	2 to 3 lb		OMRI-listed. White rust only.
Nu-Cop 50 HB	M	0	1 to 1.5 lb		-
Presidio	43	0	3 to 4 fl oz	12 fl oz	Apply every 7 to 14 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Ranman	21	0	2.1 to 2.75 fl oz	13.75 fl oz	Apply every 7 to 10 day schedule when conditions favor disease. Tank-mix with an organosilicone or non-ionic surfactant.
Revus	40	1	8 fl oz	32 fl oz	Apply every 7 to 10 days. Use a spreader/penetrant surfactant. Must be tank-mixed with a fungicide NOT in FRAC Group 40.
Ridomil Gold SL	4	21	0.25 pt	3 apps	Not for foliar application. Post-plant sidedress application. See label for instructions.
Ultra Flourish	4	21	0.5 pt		
Ridomil Gold GR	4	21	5 lb	3 apps	Can be applied preplant; see label.
MetaStar 2EC AG	4	21	1 pt		
Ridomil Gold Copper	4/M	21	2.5 lb	2 apps	Apply 21 days after at-planting treatment with Ridomil Gold EC or GR and continue every 14 days. Avoid late-season applications.
Tanos	11/27	1	8 to 10 oz	84 oz	Tank-mix with fixed copper, apply every 5 to 7 days.
Zampro	40/45	0	14 fl oz	3 apps	Downy mildew. Apply before disease onset, treat every 7 days.
<b>Leaf Spots (Anthracnose, Cercospora)</b>					
<b>Azoxystrobin<sup>4</sup></b>					
Azoxy 2SC	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
AzoxyStar	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Cabrio	11	0	12 to 16 oz	4 apps	Apply before disease onset, continue every 7 to 14 days.
<b>Fixed coppers</b>					
Badge SC	M	0	1 to 2.5 pt		-
Badge X2	M	0	0.75 to 1.25 lb		OMRI-listed.
C-O-C-S WDG	M	0	1 to 3 lb		-
Champ Formula 2 FL	M	0	1.33 to 2.67 pt		-
Champ DP	M	0	1.33 to 2.66 lb		-
Champ WG	M	0	1 to 2 lb		OMRI-listed
Copper-Count-N	M	0	3 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Kentan DF	M	0	2 lb		-
Cuprofix Ultra 40 Disperss	M	0	1.25 to 2 lb		-
Kocide 2000	M	0	1.5 to 2.25 lb		-
Kocide 3000	M	0	0.75 to 1.25 lb		-
Kocide DF	M	0	2 to 3 lb		-
Mastercop	M	0	0.5 to 1 pt		-
Nordox 75 WG	M	0	1.25 to 2 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	2 to 4 lb		OMRI-listed.
Nu-Cop 3 L	M	0	1.33 to 2.67 pt		-
Nu-Cop 50 DF	M	0	2 to 3 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	1 to 1.5 lb		-
Fontelis	7	3	16 to 24 fl oz	72 fl oz	Apply before disease onset, continue every 7 to 14 days.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 14 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Per 1,000 row-feet.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>5</sup> Use higher rate when pressure is severe.

<sup>6</sup> Restricted in some Kentucky counties. See fungicide safety table on page 20.

# Okra

Mallow family (Malvaceae): *Abelmoschus esculentus*

## Planting and Culture

Well-drained, fertile, silt loam soils are most desirable; however, okra will grow on a wide range of soil types. Prepare a firm, friable seedbed as for other vegetable crops.

Seed okra only after the soil has warmed up (65°F) in the spring to allow good seed germination (see Appendix J). Plant four to six seeds per foot in rows 28 to 36 inches apart; thin plants to 10 to 18 inches apart in rows. Ten to 12 pounds of seed is required to plant an acre. Seed should be planted 1 1/2 to 2 inches deep. Planet Jr.-type planters work well for direct seeding. In addition, very high yields have been obtained with transplanted okra using black plastic mulch and drip irrigation.

## Fertilizing

Apply P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, and lime according to soil test results. A total of about 80 to 90 pounds N per acre is used, with about half that amount applied prior to planting. Fertilizer should be applied broadcast and disked in prior to seeding. A sidedressing of nitrogen applied after the first harvest will help to prolong the harvesting period (see "Fertilizer" table). Soil pH should be 6.0 to 6.5.

## Harvesting and Handling

Harvesting under favorable conditions should start about six days after flowering.

### FERTILIZER: Okra

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
	<b>Phosphorus</b>	<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>
Low	<31	181-240
Medium	31-60	91-180
High	61-80	1-90
Very High	>80	0
	<b>Potassium</b>	<b>Potash (K<sub>2</sub>O)</b>
Low	<201	151-200
Medium	201-300	101-150
High	301-450	1-100
Very High	>450	0
	<b>Nitrogen</b>	<b>N</b>
Apply 40 to 50 lb nitrogen (N)/A before planting seed. After harvest begins sidedress plants with an additional 35 to 40 lb N/A.		

### INSECT CONTROL: Okra<sup>1</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>Aphids</b>			
Admire Pro	7 to 14 fl oz	14 fl oz	Soil application, see label for methods.
Admire Pro	1.3 to 2.2 fl oz	6.7 fl oz	Foliar application. Allow 5 days between applications. Not during bloom.

### VARIETIES: Okra

Variety	Days to Maturity From Seeding	Comments
Annie Oakley II	48	Hybrid; medium green, ridged; remain tender up to 4.5 inch, smaller plants.
Jambalaya	50	compact plant, uniform pods.
Burgundy	60	Dark Red Pods, flowers are edible and may be stuffed.
Clemson Spineless	55	Heavy yields—almost spineless pods.

Harvesting of the pods should be done on a regular basis (about every two days) so that the pods do not become over-mature. Regular picking increases yield. Old pods should be removed and discarded, because mature ones retard future pod set. The pods should be harvested when 2 to 3 1/2 inches long. Move harvested pods to a shady, cool area as soon as possible to maintain good quality. Fresh market okra is usually graded into the following sizes:

- Fancy: pods up to 3 1/2 inches long
- Choice: pods 3 1/2 to 4 1/2 inches long
- Jumbo: pods over 4 1/2 inches long but still tender

Pods should be harvested from the plant with a sharp knife to make a smooth, neat cut.

Okra can be kept for fresh consumption for two weeks at a temperature of 50°F and a relative humidity of 90 to 95 percent. Okra chilled below temperatures of 50°F will turn dark and decay.

Potential yields of 12,000 pounds per acre are possible; however, 8,000 to 10,000 pounds per acre is considered more realistic. A bushel of okra weighs approximately 30 pounds.

## Common Diseases/Management

**Seed rot, damping-off.** Plant fungicide-treated seed (Captan 40WP at 1 teaspoon per pound of seed). Planting okra in warm soil that is well drained is critical. Turn cover crops under early to ensure they are well rotted before planting. Where disease pressure is high, azoxystrobin can be applied at planting to help reduce losses to disease.

**Foliar diseases and fruit rots.** Take steps to aid drying of the fruit, such as avoiding low, wet areas and fog pockets; do not plant okra between taller bordering plants such as corn. Removing several larger upper leaves to aid sunlight penetration and air circulation is also helpful. Fungicides

### PESTICIDE SAFETY: Okra

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>INSECTICIDES</b>			
Acramite 50 WS	C	12	3
Admire Pro	C	12	21
Avaunt 30 DG	C	12	3
Belt SC	C	12	1
Bt products	C	12	0
Coragen 1.67 SC	-	4	1
Courier 40 SC	W	12	1
Intrepid 2 F	C	4	1
Kanemite 15 SC	C	12	1
Knack 0.86 EC	C	12	1
Malathion 8	C	12	1
Movento 2 SC	C	24	1
Portal 0.4 EC	W	12	1
Provado 1.6 F	C	12	0
Radiant SC	C	4	1
Requiem 25 EC	C	4	0
Rimon 0.83 EC	W	12	1
Sevin XLR	C	12	3
Zeal 72 WP	C	12	7
<b>Restricted Use</b>			
Brigade 2 EC	W	12	7
Hero 1.14 EC	W	12	7
Mustang Max	W	12	1
<b>FUNGICIDES</b>			
Ariston	C	12	3
Chlorothalonil <sup>2</sup>	C	12	3
Fixed coppers <sup>2</sup>	W	24/48	0
Microthiol Disperss	C	24	0
Quadris	C	4	0
Rally 40 WSP	W	24	0
Tebuconazole <sup>2</sup>	C	12	3
Vivando	C	12	0

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

may also be applied to manage these diseases.

**Fusarium wilt, Verticillium wilt.** Practice crop rotation. A general soil fumigant (see page 16) should be considered in fields with a history of these diseases. Avoid solanaceous crops in the rotation (potatoes, tomatoes, tobacco, eggplant, peppers).

**Nematodes.** Practice crop rotation (two to three years away from solanaceous crops). Fumigants (page 16) may be required.

(continued on next page)

**INSECT CONTROL: Okra (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Malathion 8	1.5 pt	5 applications	Before pod set only. Allow 7 days between applications.
Movovento 2 SC	4 to 5 fl oz	10 fl oz	Allow 7 days between applications.
Requiem 25 EC	2 to 4 qt	-	-
<b>Corn Earworms</b>			
Avaunt 30 WG	3.5 oz	14 oz	Allow 5 days between applications.
Belt 4 SC	1.5 fl oz	4.5 fl oz	Allow 3 days between applications.
Bt products	See labels		
Brigade 2 E	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Allow 5 days between applications.
Intrepid 2 F	10 to 16 fl oz	64 fl oz	-
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Radiant SC	5 to 10 fl oz	34 fl oz	Allow 4 days between applications.
Sevin XLR	1 to 1.5 qt	6 qt	Allow 6 to 8 days between applications.
Vetiva 2.66	12 to 17 fl oz	38 fl oz	Allow 5 days between applications.
<b>Japanese Beetles</b>			
Brigade 2 E	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Malathion 8	1.5 pt	5 applications	Before pod set only. Allow 7 days between applications.
<b>Stink bugs</b>			
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Hero 1.24 EC	4 to 10.3 fl oz	27.38 fl oz	Allow 7 days between applications.
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Rimon 0.83 EC	12 fl oz	36 fl oz	For immatures only. Allow 7 days between applications.

<sup>1</sup> Generic products available (Appendix E).

**WEED CONTROL: Okra**

Product Amt/A	Lb A.I./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
1-2 pt Dual Magnum	0.95-1.9 s-metolachlor	24(C) Special Local Need Label see label for use and restrictions. Grower assumes all risk of crop injury, yield reductions, and crop loss.
2-4 pt Gramoxone Inteon	0.67-1.35 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply preplant, pre-emergence, or before transplanting in min. 20 gal of water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v. PHI = 21 days.
1.5 pt Poast 1.5 E	0.28 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 14 days. Max. rate of 1.5 pt/application and 5.5 pt/season.
16-22 fl oz Roundup Weather-Max 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
1.25-2 pt Treflan HFP 4 E	0.62-1 trifluralin	For pre-emergence control of annual grasses and broadleaf weeds. Apply as preplant soil incorporated. Can also be applied before or immediately after planting.

**DISEASE CONTROL: Okra**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Foliar Diseases (Anthracnose, Leaf Spots, Powdery Mildew)</b>					
Ariston	M/27	3	2.0 - 2.4 pt	17.5 pt	Anthracnose only. Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxy 2SC	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
AzoxyStar	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Chlorothalonil <sup>4</sup>					Only liquid formulations are labeled.
Bravo Weather Stik	M	3	1.5 pt	12 pt	Apply every 7 to 10 days.
<b>Fixed coppers</b>					
Badge SC	M	0	0.75 to 1.8 pt		-
Badge X2	M	0	0.75 to 1.75 lb		OMRI-listed.
Kentan DF	M	0	0.5 to 1.5 lb		Apply every 5 to 10 days when conditions favor disease.
Kocide 2000	M	0	1.5 to 3 lb		Apply every 5 to 10 days when conditions favor disease. See label for mixing instructions and tank-mix precautions.
Kocide 3000	M	0	0.75 to 1.75 lb		-
Nu-Cop 50DF	M	0	1 to 2.1 lb		OMRI-listed.
Mastercop	M	0	0.5 to 1 pt		Apply every 5 to 10 days when conditions favor disease.
Microthiol Disperss	M	0	3 to 10 lb	n/a	Apply every 14 days. Phytotoxicity may occur when sulfur is applied when temperatures exceed 90°F.
Rally 40 WSP	3	0	2.5 to 5 oz	4 apps	Powdery mildew only. Apply every 14 days when conditions favor disease.
Tebuconazole <sup>4</sup>	3	3			Cercospora leaf spot only. Apply preventively. Use lowest listed rate of surfactant to improve coverage.
Vivando	U8	0	15.4 fl oz	3 apps	Powdery mildew only. Begin applications prior to disease onset and continue every 7 to 14 days. No curative activity.

(continued on next page)

**DISEASE CONTROL:** *Okra (continued)*

Product	FRAC Code	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Seedling Rot (Rhizoctonia)</b>					
Azoxystrobin <sup>4</sup>					
Azoxystrobin	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 apps	Post-emergence. Apply broadcast in a 7-inch band with spray directed at lower stems and surrounding soil.
Azoxystar	11	0	0.4 to 0.7 fl oz <sup>3</sup>	1 app	In-furrow. Apply in 5 to 15 gal/A, with nozzle directed to spray in-furrow just before seed are covered.
Quadris	11	0			
Satori	11	0			

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Per 1,000 row-feet.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

## Onions

Onion family (Alliaceae): *Allium cepa* Cepa group

### Planting and Culture

Due to weed pressure, it is recommended that onion producers use transplants or sets for planting. The easiest way to grow green bunching onions is by using sets. Sets should be planted by mid-March for best results (see Appendix J).

Typically, transplants can be planted into the field about 8 to 10 weeks after seeding. At this time the base of the plants should be ¼ to ½ inch in diameter. Transplants can be planted into raised beds on rows 8 to 12 inches apart with in-row spacing between 6 and 8 inches. Some growers have had success using black or white plastic; however, growing onions on plastic can also increase the incidence of bacterial diseases in bulbs, particularly in hot or wet weather. If using plastic mulches, white-colored mulch is preferred for onion production due to the lower soil temperatures that occur. Use drip irrigation, as onions have poor root systems and will not achieve maximum size without adequate moisture. A well-drained soil is essential for good onion production. A soil pH between 6.0 and 6.8 is most desirable for onions.

Many growers produce onions for direct market sales. Often consumers at these markets are looking for sweet “Vidalia”-type onions. In order to produce mild tasting onions for fresh consumption, growers must have the correct combination of both variety and environment. Sweet, mild varieties bred specifically for fresh consumption should be chosen. In addition, onions grown with low levels of sulfur in soils or irrigation water will tend to be milder than those grown in a high sulfur environment. Growers should also be careful to choose the correct varieties for Kentucky. Intermediate or “day-neutral” type varieties perform well at this latitude.

### VARIETIES: Onions—Green and Bulb

Variety	Days to Maturity	Comments
<b>GREEN (bunching/scallions)</b>		
Ishikura	60-65	Long very slim white stems
Evergreen White Bunching	65-70	Hardy, will overwinter, non-bulbing, white stems
<b>BULB</b>		
Olympic	88 (300) <sup>1</sup>	Medium to large bulbs, very early, yellow, mild, some success overwintering
Gunnison	100 (300) <sup>1</sup>	Medium bulbs, some success overwintering, for storage, hot and pungent.
Super Star	100	Large (¾ lb) bulbs; white, pungent, stores well; AAS winner.
Red Burgermaster	105	Large red bulbs, not for storage.
Red Beauty	105	Red, medium bulbs, uniform and early
Candy	110	Large bulbs, sweet mild flavor, not for storage.
Expression	110	Large bulbs, sweet mild, similar to Candy
Red Wing	110-115	Red, medium bulbs, uniform, long day type will mature later.
Walla Walla	125 (300) <sup>1</sup>	Very large, sweet and mild, some success overwintering, stores poorly.
Sweet Spanish	130	Yellow, very large, globe-shaped, long-day onion will mature mid-late summer.

<sup>1</sup> Days to maturity if overwintering.

### Harvesting, Curing, and Storing

Onions should be harvested when at least 70 percent of the bulbs in the field have gone “tops-down” (foliage has fallen). Irrigation can be stopped about one week prior to harvest. At harvest, bulbs should be undercut and pulled by hand, with foliage and roots removed, and put in shallow trays inside for drying. Onions can be cured outside on a dry surface for one week prior to storing as long as they are protected from rain. Throw out diseased or injured bulbs. A temperature of 35°F and a relative humidity of 70 to 75 percent is the most desirable for storing onions for long periods. Do not store bulbs at a high relative humidity, as is appropriate for many other vegetables. Good ventilation is essential.

Green-bunching onions should be pulled and put into bunches (containing five to seven plants) when they are ½ to 1 inch in diameter. To achieve the long white shoulders desired on green onions, the soil is hilled around plants two to three weeks before harvest.

### FERTILIZER: Onions

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
<b>Phosphorus</b>		
	<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>	
Low	<31	181-240
Medium	31-60	61-180
High	61-80	1-60
Very High	>81	0
<b>Potassium</b>		
	<b>Potash (K<sub>2</sub>O)</b>	
Low	<201	176-250
Medium	201-300	101-175
High	301-450	1-100
Very High	>450	0
<b>Nitrogen</b>		
	<b>N</b>	
Apply 90 to 100 lb of nitrogen (N)/A to soils of relatively low fertility; broadcast and disk before planting. Decrease nitrogen application according to soil fertility. On heavily fertilized soils, apply 50 to 60 lb N/A. Once bulbing starts sidedress with 25 lb N/A every two weeks for a total of four applications.		

### Common Diseases/Management General Practices

Onions are very susceptible to a wide range of diseases. Use production practices that maintain good air circulation in the crop. Dry onions and green onions are not always covered by the same pesticide labels because the residue risk is much higher

with green onions (the leaves are eaten in addition to the bulb). Examine labels carefully to ensure the crop/stage is covered.

**Bacterial leaf blights, bacterial soft rots, and Botrytis neck rot.** Control leaf diseases through use of fixed coppers tank-mixed with mancozeb; neck rot is suppressed by some fungicides. *Plants may be immediately topped and dried under shelter, or should be gathered into windrows and topped after several days; neck tissues should be thoroughly dry before storage.* Harvest promptly and avoid damage during handling to limit problems with bacterial rots. In storage, cure rapidly using forced air; heat (not above 100°F) may be required for up to five to seven days during humid weather.

**Damping-off, seedling blight, and smut.** Purchase fungicide-treated seed or treat with either Captan 50 WP at 1 teaspoon per pound of seed. If planting bulbs (sets), apply mancozeb at 1 pound per 25 gallons of water for 10,000 linear feet as a coarse spray into the planting furrow. For control of Pythium damping-off, apply mefenoxam or metalaxyl either preplant or banded as a soil-surface spray after planting.

**Downy mildew.** Apply fungicides when conditions are favorable for disease; a number of products are available.

**Botrytis leaf blight, purple blotch, Stemphylium blight.** Rotate away from onions for three to four years to reduce these diseases. Steps taken to improve air movement within the crop will aid in management, but fungicide sprays are usually needed on commercial plantings in Kentucky. Apply fungicides weekly beginning when disease first appears.

**PESTICIDE SAFETY: Onions**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>INSECTICIDES</b>			
Admire Pro	C	12	21
Assail 30 SG	C	12	4
Coragen 1.67 SC	C	4	1
Exirel 0.83SE	C	12	1
Intrepid 2 F	C	4	16
Knack 0.83 EC	C	12	3
Lorsban 15 G	C	24	AP <sup>2</sup>
Malathion 8	C	12	3
Movento 2 SC	C	24	3
Radiant SC	C	4	1
Requiem 25 EC	C	4	0
Scorpion 3.5 SL	C	12	AP/1
<b>Restricted Use</b>			
Agri-Mek 0.15 EC	W	12	30
Battalion 1.5 EC	DP	12	1
Diazinon AG 500	C	24	14
Diazinon 50 W	C	24	14
Lannate 90 SP	DP	48	7
Lorsban 4 E	W	24	AP <sup>2</sup>
Mustang Max	W	12	7
PennCap-M	W	96	15
Permethrin 3.2 EC	C	12	1
Proaxis 0.5 EC	C	24	14
Venom 70 SG	C	12	1
Warrior II	W	24	14
<b>FUNGICIDES</b>			
Actigard 50WG	C	12	7
Aliette WDG <sup>3</sup>	C	12	7
Ariston	C	12	7
Botran 75-W	C	12	14
Cabrio EG	C	12	7
Chlorothalonil <sup>4</sup>	D	12	7/14 <sup>5</sup>
Cuprofix MZ Dispers <sup>4</sup>	C	24	7
Endura	W	12	7
Fixed coppers <sup>4</sup>	D	24/48	0
Fontelis	C	12	3
Forum SC	C	12	0
Inspire Super	C	12	7
Iprodione 4L AG	W	24	7

**PESTICIDE SAFETY: Onions**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
Mancozeb <sup>4</sup>	C	24	7
ManKocide	D	24	7
MetaStar 2EC AG	W	48	0
Meteor	W	24	7
Nevado 4F	W	24	7
Omega 500F	W	48	7
Presidio	C	12	2
Pristine	C	12	7
Propiconazole <sup>4</sup>	W	12	14
Quadris	C	4	0
Quadris Opti	W	12	7
Quadris Top	C	12	7
Quilt	C	12	14
Quilt Xcel	W	12	0
Reason 500 SC	C	12	7
Revus	C	4	7
Ridomil Gold EC/SL	C	48	0
Ridomil Gold Bravo SC	W	48	7/21 <sup>5</sup>
Ridomil Gold Copper <sup>4</sup>	D	48	7/10 <sup>5</sup>
Ridomil Gold MZ	W	48	7
Rovral 4 Flowable	W	24	7
Revus	C	4	7
Scala	C	12	7
Sulfur <sup>4</sup>	C	24	0
Switch	C	12	7
Tanos	C	12	3
Tebuconazole <sup>4</sup>	C	12	7
Ultra Flourish	W	48	0
Zampro	C	12	0
Zing!	C	12	7

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> AP: At planting

<sup>3</sup> The use of Aliette in the following Kentucky counties has certain restrictions to protect endangered freshwater mollusks and their habitat, so read labels carefully: Campbell, Green, Hart, Kenton, Logan, Marshall, Rockcastle, Todd, Warren, and Wayne counties.

<sup>4</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

<sup>5</sup> Dependent on type of onion (green, bulb or dry), see label.

**INSECT CONTROL: Onions<sup>1</sup>**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>PREPLANT/PLANTING</b>			
<b>Onion Maggots:</b> Problems with onion maggots are often associated with soils that are high in organic matter or amended with manure. Continuous planting of onions on the same ground will increase onion maggot problems. When possible, rotate with other crops. Eliminate culls and volunteer onions after harvest to reduce the overwintering population.			
Diazinon 50 W	4 to 8 lb	-	Incorporate immediately.
Lorsban 4 E	1.1 oz/ 1,000 row-feet	1 application	Dry bulb onions only, incorporate.
Lorsban 15 G	3.7 oz/ 1,000 row-feet	1 application	Dry bulb only.
Malathion 8	1.56 pt	2 applications	-
<b>FOLIAR TREATMENTS</b>			
<b>Thrips:</b> In general, red onions are more susceptible to thrips injury. Monitor for thrips regularly, especially during hot, dry weather. When needed, treat during early bulb stage and use 10 to 25 thrips per plant as a guideline for treatment.			
Admire Pro	14 fl oz	14 fl oz	Soil application only.
Agri-Mek 0.15 EC	8 to 16 fl oz	48 fl oz	Allow 7 days between applications.
Assail 30 SG	5 to 8 oz	32 oz	Limit 4 applications. Allow 7 days between applications.
Battalion 1.5 EC	1.5 to 2.4 fl oz	9.6 fl oz	-
Knack 0.83 EC	8 fl oz	16 fl oz	Target immatures.
Lannate 90 SP	1 lb	4 lb	-
Movento 2 SC	5 fl oz	10 fl oz	For thrips larvae. Allow 7 days between applications.
Mustang Max	2.88 to 4 fl oz	20 fl oz	Allow 7 days between applications.
Pounce 3.2 EC	6 to 12 fl oz	80 oz	Dry bulb only, not for green onions.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	30.7 fl oz	Allow 5 days between applications. Not for green onions.
Radiant SC	6 to 10 fl oz	30 fl oz	-

(continued on next page)

**INSECT CONTROL: Onions<sup>1</sup> (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Requiem 25 EC	1.5 to 3 qt		-
Scorpion 355L	5.25 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Venom 70 SG	3 to 4 oz	6 oz	Foliar application. Allow 7 days between applications.
	5 to 6 oz	6 oz	Soil application.
Warrior II	1.28 to 1.92 fl oz	15.36 fl oz	Bulb and garlic only, not for green onions.

<sup>1</sup> Generic products available (Appendix E).

**WEED CONTROL: Onion**

Product Amt/A	Lb A.I./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal of water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
1-1.5 pt Buctril	0.25-0.38 bromoxynil	For selective post-emergence control of broadleaf weeds. Use in 50 to 70 gal of water/A. Apply when both soil and onion leaves are dry and when temperature is 70 to 85°F. Apply to onions with 2 to 5 leaves and when weeds are < 2 inches tall. Do not add surfactant. Do not irrigate within 2 days of a pre-emergence application or within 3 days of crop emergence.
2 oz Chateau 51 WDG	0.064 flumioxazin	Apply to transplanted onions (dry bulb) between the 2-leaf and 6-leaf stage and on direct seed onions (dry bulb) between the 3-leaf and 6-leaf stage. Apply to weed-free onions (dry bulb) for pre-emergence control of the weeds listed. For use on all soil types with up to 5% organic matter. Do not apply more than 2 oz of Chateau WDG per acre during a single application. Do not apply more than 3 oz of Chateau WDG per acre during a single growing season. PHI = 45 days. Min. 14 days between applications.
6-14 lb Dacthal W-75	4.5-10.5 DCPA	For pre-emergence control of annual grasses and small-seeded broadleaves. Can be broadcasted over transplants. Can be applied up to 14 weeks after planting at 14 pt/A rate. Do not preplant incorporate.
0.67-1.3 pt Dual Magnum	0.64-1.25 s-metolachlor	24(C) Special Local Need Label see label for use and restrictions. Grower assumes all risk of crop injury, yield reductions, and crop loss.
1 pt Fusilade-DX 2E	0.25 fluazifop-p	For selective post-emergence control of annual grasses and suppression of perennial grasses. Include 1% v/v crop oil or 0.25% v/v non-ionic surfactant/A. PHI = 45 days. Max. rate is 48 fl oz/A.
2-3 fl oz Goal 2XL	0.032-0.5 oxyfluorfen	For pre-emergence and post-emergence control of certain annual grasses and most broadleaves. For use on dry bulb onion only. Apply as a broadcast spray after onions have 2 to 4 true leaves. Spray during sunny warm weather. Applications made during or following cool, wet weather will result in more severe crop injury. Use 2 to 4 fl oz/A for seeded onion and 0.5 to 2 pt/A for transplanted onion in min. 40 gal of water/A. Apply within 1 day before or after transplanting. Max. rate = 2 pt/A per year. 45-day pre-harvest interval. Not trialed for use on plastic.
2-4 pt Gramoxone Inteon	0.67-1.35 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply preplant, pre-emergence, or before transplanting in min. 20 gal of water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v. PHI = 60 days.
10-21 fl oz Outlook	0.47-0.98 dimethanamid	For pre-emergent control of select annual grasses and broadleaf weeds. Apply to onions after the 2 leaf stage and after soil has settled around transplanted onions, or injury may be severe. Can be applied in a single or split application. PHI = 30 days.
0.5-1.5 pt Poast 1.5	0.09-0.27 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 30 days. Max. rate of 1.5 pt/application and 4.5 pt/season.
5-6 qt Prefar 4 E	5-6 bensulide	For control of annual grasses and small-seeded broadleaves. Apply preplant incorporated to a depth of 1 inch or pre-emergence after planting. Irrigate immediately after pre-emergence application.
1.8-3.6 pt Prowl 3.3 E	0.74-1.49 pendimethalin	For control of annual grasses and broadleaf weeds. Apply in min. 10 gal of water/A to plants with 2 to 9 true leaf stage. Do not apply surface pre-emergence or serious crop injury can result. Not for use on leek or green bunching onion. PHI = 45 days.
2 pt Prowl H2O	0.95 pendimethalin	For control of annual grasses and broadleaf weeds. The label allows use of 2 pints pre-emergence and 2 pints after the two leaf stage. A maximum of 4 pints (1.9 lb ai) may be applied per crop. It should not be used on soils with less than 3% OM. PHI = 30-days.
16-22 fl oz Roundup Weather-Max 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
9-32 fl oz Select Max	0.07-0.24 clethodim	For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v in min. 20 gal of water/A. Do not apply more than 32 oz per application. PHI = 45 days.
1-1.25 pt Treflan HFP 4 E	0.5-0.62 trifluralin	For pre-emergence control of annual grasses and broadleaf weeds. For dry bulb use only. Apply at lay-by to soil between onion rows.

**DISEASE CONTROL: Onions—Dry and Spanish**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Bacterial Leaf Blight</b>					
Fixed coppers					Apply every 5 to 10 days when plants reach 4 to 6 inches or before disease onset, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1.5 pt		-
Badge X2	M	0	0.75 lb		OMRI-listed.
Champ DP	M	0	0.67 to 1 lb		-
Champ Formula 2 FL	M	0	0.67 to 1 pt		-
Champ WG	M	0	2 lb		OMRI-listed.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 3 lb		-
Kentan DF	M	0	1.5 to 2 lb		-
Kocide 2000	M	0	1.5 lb		-
Kocide 3000	M	0	0.75 lb		-
Kocide DF	M	0	1 to 1.5 lb		-
Mastercop	M	0	0.5 to 1 pt		-
Nu-Cop 50 WP	M	0	2 lb		OMRI-listed.

(continued on next page)

**DISEASE CONTROL: Onions—Dry and Spanish (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Nu-Cop 3 L	M	0	1.33 to 2.66 pt		-
Nu-Cop 50 DF	M	0	1 to 1.5 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	1 lb		-
ManKocide2	M	7	1.5 to 2.25 lb	see footnote	Apply when disease appears and continue every 3 to 7 days as needed.
<b>Botrytis Leaf Blight, Downy Mildew, Purple Blotch, Stemphylium Blight</b>					
Actigard	21	7	0.75 to 1 oz	4 oz	Downy mildew only. Apply 7 to 10 days after thinning and make up to three additional applications every 7 to 10 days. Apply in a min of 20 gal/A of water. May cause phytotoxicity and yield reduction. Do not apply to stressed or injured plants.
Aliette WDG <sup>6</sup>	33	7	2 to 3 lb	7 apps	Downy mildew only. Apply when conditions favor disease and continue every 7 to 14 days. Do not tank-mix with copper compounds.
Ariston	M/27	7	1.6 - 2.4 pt	14 pt	Downy mildew and purple blotch. Apply before disease onset, continue every 7 to 9 days.
<b>Azoxystrobin<sup>4</sup></b>					
Azoxy 2SC	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	Use higher rates for downy mildew and Botrytis leaf blight. Apply before disease onset, continue every 7 to 14 days.
AzoxyStar	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Botran 75 W	14	14	1.66 to 3.33 lb	5.33 lb	Botrytis only. Apply every 14 days.
Cabrio	11	7	8 to 12 oz <sup>5</sup>	6 apps	Use higher rates for downy mildew and Botrytis leaf blight. Apply before disease onset, continue every 7 to 14 days.
<b>Chlorothalonil<sup>4</sup></b>					
Bravo Ultrex	M	7/14	0.9 to 2.7 lb	18.2 lb	Apply before disease onset; continue every 7 days as needed.
Bravo WeatherStik	M	7/14	1 to 3 pt	20 pt	
Endura	7	7	6.8 oz	6 apps	
<b>Fixed coppers</b>					
Purple blotch and botrytis leaf blight only. Apply before disease onset, continue every 7 to 14 days.					
Purple blotch and downy mildew only. Apply every 5 to 10 days when plants reach 4 to 6 inches or before disease onset, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.					
Badge SC	M	0	1.5 pt		-
Badge X2	M	0	0.75 to 1.5 lb		OMRI-listed.
Basic Copper 53	M	0	1.9 lb		OMRI-listed.
C-O-C-S WDG	M	0	3 to 4 lb		-
Champ DP	M	0	1.33 lb		-
Champ Formula 2 FL	M	0	1.33 pt		-
Champ WG	M	0	2 lb		OMRI-listed.
COC DF	M	0	3 to 4 lb		-
COC WP	M	0	3 to 4 lb		OMRI-listed.
Copper-Count-N	M	0	4 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 3 lb		-
Kentan DF	M	0	2 lb		-
Kocide 3000	M	0	0.75 lb		-
Kocide 2000	M	0	1.5 lb		-
Kocide DF	M	0	2 lb		-
Nordox 75 WG	M	0	1.25 to 2.5 lb		OMRI-listed.
Mastercop	M	0	0.5 to 1 pt		-
Nu-Cop 50 WP	M	0	2 lb		OMRI-listed.
Nu-Cop 3 L	M	0	1.33 to 2.66 pt		-
Nu-Cop 50 DF	M	0	2 lb		OMRI-listed.
Nu-Cop HB	M	0	1 lb		-
Fontelis	7	3	16 to 24 fl oz	72 fl oz	Botrytis leaf blight, botrytis neck rot, purple blotch. Apply before disease onset, continue every 7 to 14 days.
Forum SC	40	0	6 fl oz	5 apps	Downy mildew only. Must be tank-mixed with another downy mildew fungicide, excluding mfenoxam. Apply before disease onset, continue every 5 to 7 days.
Inspire Super	3/9	7	16 to 20 fl oz	80 fl oz	Botrytis leaf blight, purple blotch. Apply every 7 to 10 days.
<b>Iprodione<sup>4</sup></b>					
Rovral 4 Flowable	2	7	1 to 1.5 pt	5 apps	Botrytis leaf blight, botrytis neck rot, purple blotch. Apply before disease onset and repeat every 14 days.
<b>Mancozeb<sup>4</sup></b>					
Products include Dithane, Koverall, Manzate, Penncozeb.					
Dry formulations	M	7	2 to 3 lb	30-32 lb	
Liquid formulations	M	7	1.6 to 2.4 qt	24 qt	
ManKocide <sup>3</sup>	M	7	2.5 lb	see footnote	Apply before disease appears and continue every 3 to 7 days as needed.
Omega 500F	29	7	1 pt	6 apps	Botrytis leaf blight, Botrytis neck rot, downy mildew, purple blotch. Apply every 7 to 10 days. Do not use a spray adjuvant.
Presidio	43	2	3 to 4 fl oz	4 apps	Downy mildew. Apply every 7 to 14 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Pristine	7/11	7	14.5 to 18.5 oz	4 apps	Apply before disease onset, continue every 7 to 14 days. User lower rates for Botrytis leaf blight.
<b>Propiconazole<sup>4</sup></b>					
Tilt	3	14	4 to 8 fl oz	16 fl oz	Purple blotch and botrytis leaf blight. Apply before disease onset, continue every 7 to 10 days.
Presidio	43	2	3 to 4 fl oz	12 fl oz	Apply every 7 to 14 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Quadris Opti	11/M	7	1.6 to 3.6 pt	3 apps	Bunch and dry onions only.
Quadris Top	11/3	7	12 to 14 fl oz	42 fl oz	Apply before disease onset, apply every 7 to 14 day schedule.
Quilt	11/3	14	14 to 27.5 fl oz	55.3 fl oz	Purple blotch, botrytis leaf blight. Apply before disease onset, continue every 7 to 10 days.

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**DISEASE CONTROL: Onions—Dry and Spanish (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Quilt Xcel	11/3	0	14 to 26 fl oz	56 fl oz	Use higher rates for downy mildew and Botrytis leaf blight. Apply before disease onset, continue every 7 to 14 days.
Reason	11	7	5.5 fl oz	22 fl oz	Downy mildew and purple blotch. Apply before disease onset, continue every 5 to 10 days.
Revus	40	7	8 fl oz	32 fl oz	Downy mildew. Apply every 7 to 10 days. Use a spreader/penetrant surfactant. Must be tank-mixed with a fungicide NOT in FRAC Group 40.
Ridomil Gold Bravo SC	4/M	7/21	2.5 pt	4 apps	Apply before disease onset, continue every 14 days. Rotate to another mode of action between applications of RG Bravo. Avoid late-season applications. Observe seasonal limits for chlorothalonil.
Ridomil Gold Copper	4/M	7/10	2 lb		Downy mildew only. Apply before disease onset, continue every 14 days. Rotate to another mode of action between applications of RG Copper. Avoid late-season applications. Limit 4 apps/season.
Ridomil Gold MZ <sup>3</sup>	4/M	7	2.5 lb		Downy mildew only. Apply before disease onset, continue every 14 days. Rotate to another mode of action between applications of RG MZ. Avoid late-season applications.
Scala	9	7	9 to 18 fl oz	54 fl oz	Purple blotch and botrytis leaf blight only. Apply before disease onset, continue every 7 to 14 days.
Switch 62.5WG	9/12	7	11 to 14 oz	56 oz	Not for downy mildew. Apply every 7 to 10 days.
Tanos	11/27	3	8 oz	84 oz	Downy mildew, purple blotch. Must be tank-mixed with a multi-site inhibitor (FRAC Group M). Apply before disease onset, continue every 5 to 7 days.
Tebuconazole <sup>4</sup>	3	7			Purple blotch only. Apply preventively. Use lowest listed rate of surfactant to improve coverage.
Zampro	40/45	0	14 fl oz	3 apps	Downy mildew. Apply before disease onset, treat every 7 days.
Zing!	M/22	7	30 fl oz	8 apps	Apply before disease onset and repeat every 7 days. Alternate with another FRAC code. Do not apply directly to bulbs.

**Pythium Damping-off, Cottony Leak**

MetaStar 2E AG	4	0	2 to 4 pt	1 app	<b>Preplant.</b> Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil. <b>At planting.</b> Apply broadcast or banded, move into seed zone with 0.5 to 1 inch of irrigation if rainfall is not expected within 24 hours.
Ridomil Gold SL	4	0	0.5 to 1 pt		
Ultra Flourish	4	0	1 to 2 pt		

NOTE: Some of the chemicals listed above may not be labeled for green onions—check product labels carefully before use.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Observe seasonal limits for mancozeb.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>5</sup> Use higher rate when pressure is severe.

<sup>6</sup> Restricted in some Kentucky counties. See fungicide safety table on page 20.

## Peas

Pea family (Fabaceae): *Pisum sativum*

### Planting and Culture

Early spring plantings are a must to ensure good yields in Kentucky. The earliest plantings should be made between February 20 and March 1 or by the time the soil temperature has reached 45°F (see Appendix J). Use seed treatments to avoid decay problems.

Select soils that are well drained and adjust the pH to 6.5. Lighter, sandy loam soils are preferred because they warm up sooner.

Seed may be planted in either double or single rows. Double rows should be spaced 6 to 8 inches between rows and 18 to 24 inches between pairs of rows or adjusted to the cultivating equipment that is available. Plants in double rows will support each other. For tall-growing, indeterminate varieties, plant supports will need to be constructed. Space single rows 24 to 36 inches apart. Seed within the row should be planted 1 to 1½ inches deep and spaced 1 inch apart. Peas requires between 60 and 100 pounds of seed per acre, depending on spacing.

**VARIETIES: Peas—English, Edible Pod, Snap**

Variety	Days to Maturity	Comments
<b>ENGLISH (all are determinate)</b>		
Spring	57	Large pods for an early cultivar; excellent quality.
Oregon Trail	61	Highly productive, 2 pods per node; very sweet; resistant to pea enation mosaic virus and powdery mildew.
Maestro	61	Heavy producer of 4 inch long pods; excellent quality; tolerance to Fusarium wilt, pea enation virus, bean yellow mosaic virus, and powdery mildew.
Legacy	67	Productive, 3.5 inch pods; 2.5 pods per node; resistant to Fusarium wilt and powdery mildew.
Green Arrow	68	Productive, Fusarium wilt and powdery mildew resistant.
Utrillo	71	Productive; 5 inch pods; very sweet peas; good for fall production planted in mid August.
<b>EDIBLE POD<sup>1</sup></b>		
Oregon Giant	69	Highly productive; sweet pods 4 inches long; resistant to Fusarium wilt, pea enation mosaic virus and powdery mildew.
Oregon Sugar Pod II	70	Highly productive; pods 3 inches long; Fusarium wilt resistance.
Mammoth Melting Sugar	74	Vine 34 to 40 inches tall, pods 4 inches long.
<b>SNAP</b>		
Sugar Ann	56	Resistant to Fusarium wilt race 1, very sweet.
Super Snappy	65	Highly productive; 5 inch long pods; vines may need support; tolerant to powdery mildew.
Cascadia	67	Very productive; 3 inch long pods; pods remain tender and sweet longer than other cultivars; very good disease tolerance.
Sugar Snap	72	Resistant to common pea wilt; an All American Selection all time winner; must be trellised; very heavy yielder.
Sugar Daddy	74	Stringless, tolerant to pea leaf roll virus and resistant to powdery mildew.

<sup>1</sup> *P. sativum* var. *macrocarpon*

## Harvesting

English peas should be picked as soon as pods are well filled but before they harden and fade in color. Two or three pickings can usually be made. Peas should be cooled and processed as soon as possible because the sugar content decreases rapidly after harvest. It is best to shell the peas just before cooking.

Edible pod or snow peas are harvested while the peas are immature. Pods reach a length of 3 to 5 inches within five to seven days after flowering. Consequently, pods should be harvested every other day to prevent the development of large seeds and tough pods. Edible pod peas in plastic bags will store 10 days under refrigeration without loss of quality.

Edible pod snap peas can be harvested from the time the peas begin to form until the pods are well filled.

Peas should be stored at 32° to 34°F and 90 to 95 percent relative humidity.

## Common Diseases/Management

**Fusarium wilt.** Use resistant varieties in fields with a history of Fusarium wilt.

**Anthracnose, Ascochyta leaf spot and pod blight, leaf spots, powdery mildew.** Several fungicide products are labeled. Some resistant varieties are available. Plant disease-free seed to reduce leaf spots and pod diseases. Rotate away from legumes for three to four years to reduce inoculum levels in soil.

**Damping-off, root rot.** Rotate fields with a history of root rot for four or more years to small grains, corn, or other grasses; avoid legumes during the rotation. Purchase seed that has been commercially

## PESTICIDE SAFETY: Peas

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>INSECTICIDES</b>			
Acramite 4 SC	C	12	3
Admire Pro	C	12	7/21 <sup>3</sup>
Assail 30 SG	C	12	7 <sup>3</sup>
Belt 4 SC	C	12	1/14 <sup>3</sup>
Blackhawk 36 WG	C	4	3/28 <sup>3</sup>
Bt products	C	4/12	0
Coragen 1.67 SC	-	4	1
Dimethoate 4 E	W	48	0
Intrepid 2 F	C	4	7
Malathion 8	C	12	3
Movento 2 SC	C	24	1/7 <sup>3</sup>
Radiant SC	C	4	3/28
Scorpion 1.67 SL	C	12	7/21 <sup>3</sup>
Sevin XLR	W	12	3
<b>Restricted Use</b>			
Asana XL	W	12	3/21 <sup>3</sup>
Baythroid XL	W	12	7
Brigade 2 EC	W	12	3
Brigadier 2	W	12	7
Danitol 2.4 EC	W	24	7 <sup>3</sup>
Diazinon 50W	C	24	7
Hero 1.24 EC	C	12	3

## PESTICIDE SAFETY: Peas

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
Lannate 90 SP	DP	48	1 <sup>3</sup>
Leverage 2.7	W	12	7 <sup>3</sup>
Mustang Max	W	12	1/21 <sup>3</sup>
Proaxis 0.5 EC	C	24	7/21 <sup>3</sup>
Renounce 20 WP	C	12	7
Voliam Xpress	W	24	7/21 <sup>3</sup>
Warrior II	W	24	7/21 <sup>3</sup>
<b>FUNGICIDES</b>			
Fixed coppers <sup>2</sup>	D	24/48 <sup>4</sup>	0
Endura	W	12	7/21
Fontelis	C	12	0
Headline <sup>3</sup>	W	12	7/21
MetaStar 2EC AG	W	48	0
Priaxor	C	12	7
Proline 480 SC	C	12	7
Quadris	C	4	0
Ridomil Gold SL	C	48	0
Sulfur <sup>2</sup>	C	24	0
Ultra Flourish	W	48	0

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

<sup>3</sup> PHI depends on the type of pea, see label.

<sup>4</sup> Depends on type of application and product.

treated, or treat with Captan at 1 teaspoon per pound of seed. Mefenoxam or metalaxyl can be applied at planting to suppress *Pythium*; azoxystrobin can be applied for control of *Rhizoctonia*.

**White mold.** Steps taken to reduce periods of wetness in the canopy are helpful, and a number of fungicides are labeled for this disease. Avoid fields with a history of the disease in any crop.

**Viruses.** Virus diseases occur in every planting every year. Practical controls are not available; avoid planting peas next to other legumes.

## FERTILIZER: Peas

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)
<b>Phosphorus</b>	
	<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>
Low	<31
Medium	31-60
High	61-80
Very High	>81
	0
<b>Potassium</b>	
	<b>Potash (K<sub>2</sub>O)</b>
Low	<201
Medium	201-300
High	301-450
Very High	>450
	0
<b>Nitrogen</b>	
	<b>N</b>
Poor soils	50-60
Fertile soils	30-40

## INSECT CONTROL: Peas<sup>1</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>PREPLANT INCORPORATED</b>			
<b>Cutworms, Wireworms:</b> Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites. Wireworms can be a potential problem where peas follow grass or grass-legume sod.			
Diazinon 50 W	4 to 8 lb		Incorporate immediately.
<b>PLANTER BOX</b>			
<b>Seedcorn Maggots:</b> Usually only a serious pest early in the season. Shallow planting in well-prepared seedbeds and adequate soil temperature to promote rapid germination will aid in reducing problems. Heavy cover crops or manure should be plowed early to render fields less attractive for egg laying.			
<b>FOLIAR TREATMENTS</b>			
<b>Alfalfa Loopers, Green Cloverworms</b>			
Asana XL	2.9 to 9.6 fl oz	38.4 fl oz	Do not feed vines.
Belt 4 SC	2 to 3 fl oz	6 fl oz	Allow 5 days between applications.
Blackhawk 36 WG	2.2 to 3.3 oz	20 oz	Allow 5 days between applications.
Bt products	See labels.	-	-
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	-
Intrepid 2 F	4 to 16 fl oz	64 fl oz	Allow 7 days between applications.
Lannate 90 SP	0.25 to 1 lb	3 lb	Wait 5 days to feed forage. Succulent peas only.
Mustang Max	2.72 to 4 fl oz	24 fl oz	Allow 5 days between applications.
Proaxis 0.5 EC	1.92 to 3.84 fl oz	15.36 fl oz	-
Warrior II	0.96 to 1.92 fl oz	7.68 fl oz	-
<b>Aphids</b>			
Admire Pro	7 to 10.5 fl oz	10.5 fl oz	Soil application.
Assail 30 SG	2.5 to 5.3 oz	16 oz	Limit 3 applications. Allow 7 days between applications. Not for dried peas.

(continued on next page)

**INSECT CONTROL: Peas<sup>1</sup> (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	-
Malathion 8	1 pt	2 applications	Allow 7 days between applications.
Movento 2 SC	4 to 5 fl oz	10 fl oz	Allow 7 days between applications.
Sivanto 1.67 SL	7 to 10.5 fl oz	28 fl oz	Allow 10 days between applications.
<b>Armyworms, Cutworms</b>			
Asana XL	5.8 to 9.6 fl oz	38.4 fl oz	Do not feed vines.
Baythroid XL	0.8 to 1.6 fl oz	6.4 fl oz	Dry peas only. Limit 3.2 fl oz per 14-day period.
Belt 4 SC	2 to 3 fl oz	6 fl oz	Allow 5 days between applications.
Blackhawk 36 WG	2.2 to 3.3 oz	20 oz	Allow 5 days between applications.
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	-
Coragen 1.67 EC	3.5 to 5 fl oz	15.4 fl oz	For beet and fall armyworm. Allow 3 days between applications.
Intrepid 2 F	4 to 16 fl oz	64 fl oz	Allow 7 days between applications.
Mustang Max	2.72 to 4 fl oz	24 fl oz	Allow 5 days between applications.
Proaxis 0.5 EC	1.92 to 3.84 fl oz	15.36 fl oz	-
Sevin XLR	1 to 1.5 qt	6 qt	Limit 4 applications. Allow at least 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	7.68 fl oz	-

<sup>1</sup> Generic products available (Appendix E).

**WEED CONTROL: Peas**

Product Amt/A	Lb A.I./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal of water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
1-2 pt Basagran 4S	0.5-1 bentazon	For post-emergence control of annual broadleaves and suppression of yellow nutsedge. Two applications are needed for nutsedge and Canada thistle control. Do not add crop oil. Apply after peas have at least 3 pairs of leaves (or 4 nodes) or severe crop damage may occur. PHI for dry peas is 30 days and for succulent peas is 10 days. Do not apply when peas are in bloom.
1.3 pt Command 3ME	0.5 clomazone	For pre-emergence control of annual grasses and broadleaf weeds. Apply once in a min. 10 gal of water/A. Apply and incorporate 2 to 3 inches before planting. Use in combination with other herbicides to broaden weed control spectrum.
1.3-1.7 pt Dual II Magnum 7.6 E	1.3-1.6 s-metolachlor	For control of most annual grasses and certain broadleaves. Apply preplant surface or incorporated or pre-emergence. Small grains may be planted 4½ months following this treatment. See label for other rotational crops.
2-4 pt Gramoxone Inteon	0.69-1.38 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply preplant, pre-emergence, or before transplanting in min. 10 gal water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v.
0.5-2.5 pt Poast 1.5	0.09-0.48 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. Dry and succulent peas. Max. rate 4 pt/A per year. Include 1% v/v crop oil. PHI = 15 days for succulent peas and 30 days for dry peas.
3 oz Pursuit 2L	0.05 imazethapyr	For control of annual grasses and broadleaf weeds. Can be applied preplant incorporated within 1 week before planting. Can be applied pre-emergence within 3 days after planting. Can be applied post-emergence to plants at least 3 inches tall but before 5 nodes and before flowering. Add non-ionic surfactant 0.25% v/v.
3 fl oz Raptor	0.018 imazamox	For control of annual grasses and broadleaf weeds. Some varieties are sensitive and injury can occur. Apply post-emergence to actively growing dry peas with at least 3 pairs of leaves and before bloom. Max. 1 application/season.
16-22 fl oz Roundup WeatherMax 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
9-16 fl oz Select Max	0.068-0.12 clethodim	For control grasses. Do not apply more than 16 oz/A in a single application. For peas apply before bloom, but no more than 21 days before harvest.
1-2 pt Treflan HFP 4 E	0.5-1 trifluralin	For control of annual grasses and broadleaf weeds. Apply and incorporate in spring before planting or in fall in advance of spring planting.

**DISEASE CONTROL: Peas**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Anthraxnose, Ascochyta Leaf Spot/Pod Blight, Leaf Spots, Powdery Mildew</b>					
Azoxystrobin <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxy 2SC	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
AzoxyStar	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Endura	7	7/21	6 to 11 oz	2 apps	Apply before disease onset, continue every 5 to 14 days.
Fontelis	7	0	14 to 30 fl oz	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Fixed coppers					
Badge SC	M	0	1 to 2.5 pt		Powdery mildew.
Badge X2	M	0	0.5 to 1.5 lb		OMRI-listed. Powdery mildew.
Basic Copper 53	M	0	1.5 lb		OMRI-listed. Powdery mildew.
Champ DP	M	0	1 to 2 lb		-
Champ Formula 2 FL	M	0	1 to 2 pt		-
Champ WG	M	0	1.5 to 3 lb		OMRI-listed.
COC DF	M	0	1.5 to 3 lb		-
COC WP	M	0	1.5 to 3 lb		OMRI-listed.
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.

(continued on next page)

**DISEASE CONTROL: Peas (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Cuprofix Ultra 40 Disperss	M	0	1 to 2 lb		-
Kentan DF	M	0	1 to 2 lb		-
Kocide 2000	M	0	1 to 2.25 lb		-
Kocide 3000	M	0	0.5 to 1.25 lb		-
Kocide DF	M	0	1.5 to 3 lb		-
Mastercop	M	0	0.5 to 1 pt		-
Nordox 75 WG	M	0	0.66 to 2.5 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	1.5 to 3 lb		OMRI-listed.
Nu-Cop 3 L	M	0	1 to 4 pt		-
Nu-Cop 50 DF	M	0	1.5 to 3 lb		OMRI-listed.
Nu-Cop HB	M	0	0.75 to 1.5 lb		-
Headline	11	7/21	6 to 9 fl oz <sup>5</sup>	18 fl oz	Apply before disease onset, continue every 7 to 14 days.
Headline SC	11	7/21			
Priaxor	7/11	7	4 to 8 fl oz	16 fl oz	Apply prior to development of disease, continue every 7 to 10 days.
Sulfur <sup>4</sup>	M				Powdery mildew. Apply when disease is first observed; continue every 14 days as needed. Phytotoxicity may occur if applications are made when temperatures exceed 90°F. Some products are OMRI-listed; refer to labels.

**Pythium Damping-off, Root Rot**

MetaStar 2E AG	4	0	2 to 4 pt	1 app	Apply pre- or post-planting as a broadcast or banded spray (7-inch band) in sufficient water to provide uniform coverage. Incorporate into the upper 2 inches of soil mechanically or by rainfall/irrigation.
Ridomil Gold SL	4	0	0.5 to 1 pt		
Ultra Flourish	4	0	1 to 2 pt		

**Rhizoctonia Damping-off, Seedling Disease, Stem/Root Rot**

Azoxystrobin <sup>4</sup>					
Azoxy 2SC	11	0	0.4 to 0.7 fl oz <sup>3</sup>	1 app	At-planting. Apply as an in-furrow spray in 0.3 to 1 gal water/1,000 row-feet (5- to 15-gal/A). Spray should be applied to the furrow just before seed are covered. Post-emergence. Apply in a 7-inch (or less) band directed at the soil at the base of the plant. Arrange nozzles to provide good coverage of lower stems and soil at base of plants. Incorporation following application will improve distribution in soil. Foliar contact may occur; post-emergence sprays are considered foliar applications for resistance management purposes.
AzoxyStar	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 foliar apps	
Quadris	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 foliar apps	
Satori	11	0	0.4 to 0.8 fl oz <sup>3</sup>	see label	

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Per 1,000 row-feet.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>5</sup> Use higher rate when pressure is severe.

## Peppers

Nightshade family (Solanaceae): *Capsicum annuum*

### Planting and Culture

Peppers are grown primarily for the fresh market in Kentucky. To be successful it is important to begin by selecting a good field location. Low-lying fields next to creeks and rivers are subject to high humidity and moisture conditions that result in serious disease risks; these areas are especially prone to bacterial leaf-spot epidemics. Avoid poorly drained fields or fields where imazaquin or atrazine herbicides may have been used the previous season. Herbicide carryover (especially from corn and soybean herbicides) can cause serious injury to peppers (see "Weed Management" on page 9).

Growers also should locate pepper plantings as far away from tobacco plantings as possible because of the danger of aphid movement and virus disease spread from tobacco to peppers. Although tobacco ground may represent some

of the best land on a farm, it is also not advisable to grow peppers after tobacco, tomatoes, eggplants, potatoes, or vining crops for a period of three years, because these crops are susceptible to many of the same diseases.

Soils known to be high in residual nitrogen should also be avoided to prevent peppers from producing excessive foliage at the expense of fruit. Consider the previous crop when deciding how much nitrogen to apply; there will probably be some residual nitrogen following a crop that received heavy doses of nitrogen fertilizer during the previous season.

Potassium and especially phosphorus are likely to accumulate in most Kentucky soils following several years of heavy applications for vegetable crops. Make sure to get your soil tested in the fall or early winter so that you will know exactly what nutrients are required.

Plow soil 8 to 10 inches deep several weeks in advance of the transplanting date. Peppers do extremely well following fescue sod. Prepare a fine seedbed by disking or rototilling.

### Fresh Market Bell Peppers Production with Plasticulture

Planting hybrid bell peppers on 6- to 8-inch-high raised beds covered with black plastic mulch and using drip irrigation has resulted in high yields of excellent quality peppers for fresh market sales. A bed shaper/plastic mulch layer and a setter that will transplant through plastic are essential for this production system. Two rows of peppers spaced 15 inches apart are planted on each bed; plants are spaced 12 to 15 inches apart within each row. The beds are usually 5 to 6 feet from center to center (approximately 14,500 plants per acre).

Since a portion of the fertilizer will be applied through the drip irrigation system (fertigation), uniform watering will ensure that plants receive adequate nutrients. Don't assume that because it has rained there will be water in the root zone under plastic. Also, while the consequences of under-watering (and therefore under-fertilizing) are obvious, many growers overlook the fact that over-watering will leach nutrients out of the root zone. Growers using trickle irrigation and plastic mulch

**VARIETIES: Peppers**

Variety	Days to Maturity	Comments
<b>BELL</b> (all are F1 hybrids and have resistance to several races of Bacterial spot)		
Socrates	64	Race 1, 2, 3 resistant, PVY, early blocky fruits.
Declaration	70	Race 1, 2, 3, 5 resistant, intermediate resistance to phytophthora, CMV, TSWV, high yields, little silvering.
Aristotle	70	Race 1, 2, 3 resistant, phytophthora tolerant.
Karisma	75	Race 1,2,3 intermediate resistant. Resistant to TMV, PVY 0, 1, 1-2. Intermediate resistance to PepMoV, PepYMV, and CMV. Blocky, large to extra large fruit.
Currier	73	Race 1, 2, 3 resistant, TMV, PVY 0, 1, 1-2, PepMoV, PepYMV, and intermediate resistance to CMV. Blocky, large to extra large fruit.
Bastille	75	Race 1, 2, 3, 4, 5, 7, 8, 9 resistant, TMV, and PepMoV. Blocky, large to extra large fruit.
Alliance	74	Race 1, 2, 3, 5 resistant, PVY 0, 1, 1-2, TMV, PepMoV, Pep YMV with intermediate resistance to CMV, high yields, light to medium green fruit, little silvering, top recommendation.
Revolution	74	Race 1, 2, 3, 5 resistant, CMV resistant, somewhat <i>Phytophthora</i> tolerant, light to medium green fruit, may flatten in very hot weather, top recommendation.
<b>Colored Bell</b>		
Mavras	68	TMV, large blocky deep purple fruit (for trial).
Blushing Beauty	70	Race 1, 2, 3 resistant, matures green to ivory to orange to red.
Early Sunsation	70	Race 1, 2, 3 resistant, PVY tolerant, green to golden yellow, blocky.
Ivory	70	TMV, creamy white to deep yellow, mostly three lobed fruit.
Valencia	72	Spot resistant, TMV, green to orange, blocky.
<b>SPECIALTY</b>		
<b>Cherry</b>		
Sweet Cherry Large	62	High yielding, sweet.
Red Cherry Large	75	Very hot, 1¼ inch diameter fruits.
<b>Pimento</b>		
Pimento Elite (hybrid)	87	Heart-shaped, 3 x 3 inches, tapered.
<b>Jalapeño</b> (all are F1 hybrids)		
El Rey	65	Race resistant 1,2,3, PVY 0,1,2, and TEV.
Ixtapa X3R	70	Race 1, 2, 3 resistant; some purpling in cool weather; susceptible to ozone injury.
Tormenta	72	Race 1, 2, 3 resistant, TEV, large upright plant with thick fruit, average heat.
Grande	70	Large fruits, thick walled; fruit 3.5 to 4 inches long, TEV, PVY tolerant.
El Jefe	72	Bacterial spot resistant (races 1, 2, 3); dark green.
<b>Banana and Wax</b>		
Inferno	60-65	Hot banana, thick walled fruits, yellow and red.
X3R Hot Spot	65-70	Race 1,2,3 resistant, hot banana, 2 x 6 inches.
Hungarian Yellow Wax	65-70	Yellow to orange red, medium hot, fruit 6 to 6.5 inches long, tapered.
X3R Sweet Spot	70	Race 1, 2, 3 resistant, banana, light yellow to red, 2 x 8 inches.
Santa Fe Grande	65	Very hot, pale yellow, jalapeño-like fruits.
<b>Italian/Cubanelle</b>		
Aruba	65	High yielding, 2 x 7.5 inches, light green to pale yellow.
Corno di Toro	70-75	Light to medium green, 8 inches long, tapered, large plant, heirloom type from Italy.
X3R Key West	70-75	Light green, 2.5 x 7.5 inches, bacterial spot resistant (races 1, 2, 3).
Carmen	75	Green to red, fruit 7 inches long, AAS winner.
<b>Poblano/Ancho</b>		
San Ardo	75	Dark green to red, early and productive.
Don Emilio	80	Uniform, blocky fruit, season long production.
Tiburón	80	Dark green, 2.5 x 5.5 inches, high yields, sturdy plant.
<b>Anaheim</b>		
Anaheim TMR 23	75	Thick walled, 8 inches long, TMV tolerant.
Anaheim 118	75	Thick fleshed, light green to red
<b>Serrano</b>		
Tuxtlas	70	Medium pungency, 0.5 x 3 inches, PMV, PVY, TEV.
Serrano del Sol	70-72	High yielding and attractive fruits, 0.5 x 3.5 inches, tolerance to PMV and PVY.
Don Picoso	75	Medium pungency, ¾ x 3 inches, sets well throughout season.

Most of these have been tested at two or more locations by the University of Kentucky. We recommend that only bacterial spot resistant varieties be used. See "Common Diseases and Management" for more information on management of this important disease.

should carefully monitor soil moisture using tensiometers. Check these instruments daily. For more details on how to set up a trickle irrigation system with fertilizer injection, contact your county Extension agent or irrigation supply representative.

In Kentucky, pepper plants should be transplanted to the field after danger of frost, usually around the second week of May (see Appendix J). A 7- to 8-week-old transplant is best.

Greenhouse container-grown plants are recommended for planting with mulch and trickle irrigation. Trays with 72-128 cells are considered economical but large enough to produce large and vigorous transplants. Using a larger transplant container (larger cell size) will usually result in better transplant survival and earlier yields.

Seed should be treated by the seed company or treated with chlorine bleach

by the grower to help reduce seed transmission of bacterial leaf spot (see Appendix H). Bacterial spot remains a serious risk to pepper plantings in many parts of the state, and most growers should use resistant varieties as well as early-season sprays containing fixed copper plus manzate to reduce ephytic populations of leaf spot bacteria. Bare root transplants are not recommended for fresh market pepper production.

When transplanting, use 4 to 8 ounces of a starter solution around the roots of each plant. Use 3 pounds of a 10-52-17 or similar analysis fertilizer in 50 gallons of water for the starter mix.

Poor fruit set and deformed fruit may result when nighttime temperatures drop below 60°F or when daytime temperatures exceed 90°F. Varieties differ considerably in their response to temperature extremes.

Most types of hot and specialty peppers can be grown using the same techniques and spacings as for bell peppers; however, some types require staking and tying. Serrano peppers, anaheims, poblanos, and some cubanelle varieties should be staked and tied when using plasticulture and high plant populations. Tomato stakes are placed every 6 to 10 feet on each side of the double-row beds. Tomato twine is looped and tightened around each stake at 7 to 9 inches above the soil to “fence-in” the plants. Second and third stringings can be used higher on the stakes as needed during the season. To reduce sunburn to fruit, shorter (2½ to 3 feet) stakes are sometimes also used for very tall bell pepper varieties or where bell pepper plantings are exposed to high winds.

**(Note:** See *Kentucky Pepper Integrated Crop Management Grower Manual* (IPM-13), [uky.edu/Ag/IPM/manuals/ipm13pep.pdf](http://uky.edu/Ag/IPM/manuals/ipm13pep.pdf), for more detailed information on bell pepper production and pest management. Growers and cooperatives are strongly advised to use UK’s degree-day model, pheromone traps, and regular scouting to monitor second generation European corn borer populations in July. The degree-day model is available on the Web at [www2.ca.uky.edu/entomology/entfacts/ef106.asp](http://www2.ca.uky.edu/entomology/entfacts/ef106.asp).

## Peppers for Processing

There are few processing peppers being produced in Kentucky. Peppers grown for processing are usually transplanted 16 inches apart in single rows 36 to 42 inches apart, which will require about 10,000 plants per acre. If pimento peppers are grown, space plants 18 to 22 inches apart in rows 40 to 42 inches apart (7,500 plants per acre). Although processing peppers have traditionally been grown on bare ground in Kentucky, several growers in recent years have doubled their profits by using higher plant populations, hybrid varieties, and black plastic mulch with drip irrigation.

Given the higher cost of the raised bed/plasticulture production system, most processors do not object to growers selling a portion of the crop as fresh greens.

In fact, it has become very common for growers to sell the first harvests as green peppers for the fresh market and sell later-maturing fruits as red peppers for processors. Yields can be dramatically increased with plastic and drip irrigation, especially in a dry season.

Techniques (including double-row spacings) for using this system with processing peppers are the same as those described for fresh market peppers (see page 66).

Growers contracting with a processor, however, are advised to check with the processing company regarding varieties. Due to the devastating nature of bacterial leaf spot on peppers in Kentucky it is advised that growers use a hybrid variety with leaf spot resistance. Some processors may supply open-pollinated, non-resistant varieties. The risks of using a non-resistant variety are too great for large wholesale growers in Kentucky and should be avoided.

## Fertilizing

For fresh-market bell pepper production on most medium-textured soils where plastic mulch and drip irrigation are being used, we recommend that all of the phosphorus, all the potassium, and 50 percent of the nitrogen requirement be applied prior to bedding and laying plastic.

Consider the previous crop when deciding how much nitrogen to apply; there will probably be some residual nitrogen following a crop that received heavy doses of nitrogen fertilizer during the previous season. The fertigated portion of the total nitrogen requirement can be divided into equal amounts (remaining nitrogen requirement divided by the number of weeks until final harvest) and injected weekly as in the “Fertigation” table (based on 14,500 plants per acre). Growers with very sandy soils should also consider applying 50 to 60 percent of their potassium requirement in weekly increments through the drip system in addition to nitrogen.

## FERTILIZER: Peppers

Soil Test Results (lb/A)		Fertilizer Needed (lb/A)
<b>Phosphorus</b>		<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>
Low	<31	81-100
Medium	31-60	61-80
High	61-80	1-60
Very High	>80	0
<b>Potassium</b>		<b>Potash (K<sub>2</sub>O)</b>
Low	<201	81-100
Medium	201-300	61-80
High	301-450	1-60
Very High	>450	0
<b>Nitrogen</b>		<b>N</b>

Peppers use approximately 100 to 150 lb of N/A. Apply 25 to 50 lb of N/A preplant. Rate to use will vary depending on previous crop and general fertility of the soil. Following sod, apply 50 lb of N prior to planting. After fruit begin setting, sidedress with another 30 to 50 lb of N/A. Two weeks later, make an additional application of 30 to 50 lb of N/A. For N fertigation, see comments in text and specific recommendations in the “Fertigation” table.

Growers should always have annual soil test results on which to base phosphorus and potassium applications. Potassium and especially phosphorus are likely to accumulate in most Kentucky soils following several years of heavy applications for vegetable crops or tobacco. A pH range of 6.5 to 7.0 is best for peppers, and liming may be required if soil pH falls below 6.0. For bare ground plantings apply 50 pounds of nitrogen per acre preplant. Apply one-half at plowing and one-half just prior to transplanting, and disk into the soil.

For processing bell pepper production where plastic mulch is not used, sidedressing or banding additional nitrogen to either side of the plant when the first fruit begin setting is essential for good yields. Apply 30 pounds of nitrogen per acre at the first sidedressing. A second sidedressing of 30 pounds of nitrogen two weeks later should also be applied.

## Harvesting

Mature green peppers ready for harvest will be firm and will have attained their maximum size. Fresh market green pep-

## FERTIGATION: Bell Peppers<sup>1</sup>

<b>Moderate Rate</b>	Total amount/season:	125 lb/A (moderate rate) 150 lb/A (high rate)
Actual N/week: 6 lb 4 oz/A	Preplant amount:	50 lb/A
Calcium 40 lb/A	Fertigated amount:	75 lb/A (moderate rate) 100 lb/A (high rate)
Nitrate 3 lb/1,000 plants	Growing season:	12 weeks
<b>High Rate</b>	Fertigation should begin about 2 weeks after transplanting.	
Actual N/week: 8 lb 5 oz/A	The dose for 1,000 plants is based on a plant population of 14,500 plants/A (i.e., double rows on 6 foot centers with plants 12 inches apart in the rows).	
Calcium 54 lb/A	For seasons extending beyond 12 weeks, a maintenance dose of 1 to 1.5 lb N/week is adequate.	
Nitrate 4 lb/1,000 plants		

<sup>1</sup> All recommendations assume starter fertilizer was used.

pers are normally harvested when firm and before they lose their dark green color. Harvest peppers for processing when red ripe.

Peppers should be handled carefully when picking and dumping to avoid bruising and punctures. Hard and rough picking containers may cause skin breakage or punctures and should be avoided. Do not use plastic bags, because peppers will heat up and quickly decay.

Pack only clean, undamaged, insect- and disease-free peppers. Peppers are graded into "U.S. Fancy" (not less than 3 inches in diameter and not less than 3½ inches long) and U.S. No. 1 (not less than 2½ inches in diameter or length).

All grades must have similar varietal characteristics, be firm, fairly well shaped, and free from damage caused by freezing injury, hail, scars, sunburn, disease, insects, or mechanical or other means. Free copies of USDA standards for grades of peppers and other fruit and vegetables are available on the Web at [ams.usda.gov/AMSV1.0/freshmarketvegetablestandards](http://ams.usda.gov/AMSV1.0/freshmarketvegetablestandards).

## Storage

Cool peppers to 45° to 50°F by putting them in the cooler as soon as possible after harvest; cool rooms with forced-air equipment will greatly speed the process and extend shelf life. Once fruit are precooled, hold them at 45° to 50°F with a relative humidity of 90 to 95 percent. Peppers suffer chilling injury when stored at temperatures below 40°F. Symptoms of chilling injury are browning at the calyx end and surface pitting. Peppers are usually packed in 1½ bushel waxed corrugated cartons (30 to 33 pounds) or in bushel crates (28 to 30 pounds) according to the preference of your particular market.

## Common Diseases/Management

### General Practices

Diseases are a major factor in pepper production in Kentucky. Select varieties with resistance to bacterial leaf spot. The most important diseases targeted with a spray program are bacterial leaf spot,

### MARKETING CONTAINERS: Peppers

Pepper Type	Container Weight	Volume	No. Fruit/ Container
Long hot	30 lb	1 bu	variable
Jumbo bells	30 lb	1½ bu	40-45
Extra Large bells	30 lb	1½ bu	55-65
Large bells	30 lb	1½ bu	65-75
Medium bells	30 lb	1½ bu	75-90
Cubanelle	30-32 lb	1½ bu	variable
Specialty hot peppers <sup>1</sup>	16 lb	½ bu	variable

<sup>1</sup> Including most of the small-fruited hot and specialty peppers in the "Varieties" table.

### SAMPLE FUNGICIDE PROGRAM: Field-grown Pepper

Refer to "Disease Control" table in this chapter for product rates; read product labels carefully before application.

**At-transplant:** Apply Actigard + mancozeb.

**Post-transplant to harvest:** Apply copper + mancozeb on a 7-day schedule during dry to normal conditions, and on a 3- to 5-day schedule during wetter-than-normal conditions or when disease pressure is severe.

**Four weeks post-transplant:** Apply Actigard + mancozeb.

**Mid-late bloom to harvest:** Alternate weekly (or twice weekly) sprays of copper + mancozeb with Quadris, Cabrio, or Tanos beginning prior to fruit set to suppress Anthracnose (apply on a 7- to 14-day schedule; limit of 4 applications of any combination of Quadris, Cabrio, or Tanos). Apply Ridomil Gold EC and Ridomil Gold/Copper or Forum SC if Phytophthora blight is a concern.

anthracnose, and (occasionally) Phytophthora blight. A sample fungicide spray program for peppers is included below.

**Alternaria fruit rot, Anthracnose, leaf spots/blights.** Use disease-free seed and/or transplants. Rotate for three to four years to crops not related to peppers and control solanaceous (nightshade family)

### PESTICIDE SAFETY: Peppers

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>INSECTICIDES</b>			
Acramite 50 WS	C	12	3
Actara 25 WDG	C	12	0
Admire 2 F	C	12	0/21 <sup>3</sup>
Assail 30 SG	C	12	7
Avaunt 30 DG	C	12	3
Belay 2.13 SC	C	12	21
Beleaf 50 SG	C	12	0
Belt SC	C	12	1
Bt products	C	4/12	0
Closer 2 SC	C	12	1
Confirm 2 F	C	4	7
Coragen 1.67 SC	-	4	1
Courier 40 Sc	W	12	1
Dimethoate 4 E	W	48	0
Exirel 0.83 SE	C	12	1
Fulfill 50 DF	C	12	0
Intrepid 2 F	C	4	1
Kanemite 15 SC	C	12	1
Knack 0.86 EC	C	12	4
Malathion 8	C	12	3
Movento 2	C	24	1
Oberon 2 SC	C	12	7
Orthene 75 S	C	24	7
Platinum 2 SC	C	12	30
Portal 0.4 EC	W	12	1
Radiant SC	C	4	1
Requiem 25 EC	C	4	0
Rimon 0.83 EC	W	12	1
Scorpion 3.5 SL	C	12	1/21 <sup>3</sup>
Sevin XLR	W	12	3
Trigard 75 WP	C	12	0
Venom 70 SG	C	12	1/21 <sup>3</sup>
Zeal 72 WP	C	12	7
<b>Restricted Use</b>			
AgriMek 0.15 EC	W	12	7
Asana XL	W	12	7
Battalion 1.5 EC	DP	12	1
Baythroid XL	W	12	7
Brigade 2 EC	W	12	7
Danitol 2.4 EC	W	24	3
Dimilin 25 W	C	12	7
Hero 1.24 EC	C	12	7
Lannate 90 SP	DP	48	3
Mustang Max	W	12	1

weeds during the rotation. Plow down crop residues immediately after harvest. Apply fungicides weekly. Maneb is no longer labeled or available for use on peppers.

**Bacterial soft rot of fruit.** Control insect pests (especially European corn borer) and spotting diseases to minimize wounding.

### PESTICIDE SAFETY: Peppers

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
Permethrin 3.2 EC	C	12	3
Proaxis 0.5 EC	C	24	5
Proclaim 5 WDG	C	48	7
Renounce 20 WP	C	12	0
Vydate L	DP	48	7
Warrior II	W	24	5
<b>FUNGICIDES</b>			
Actigard 50WG (chile only)	C	12	14
Aftershock	C	12	3
Ag Streptomycin, Agri-Mycin 17, Harbour	C	12	n/a
Ariston	C	12	3
Blocker 10G/4F	C	12	0
Bravo Weather Stik	C	12	3
Cabrio EG	C	12	0
Endura	W	12	0
Evito	C	12	3
Flint	C	12	3
Fixed coppers <sup>2</sup>	D	24/48 <sup>4</sup>	0
Fontelis	C	12	0
Forum SC	C	12	0
Inspire Super	C	12	0
Koverall	C	24	7
ManKocide	D	48	7
Manzate Flowable	C	24	7
Manzate Pro-Stick	C	24	7
Meta Star 2EC AG	W	48	7
Presidio	C	12	2
Priaxor	C	12	7
Quadris	C	4	0
Quadris Top	C	12	0
Ranman	C	12	0
Reason 500 SC	C	12	14
Revus	C	4	1
Ridomil Gold SL	W	48	7
Ridomil Gold Copper	D	48	7
Sulfur <sup>2</sup>	C	24	0
Tanos	C	12	3
Ultra Flourish	W	12	7
Vivando	C	12	0
Zampro	C	12	4

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

<sup>3</sup> Depending on rate or type of application.

<sup>4</sup> Formulations vary, so check label carefully.

Where acceptable, pack fruit without washing. If wash water is used in packing operations, it should contain 25 ppm of available chlorine. See "Post-Harvest Decays" on page 19. Fixed coppers applied for management of bacterial leaf spot during the harvest season can reduce the incidence bacterial soft rot.

**Bacterial leaf spot (BLS).** The bacterium causing this disease is seed-borne, transplant-borne, and overwinters on-site and nearby in weeds and crop residues. Control must focus on preventing introduction and slowing spread of the bacterium rather than eradication after it occurs. Fortunately, resistant varieties are available. General guidelines for control of BLS include:

- **Use resistant varieties.** Resistant varieties should be used where possible for both fresh market and processing. There are multiple races of the BLS pathogen. See the "Varieties" table for a list of suggested resistant cultivars.
- **Practice crop rotation.** Do not grow peppers after peppers or related crops (tobacco, tomatoes, eggplants, potatoes) for two to three years. Also exclude small grains from the rotation in the year before peppers are to be planted. Control broadleaf weeds during the rotation and around field borders.
- **Disk all crop residues into the soil promptly after harvest** to encourage more rapid decline of the bacterium. If cover crops are used, plow them under very early in the spring to minimize carryover.
- **Do not work wet plants.** Spraying wet plants with high pressure equipment may encourage disease spread by blowing bacteria around the field.
- **Use disease-free seed and transplants.** Select disease-free seed and treat with household bleach (see Appendix H). If transplants are grown in outdoor seedbeds, make frequent applications (every 3 to 5 days) of agricultural streptomycin (Agri-Mycin 17%) at 200 ppm or 2 teaspoons/gallon of water beginning at the first true leaf stage. Streptomycin is not labeled for this use in the greenhouse, but can be applied on plants that have been moved outside the greenhouse for hardening prior to transplanting. This product is not labeled for field use. Fixed copper is labeled for both outdoor and greenhouse transplant production. Do not expect the high degree of control with fixed coppers as is possible with streptomycin. Many bacterial strains are controlled by both materials; however, some strains are

resistant to streptomycin, while others are resistant to copper. Some strains have tolerance to both streptomycin and copper. Consequently, multiple tools are needed in the control program. If you purchase transplants, make sure that they are certified "disease-free."

- **Maintain proper fertility.** The disease can be minimized by maintaining adequate fertility while being careful not to over-fertilize with N.
- **Spray on a schedule** (see sample program). Chemical applications made before symptoms are evident are the key to keeping bacterial populations low. Start sprays immediately after transplanting using fixed copper plus Manzate. Continue at seven-day intervals during wet weather to reduce buildup and spread of the bacterium in the field.

**Blossom end rot.** Maintain uniform soil moisture throughout the growing season and avoid damaging roots by cultivation, fertilization, or by diseases. In general, foliar applications of calcium do not alleviate blossom end rot; however, calcium levels in soil should be maintained.

**Phytophthora blight.** An integrated management approach is required. Good soil drainage is critical to control; avoid wet fields, wet sites in fields, and fog pockets. Plant into well-drained soils on properly formed, raised beds to minimize soil moisture and the pooling of water around plants. Avoid excessive irrigation, and if possible, do not use surface water in irrigation systems, as the pathogen can be spread easily. Remove infected plants and destroy them immediately (bury or burn them) and practice sanitation (avoid moving both equipment and yourself between infested fields and "clean" fields). *Phytophthora capsici*, the causal agent of *Phytophthora* blight, has many hosts. Rotations of three to four years away from cucurbits and solanaceous plants (peppers, tomatoes, eggplant, potatoes, tobacco) can be effective in reducing pathogen populations. Where *Phytophthora* blight is common, make a preplant incorporated application of mefenoxam and follow up with additional applications at 30 and 60 days after transplanting. Several fungicides are effective against foliar and fruit phases of *Phytophthora* blight. A few *Phytophthora*-resistant pepper varieties are now available, including 'Paladin,' 'Revolution,' 'Conquest,' and 'Aristotle,' but horticultural characteristics and possible susceptibility to bacterial spot must also be taken into account (see "Varieties" table). Please note that the level of resistance to *Phytophthora* in these varieties

varies; no variety is immune to *Phytophthora* blight. For example, 'Paladin' has a high level of resistance to the crown rot phase of *Phytophthora* blight but very little resistance against foliar and fruit blight caused by *Phytophthora*. 'Aristotle' has moderate resistance to *Phytophthora* crown rot and low resistance to foliar and fruit rots caused by this pathogen.

**Southern blight.** Avoid fields with a history of this disease and rotate problem fields with sod crops. Deep plow to bury sclerotia and crop debris. Bury cover crops early to ensure they are well rotted before transplanting. Remove and destroy infected plants promptly. PCNB (Blocker) can be drenched around plants at transplanting or applied in-furrow to suppress Southern blight; Cabrio, fluoxastrobin (Evito or Aftershock), and Priaxor can be applied to soil.

**Tomato spotted wilt virus (TSWV) and Impatiens necrotic spot virus (INSV).** Ensure that transplants are from fields or greenhouses certified to be free of TSWV and INSV. Local transplant producers should take steps to reduce spread of TSWV and INSV by following recommended thrips control measures and by not producing pepper transplants in houses where ornamentals are being produced or sold. Maintain a good thrips control program in the field. TSWV-resistant varieties are also available (see "Varieties" table).

**Virus complex.** Tobacco etch, Potato Virus Y, Tobacco Ring Spot Virus, Alfalfa Mosaic, Tobacco Mosaic, and Cucumber Mosaic are the viruses most common in Kentucky peppers. Grow virus-resistant varieties if they have horticulturally acceptable yields and fruit characteristics. In addition to the varieties listed in the "Varieties" table, 'Gator Belle,' 'Bell Boy,' 'Bell Captain,' and 'Super Sweet 860' are resistant to tobacco mosaic; the long green chile 'Tam Mild Chile-2' has resistance to tobacco mosaic, potato virus Y, and tobacco etch. Eliminate broadleaf weeds and other virus hosts within 150 feet of the field prior to transplanting. Locate fields between plantings of corn or other non-host field crops in which weeds are killed before peppers are transplanted. Do not grow peppers within 150 feet of tobacco. If tobacco and peppers must be planted in close proximity, locate the pepper planting upwind of the tobacco. Use virus-resistant tobacco varieties, and carefully control aphids in the tobacco crop. Control aphids in peppers, especially in transplant production and in later plantings. Reflective mulches may be of value in reducing virus incidence.

**INSECT CONTROL:** *Peppers*<sup>1,2,3</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>SOIL TREATMENT</b>			
<b>Aphids, Flea Beetles, Thrips:</b> Do not use a foliar spray of Actara, Assail, Belay, Provado, or Venom in combination with a soil application of Admire, Belay, Platinum, or Venom in the same season.			
Admire Pro	10 to 14 fl oz	14 fl oz	See label for application alternatives (sidedress, in-furrow, banded, or drip or trickle irrigation).
Belay 2.13 SC	9 to 12 fl oz	12 fl oz	At planting only. See label for application methods.
Platinum 2 SC	5 to 8 fl oz	11 fl oz	See label for application alternatives (sidedress, in-furrow, banded, or drip or trickle irrigation).
Venom 70 SG	5 to 6 oz	12 oz	-
<b>FOLIAR TREATMENT</b>			
<b>Aphids</b>			
Actara 25 WDG	2 to 3 oz	8 oz	Allow 5 days between applications. Not during bloom.
Admire Pro	1.3 to 2.2 fl oz	6.7 fl oz	Allow 5 days between application. Not during bloom.
Assail 30 SG	2 to 4 fl oz	16 oz	Limit 4 applications. Allow 7 days between applications.
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Beleaf 50 SG	2 to 2.8 oz	8.4 oz	Allow 7 days between applications.
Closer 2 SC	1.5 to 2 fl oz	17 fl oz	Allow 7 days between applications.
Dimethoate 4	0.5 to 0.67 pt	10.5 fl oz	Allow 7 days between applications.
Exirel 0.83 SE	13.5 to 20.5 fl oz	61.5 fl oz	Allow 7 days between applications. Use an adjuvant.
Fulfill 50 DF	2.75 oz	5.5 oz	Allow 7 days between applications.
Malathion 8	1.5 pt	2 applications	Allow 5 days between applications.
Movento 2 SC	4 to 5 fl oz	10 fl oz	Allow 7 days between applications.
Orthene 75 S	0.67 to 1.33 lb	2.67 lb	For bell types.
	0.67 lb	1.33 lb	For non-bell type peppers.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications. Not during bloom.
<b>Beet Armyworm:</b> First detected in Kentucky in 1993, this insect can cause serious pepper losses when present. A Southern insect that doesn't usually occur in Kentucky. Large larvae cannot be controlled effectively with insecticides. Monitor for this insect and treat when larvae are small.			
Avaunt 30 WDG	3.5 oz	14 oz	Allow 5 days between applications.
Belt 4 SC	1.5 fl oz	4.5 fl oz	Allow 3 days between applications.
Confirm 2 F	6 to 16 fl oz	64 fl oz	-
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Foliar and soil applications possible. See label for limitations.
Dimilin 25 W	4 to 8 oz	24 oz	Limit 5 applications.
Exirel 0.83 SE	7 to 13.5 fl oz	61.5 fl oz	Allow 7 days between applications.
Intrepid 2 F	4 to 16 fl oz	64 fl oz	-
Proclaim 5 WDG	2.4 to 4.8 oz	28.87 oz	Allow 7 days between applications.
Radiant SC	5 to 10 fl oz	34 fl oz	Allow 4 days between applications.
Requiem 25 EC	2 to 4 qt	-	-
Rimon 0.83 EC	9 to 12 fl oz	36 fl oz	Allow 7 days between applications.
XenTari	0.5 to 2 lb	-	-
<b>Cutworms:</b> Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites.			
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Belt 4 SC	1.5 fl oz	4.5 fl oz	Allow 3 days between applications.
Brigade 2 E	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Proaxis 0.5 EC	1.92 to 3.2 fl oz	46 fl oz	Allow 5 days between applications.
Requiem 25 EC	2 to 4 qt	-	-
Sevin XLR	2 qt	8 qt	Limit 7 applications. Allow 7 days between applications.
Warrior II	0.96 to 1.6 fl oz	23 fl oz	Allow 5 days between applications.
<b>Flea Beetles</b>			
Actara 25 WDG	2 to 3 oz	8 oz	Allow 5 days between applications. Not during bloom.
Asana XL	5.8 to 9.6 fl oz	67.2 fl oz	-
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Brigade 2 E	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	64 fl oz	Bell peppers only.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	46 fl oz	Allow 5 days between applications.
Sevin XLR	0.5 to 1 qt	8 qt	Limit 7 applications. Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	23 fl oz	Allow 5 days between applications.
<b>Thrips</b>			
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Baythroid XL	2.8 fl oz	16.8 fl oz	Allow 7 days between applications.
Brigade 2 E	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	46 fl oz	Allow 5 days between applications.
Radiant SC	6 to 10 fl oz	34 fl oz	Allow 4 days between applications.
Requiem 25 EC	2 to 4 qt	-	-
Rimon 0.83 EC	12 fl oz	36 fl oz	Allow 7 days between applications. For immatures only.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	23 fl oz	Allow 5 days between applications.

(continued on next page)

**INSECT CONTROL: Peppers<sup>1,2,3</sup> (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>European Corn Borer:</b> Key insect pest of peppers. Use pheromone traps to monitor for adult activity. Begin applications when trap catches exceed 10 moths per week. Advisories are also issued to county Extension offices when the damaging second generation borer larvae are likely to appear in Kentucky.			
Asana XL	5.8 to 9.6 fl oz	67.2 fl oz	-
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	16.8 fl oz	Allow 7 days between applications.
Belt 4 SC	1.5 fl oz	4.5 fl oz	Allow 3 days between applications.
Brigade 2 E	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Confirm 2 F	6 to 16 fl oz	64 fl oz	-
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Foliar and soil applications possible. See label for limitations.
Exirel 0.83 SE	13.5 to 20.5 fl oz	61.5 fl oz	Allow 7 days between applications. Use an adjuvant.
Intrepid 2 F	4 to 16 fl oz	64 fl oz	-
Orthene 75 S	1 to 1.33 lb	2.67 lb	Bell peppers only.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	8 fl oz	64 fl oz	Bell peppers only.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	46 fl oz	Allow 5 days between applications.
Radiant SC	5 to 10 fl oz	34 fl oz	Allow 4 days between applications.
Rimon 0.83 EC	9 to 12 fl oz	36 fl oz	Allow 7 days between applications.
Sevin XLR	1 to 2 qt	8 qt	Limit 7 applications. Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	23 fl oz	Allow 5 days between applications.
<b>Stink Bugs</b>			
Actara 25 WDG	3 to 4 oz	8 oz	Allow 5 days between applications. Not during bloom.
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	16.8 fl oz	Allow 7 days between applications
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Brigade 2 E	2.1 to 6.4 fl oz	12.8 fl oz	Allow 7 days between applications.
Danitol 2.4 EC	10.67 to 16 fl oz	42.67 fl oz	Allow 7 days between applications.
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	46 fl oz	Allow 5 days between applications.
Rimon 0.83 EC	12 fl oz	36 fl oz	Allow 7 days between applications. For immatures only.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	23 fl oz	Allow 5 days between applications.

<sup>1</sup> See also *Kentucky Pepper Integrated Crop Management Grower Guide (IPM-13)* for more information on scouting and insect pest management.

<sup>2</sup> To view color pictures of the pests, see: <http://www.uky.edu/Ag/IPM/picturesheets/pepperinsects.pdf>

<sup>3</sup> Generic products available (Appendix E).

**WEED CONTROL: Peppers**

Product Amt/A	Lb A.I./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal of water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
0.67-2.67 pt Command 3ME	0.25-1 clomazone	For pre-emergence control of annual grasses and broadleaves. Apply and incorporate 1 to 2 inches before transplanting. Use in combination with other herbicides like Treflan or Devrinol to broaden the weed control spectrum. Can be used on bell, hot, pimento, and sweet peppers but not on banana peppers. Be sure to set transplants with their roots below chemical barrier when transplanting.
2-4 lb Devrinol 50 DF	1-2 napropamide	For control of annual grasses and broadleaves. Apply before transplanting and water-in or incorporate to a depth of 1 to 2 inches. Can be applied on bare ground middles between beds of plastic 24 hours before rain or if watered-in or incorporated. To avoid injury, do not replant with crops not specified on the label until 12 months if using the 4-lb rate.
0.5-1.0 pt Dual Magnum	0.48 - 0.97 s-metolachlor	24(C) Special Local Need Label (transplanted) see label for use and restrictions. Grower assumes all risk of crop injury, yield reductions, and crop loss.
1-2 pt Goal 2XL	0.25-0.5 oxyfluorfen	For pre-emergence and post-emergence control of certain annual grasses and most broadleaves. For fallow bed preparation only. Best if used with glyphosate for control of winter annual broadleaf weeds. Min. 30 days between application and transplanting.
2.0-4.0 pt Gramoxone Inteon	0.69-1.38 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply pre-plant, pre-emergence, or before transplanting in min. 10 gal water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v.
0.5-2.5 pt Poast 1.5	0.09-0.49 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 20 days. Max. rate of 1.5 pt/application and 4.5 pt/season.
5-6 qt Prefar 4 E	5-6 bensulide	For control of grasses and broadleaf weeds. Apply preplant and incorporate to 1 to 2 inch depth. Apply pre-emergence only if it can be watered in within 36 hours. Max. rate of 6 qt/season.
1.5-2 pt Prowl H2O 3.8 E	0.7-1 pendimethalin	For pre-emergence control of broadleaves and grasses. Apply preplant and incorporate prior to transplanting pepper or as a post-directed application to established plants. PHI = 70 days.
16-22 fl oz Roundup WeatherMax 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 3 days before seeding and min. 30 days before planting any non-labeled crop.
0.5-1 oz Sanda 75 DF	0.023-0.047 halosulfuron	For control of annual broadleaf weeds and yellow nutsedge. Can be applied in row middles of direct-seeded or transplanted peppers. Avoid contact with the crop or with plastic if plastic mulch is used. Max. 2 applications/crop and 2 oz/A per season.
9-16 fl oz Select Max	0.07-0.12 clethodim	For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. Max. 16 fl oz/application. Min. 14 days between applications. PHI = 20 days.
1.25-2 pt Treflan HFP 4 E	0.62-1 trifluralin	For pre-emergence control of annual grasses and broadleaf weeds. For transplanted pepper use only. Apply as pre-plant soil incorporated before transplanting.

**DISEASE CONTROL: Peppers**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Alternaria Fruit Rot, Anthracnose, Leaf Blights</b>					
Aftershock	11	3	2.0 to 5.7 oz	4 apps	Early blight. Apply before disease onset. Alternate with a different FRAC code.
Ariston	M/27	3	2.0 - 2.4 pt	17.5 pt	Anthracnose only. Apply before disease onset, continue every 7 to 14 days.
Cabrio	11	0	8 to 12 oz	4 apps	Apply before disease onset, continue every 7 to 14 days.
Chlorothalonil <sup>4</sup>					Apply every 7 to 10 days when conditions favor disease.
Bravo Ultrex	M	3	1.4 lb	10.9 lb	
Bravo WeatherStik	M	3	1.5 pt	12 pt	
Endura	7	0	2.5 to 3.5 oz	6 apps	Alternaria only. Apply before disease onset, continue every 7 to 14 days.
Fixed coppers					Apply before disease onset, continue every 7 to 10 days, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1 to 2.5 pt	-	-
Badge X2	M	0	0.75 to 2.25 lb	-	OMRI-listed.
Basic Copper 53	M	0	1.5 lb	-	OMRI-listed.
C-O-C-S WDG	M	0	2 to 4 lb	-	-
Cueva	M	0	0.5 to 2 gal	-	OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 3 lb	-	-
Kentan DF	M	0	2 lb	-	-
Kocide 2000	M	0	1.5 to 2.25 lb	-	-
Kocide 3000	M	0	0.75 to 1.25 lb	-	-
Kocide DF	M	0	2 to 3 lb	-	-
Mastercop	M	0	0.5 to 3 pt	-	-
Nordox 75 WG	M	0	1.25 to 2.5 lb	-	OMRI-listed.
Flint	11	3	2 to 4 oz	4 apps	Apply before disease onset, continue every 7 to 14 days.
Fontelis	7	0	14 to 30 fl oz	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Inspire Super	3/9	0	16 to 20 fl oz	80 fl oz	Botrytis leaf blight, purple blotch. Apply every 7 to 10 days.
Koverall	M	7	3 lb	19.2 lb	Apply before disease appears and continue every 7 to 10 days as needed.
ManKocide <sup>3</sup>	M	7	2 to 3 lb	see footnote	
Manzate Flowable	M	7	2.4 to 4.8 pt	14.4 qt	
Manzate Pro-Stick	M	7	1.6 to 3.2 lb	19.2 lb	Begin treatment prior to symptom development and continue every 7-to 10 days as needed.
Priaxor	7/11	7	4 to 8 fl oz	24 fl oz	Apply prior to development of disease, continue every 7 to 14 days.
Azoxystrobin <sup>4</sup>					Anthracnose only. Apply before disease onset, continue every 7 to 14 days.
Azoxy 25C	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
AzoxyStar	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Quadris Top	11/3	0	8 to 14 fl oz	55.3 fl oz	Apply before disease onset, continue every 7 to 10 day schedule.
Tanos	11/27	3	8 to 10 oz		Tanos must be tank-mixed with a fungicide from FRAC Group M appropriate for the target disease. Apply before disease onset, continue every 5 to 7 days. Limit 72 oz/A per season.
<b>Bacterial Leaf Spot</b>					
Actigard	21	14	0.33 to 0.75 oz	8 apps	Chile peppers only. Apply 1 week after transplanting or emergence; begin with lowest rate and increase as plants grow; use 30 to 50 gal/A water early, increasing to 100 gal/A by the final application. Apply every 14 days. May be applied through drip irrigation.
Ag Streptomycin, Agri-Mycin 17, Harbour	25	n/a	16 oz/100 gal	n/a	Pre-transplant treatment. Apply when seedlings are in 2-leaf stage and continue every 4 to 5 days until transplanting. Alternate with fixed copper. Not for field use.
Fixed coppers					Apply before disease onset, continue every 5 to 10 days, depending upon product and conditions. Performance will be enhanced by tank-mixing with Manzate or Koverall. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1 to 2.5 pt	-	-
Badge X2	M	0	0.75 to 2.25 lb	-	OMRI-listed.
Basic Copper 53	M	0	1.5 lb	-	OMRI-listed.
Champ DP	M	0	1.33 to 2 lb	-	-
Champ Formula 2 FL	M	0	1.33 to 2 pt	-	-
Champ WG	M	0	2 to 3 lb	-	OMRI-listed.
COC DF	M	0	3 to 4 lb	-	-
COC WP	M	0	3 to 4 lb	-	OMRI-listed.
Copper-Count-N	M	0	3 to 6 pt	-	-
Cueva	M	0	0.5 to 2 gal	-	OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 3 lb	-	-
Kentan DF	M	0	2 lb	-	-
Kocide 2000	M	0	1.5 to 2.25 lb	-	-
Kocide 3000	M	0	0.75 to 1.25 lb	-	-
Kocide DF	M	0	2 to 3 lb	-	-
Mastercop	M	0	0.5 to 3 pt	-	-
Nordox 75 WG	M	0	1.25 to 2.5 lb	-	OMRI-listed.
Nu-Cop 50 WP	M	0	2 to 3 lb	-	OMRI-listed.
Nu-Cop 3 L	M	0	1.33 to 4 pt	-	-
Nu-Cop 50 DF	M	0	2 to 3 lb	-	OMRI-listed.
Nu-Cop HB	M	0	1 to 1.5 lb	-	-

(continued on next page)

**DISEASE CONTROL: Peppers (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Phytophthora Blight</b>					
Badge X2	M	0	0.75 to 1.25 lb	42 lb	OMRI-listed.
Forum SC	40	0	6 fl oz	5 apps	Must be tank-mixed with another <i>Phytophthora</i> fungicide. Apply before disease onset, continue every 5 to 10 days.
Presidio	43	2	3 to 4 fl oz	12 fl oz	Apply every 7 to 14 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Ranman	21	0	2.75 fl oz	16.5 fl oz	Apply every 7 to 10 days when conditions favor disease. Tank-mix with an organosilicone or non-ionic surfactant.
Reason 500 SC	11	14	8.2 fl oz	24.6 fl oz	Foliar and fruit phases of disease only. Apply before disease onset, continue every 5 to 10 days.
Revus	40	1	8 fl oz	32 fl oz	Apply every 7 to 14 days. Use a spreader/penetrant surfactant. Must be tank-mixed with a fungicide NOT in FRAC Group 40.
MetaStar 2EC AG	4	7	4 to 8 pt	12 pt	Ridomil Gold, Ultra Flourish, and MetaStar can be applied preplant, at planting, and post-planting—refer to label for instructions. Best control of disease is achieved with a pre- or at-plant application, with supplemental applications if needed. Will not control foliar or fruit rot phases of disease.
Ridomil Gold SL	4	7	1 pt	3 pt	
Ultra Flourish	4	7	2 pt	6 pt	
Ridomil Gold Copper	4/M	7	2.5	4 apps	Apply 30 days after soil application of Ridomil Gold or similar product and continue every 10 to 14 days. Observe seasonal limits for mefenoxam.
Tanos	11/27	3	8 to 10 oz	72 oz	Foliar and fruit phase only. Tanos must be tank-mixed with a fungicide from FRAC Group M appropriate for the target disease. Apply before disease onset, continue every 5 to 7 days.
Zampro	40/45	4	14 fl oz	3 apps	Apply at planting as a drench or by drip irrigation; make supplemental applications every 5 to 7 days.
<b>Southern Blight</b>					
Aftershock	11	3	2 to 5.7 fl oz	22.8 fl oz	Apply before onset of disease and continue applications every 7 to 10 days as needed.
Blocker Flowable	14	0	4.5 pt/100 gal	1 app	Apply as a drench at planting. Actual rate is dependent on row spacing; see label for application instructions.
Cabrio	11	0	12 to 16 oz	96 oz	Apply as a stem-directed spray; complete coverage of the lower stem and soil surface is required for suppression.
Evito 480 SC	11	3	3.8 to 5.7 fl oz	4 apps	Apply before onset of disease and continue applications every 7 to 10 days as needed.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Observe seasonal limits for mancozeb.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

## Potatoes

Nightshade family (Solanaceae): *Solanum tuberosum*

Potatoes are grown in Kentucky as an early crop primarily for fresh market sales. Opportunity exists for the production of small red “new potatoes,” russets, heirlooms, and other specialty or “gourmet” types for local markets, sales to restaurants, or sales to local/area wholesalers. Sales of very small “baby” or “mini” potatoes are also possible and command premium prices in some markets.

### Planting and Culture

Loam soils are most desirable for good potato yields, though potatoes can be grown on a wide range of soil types. Select a well-drained soil. Sod ground should be treated with a soil insecticide prior to planting to control grubs and wireworms.

Optimum planting times are from March 15 to April 10 for early potatoes and from June 15 to July 15 for a late crop (see Appendix J).

Planting should be made in rows 30 to 36 inches apart with a seed piece dropped each 10 to 12 inches in the furrow. Seed planted in mid-March should be planted

### VARIETIES: Potatoes

Maturity	Variety	Comments
Early	Dark Red Norland	Red skinned, shallow eyes—very suitable for table and “new” potatoes.
	Red Gold	Light red skin, yellow flesh, good yields of high quality tubers, not suitable for long term storage.
Early-mid-season	Superior	White skinned, resistance to scab, tubers are oval to oblong, suitable for table use and chipping.
	Yukon Gold	Yellow flesh, round, smaller size, nice appearance and flavor, performance variable across state.
	Red Pontiac	Red skinned, readily available, easy to grow.
Midseason	Norchip	White skinned, tubers are round to oblong in shape with shallow eyes—very suitable for chipping. Moderate resistance to scab. Variety has a heavy tuber set and seed should be spaced 12 inches apart in row.
	Kennebec	White skinned, a good general purpose potato, best full season yields in KY.
	Norkota	White russet type, good baking-type potato.
	Red Lasoda	Red skinned, heat tolerant, readily available, not as attractive as some other red types.

### FINGERLING TYPES

Early-mid-season	Russian Banana	White skin, light yellow flesh, long, thin shape, unique taste.
	Swedish Peanut	White skin, golden yellow flesh, shorter, teardrop shapes with shallow eyes, unique taste.

2 to 3 inches deep. The late crop should be planted 4 to 5 inches deep. Seed pieces should be 1 ½ to 2 ounces in size. Only certified disease-free seed stock should be purchased. Freshly cut seed should be planted as soon as possible after cutting. Seed may be pre-cut several days in advance of planting if proper storage conditions are provided so the seed pieces can “heal over.” A storage temperature

of 60°F for 10 days to two weeks before planting will help initiate sprout activity and encourage more rapid emergence.

Fifteen to 18 (100-pound) bags of seed potatoes are usually needed to plant an acre. Potatoes should not follow potatoes or other solanaceous crops (tomatoes, tobacco, peppers) on the same ground year after year. Follow a three- or four-year rotation program.

**FERTILIZER: Potatoes**

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
<b>Phosphorus</b>	<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>	
Low	<31	181-240
Medium	31-60	91-180
High	61-80	61-90
Very High	>80	60
<b>Potassium</b>	<b>Potash (K<sub>2</sub>O)</b>	
Low	<201	251-300
Medium	201-300	101-250
High	301-450	51-100
Very High	>450	50
<b>Nitrogen</b>	<b>N</b>	
Total of 150 lb nitrogen/A is recommended. Apply 75 to 100 lb of nitrogen/A at time of planting and apply a sidedressing of 50 to 75 lb N/A when plants are 4 to 8 inches tall or at lay-by.		

When planting, there will be a small ridge of soil developed over each row. Dragging across the ridges just before the sprouts break through helps to eliminate weeds and allows the potato sprouts to more easily break through compacted soil.

**Production with Plasticulture**

Potatoes can also be grown on raised beds with black plastic and drip irrigation. Growers have obtained higher and earlier yields of better quality potatoes with plasticulture; potatoes grown on plastic mulch are also easier to dig by hand at harvest. If mechanical harvesting or growing large acreages, plastic mulch should be avoided.

All fertilizer can be applied prior to planting or half the nitrogen requirement can be applied before planting with the remainder divided into equal doses fertigated weekly. Planting holes can be made in plastic mulch using a waterwheel setter and seed pieces dropped in the holes and covered with soil by hand. Kentucky growers have used two rows per bed with 18 inches between rows, 9 to 12 inches between plants within the rows, and 5 feet between bed centers. Pennsylvania growers have used double rows 13 inches apart with 8 inches between plants in the rows. Closer spacings promote higher percentages of smaller tubers and should be used to produce potatoes to be sold as "new," "gourmet," "baby," or "mini" (see also "Harvesting and Handling" below). Vine killing can be more problematic for some specialty potato varieties. In addition to chemical dessicants, a plastic mulch lifter can be used to undercut the plants to assist in vine killing prior to digging.

**Fertilizing**

Fertilize and lime based on soil test results; a soil pH of 6.0 to 6.5 is considered most desirable for maximum availability of nutrients for potatoes. However, potato scab will usually be more serious at high pH levels. There will normally be less scab when the pH is between 5.0 to 5.2. Potatoes

**PESTICIDE SAFETY: Potatoes**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days) <sup>2</sup>
<b>INSECTICIDES</b>			
Acramite 4 SC	C	12	14
Actara 25 WDG	C	12	14
Admire Pro	C	12	AP/7 <sup>5</sup>
Assail 30 SG	C	12	7
Avaunt 30 WDG	C	12	7
Belay 2.13SC	C	12	14
Beleaf 50 SG	C	12	7
Coragen 1.67 SC	-	4	14
Dimethoate 4 E	W	48	0 <sup>4</sup>
Fulfill 50 WDG	C	12	14
Imidan 70 WP	W	24	7
Knack 0.83 EC	C	12	3
Malathion 8	C	12	0
Miteus 0.42 EC	W	12	7
Movento 2	C	24	7
Oberon 2 SC	C	12	7
Platinum 2 SC	C	12	AP
Radiant SC	C	4	7
Requiem 25 EC	C	4	0
Rimon 0.83 EC	W	12	14
Scorpion 3.5 SL	C	12	AP/7 <sup>5</sup>
Sevin XLR	W	12	7
Sivanto 1.67 SL	C	12	7
Transform 50 WG	D	24	7
Venom 70 SG	C	12	7 <sup>5</sup>
<b>Restricted Use</b>			
AgriMek 0.15 EC	W	12	14
Asana XL	W	12	7
Battalion 1.5 EC	DP	12	3
Baythroid XL	W	12	0
Brigade 2 EC	W	12	21
Hero 1.24 EC	C	12	21
Lannate 90 SP	DP	48	6
Mustang Max	W	12	1
PennCap-M	W	96	5
Permethrin 3.2 EC	C	12	14
Renounce 20 WP	C	12	0
Thimet 20 G	DP	48	90
Vydate L	DP	48	7
Warrior II	W	24	7
<b>FUNGICIDES</b>			
Aftershock	C	12	7
Ag Streptomycin, Agri-Mycin 17, Harbour	C	12	n/a
Ariston	C	12	14
Bloker Flowable/4F	C	12	0
Bravo ZN	W	48	7

grown for chipping should be grown at the higher pH and those for fresh market at the lower pH if scab is a problem.

It is suggested that one-half the fertilizer used at planting be broadcast prior to planting and disked in. Band the remaining fertilizer 2 to 3 inches to the side and slightly below the seed piece. Fertilizer should not come in contact with the seed piece. Sidedress with 50 to 75 pounds of actual nitrogen (N) per acre when plants are 4 to 8 inches tall or at lay-by.

**Harvesting and Handling**

When to dig potatoes will depend on the price and method of selling. For local market, it may be desirable to dig before

**PESTICIDE SAFETY: Potatoes**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days) <sup>2</sup>
Cabrio Plus	C	24	14
Chlorothalonil <sup>3</sup>	D	12	7
Curzate 60 DF	W	12	14
Endura	W	12	30
Evito 480 SC	C	12	7
Fixed coppers <sup>3</sup>	D	12/24 <sup>4</sup>	0
Forum SC	C	12	4
Gavel 75 DF	C	48	14
Gem	C	12	7
Headline	W	12	3
Iprodione 4L AG	C	12	14
Luna Tranquility	C	12	7
Mancozeb <sup>3</sup>	C	24	14
Maxim Potato Seed Protectant	C	12	0
Meteor	C	12	14
Moncut 70 DF	C	12	0
Nevado 4F	C	12	14
Omega 500F	W	48	14
Polyram	C	24	14
Presidio	C	12	7
Previcur Flex	C	12	14
Priaxor	C	12	7
Quadris	C	4	14
Quadris Opti	W	12	14
Quadris Top	C	12	14
Quash	C	12	1
Ranman	C	12	7
Reason 500 SC	C	12	14
Revus	C	4	14
Revus Top	C	12	14
Ridomil Gold Bravo SC	W	48	14
Ridomil Gold Copper	D	48	14
Ridomil Gold SL	C	48	0
Ridomil Gold MZ	C	48	14
Rovral 4 Flowable	C	12	14
Scala	C	12	7
Sulfur <sup>3</sup>	C	24	0
Tanos	C	12	14
Thiophanate-methyl <sup>3</sup>	C	12	21
Ultra Flourish	W	48	0
Vertisan	W	12	7
Zampro	C	12	4
Zing!	C	12	7

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> AP: At planting

<sup>3</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

<sup>4</sup> Safety information varies by product; read the label carefully.

<sup>5</sup> PHI dependent on application method.

vines die back. Vines of potatoes grown for storage should be dead before digging. Potatoes dug when immature are very susceptible to skinning and bruising. Using chemical desiccants to artificially kill the plant tops will aid in earlier harvest and promote a firmer skin set. Growers often mow plants prior to harvest. Harvesters or diggers should have digger chain speed adjusted to minimize injury to tubers. Protect freshly dug potatoes from hot sun and drying winds. Smaller-sized "new," or "gourmet," potatoes are often dug by hand.

If tablestock potatoes are to be stored and kept for long periods, the storage facil-

ity should be clean and sanitized. Potatoes should be held at 55°F for two weeks at a relative humidity of 90 percent, and then the temperature should be lowered to 40°F with a relative humidity of 85 to 90 percent.

Washing potatoes for fresh market is desirable. Chlorine at the rate of 150 to 200 parts per million should be added to the water to help destroy surface disease organisms. Potato tubers should dry before bagging, especially into plastic, to reduce chances of bacterial soft rot. Do not wash potatoes going into storage.

Sprouting in storage can be reduced by spraying potato plants while still in the field with maleic hydrazide. Apply to the plants when tubers are 1 ½ to 2 inches in diameter. Read the product label for directions and precautions.

Potatoes are marketed in a variety of containers with several grade specifications. Russet potatoes are usually packed in consumer packs, count cartons, or large institutional packs. The most valuable potatoes are generally 8- to 14-ounce tubers packed in 50-pound cardboard boxes, or "count cartons." Each carton has a number that tells how many tubers are in a box. These are sold to retail stores and restaurants and are typically used for baking. Red and white potatoes are sold in a wider range of sizes per container ("non-size" Grade A) including 5-, 8-, 10-, and 50-pound plastic, poly mesh, paper, and burlap bags. Prices for 50-pound cartons of graded U.S. No. 1 potatoes can triple those for 50-pound bags of U.S. No. 1 non-size potatoes.

New potatoes are usually B size (1 ½ to 2 ¼ inches in diameter) tubers, while "gourmet," "baby," or "creamer" potatoes may be even smaller (1 to 1 ½ inches in diameter). Fingerling potatoes are sorted by length and range from 2 to 3 ½ inches long. Specialty potatoes are often sold for premium prices and are packed in small mesh bags, vented poly bags, baskets, cartons, tray packs, or clamshells.

### Common Diseases/Management

**Black leg, seed-piece rots, and tuber-borne diseases.** Planting quality seed pieces prevents losses to certain potato diseases. Do not save seed; local diseases build up quickly. Keep in mind that certified seed may still carry pathogens at low levels.

Seed potatoes should be allowed time to become physiologically active by warming at 65° to 70°F for two to three weeks prior to planting. Buy seed tubers that have been treated prior to storage with thiabendazole (Mertect 340F) to reduce

*Fusarium*. Plant whole seed tubers, if possible; seed-piece decay can be reduced greatly by this practice. For best results with cut seed-pieces, treat with fungicide immediately, allow time for the fungicide to dry, and plant within six hours after cutting. If cut seed must be held over, let it dry in open slatted crates for two days before bagging. Avoid bruising of seed during handling. Dust seed pieces with mancozeb or Maxim. Soaking seed pieces in a solution of streptomycin sulfate (Agri-Mycin 17) solution at 0.5 pounds per 100 gallons of water for 30 minutes (prior to applying the seed treatment dusts) will assist in controlling black leg.

**Early blight.** Early blight, caused by *Alternaria solani*, is a major cause of early defoliation of potatoes in Kentucky and its control requires a good preventive fungicide spray program. Two year rotations away from potatoes, tomatoes, eggplant, and tobacco are helpful. Minimize stress on plants by avoiding poorly drained sites and irrigating when necessary. Maintain adequate soil fertility, particularly N and K.

**Late blight.** In general, temperatures in the Commonwealth are too high during the normal growing season to support late blight even when leaf wetness is ideal. To minimize problems with late blight, plant certified seed, destroy all cull piles, and do not plant in fields with volunteer potatoes. Eliminate volunteer potatoes and volunteer tomatoes on the farm. Do not harvest until the vines are completely dead. If late blight appears near harvest, quickly kill vines using a labeled vine-killer. When applied as part of a regular program, many of the fungicides for early blight should provide adequate control of late blight. Under severe conditions in Kentucky, shorten spray intervals and increase gallons per acre to improve coverage; late blight-specific fungicides may be needed. Fixed coppers are more effective on late blight than on early blight and are an excellent option for early in the season.

**Nematodes.** Avoid problem fields if at all possible until they can be properly rotated to non-host crops. If problem sites must be used, fumigate prior to planting (see "Soil Fumigants for Control of Nematodes and Soilborne Diseases" on page 16). With low populations, adequate control can be obtained with Vydate L at 1 to 2 gallons per 20 gallons of water per acre applied in seeding furrows at 1 to 2 ounces per 100 feet of treated row or with Mocap 15G at 20 pounds per acre applied in a 12-inch band on the side of the row at planting. Rotation for two to three years with grasses is also effective in reducing nematode numbers.

**Rhizoctonia stem canker and black scurf.** Avoid heavily infested fields, plant uncontaminated seed, and be sure that the previous crop residues are well rotted prior to planting. At-planting applications of azoxystrobin, and PCNB will also reduce losses to black scurf.

**Scab.** Scab is less problematic in slightly acidic soil; maintain a soil pH of 5.0 to 5.2, especially if the field was planted to potatoes within the last three years. Rotate away from potatoes for three to four years in scab-prone fields. Scab is favored by additions of manure or organic matter immediately prior to planting. This makes scab a significant threat in organic production. Cover crops should be turned well in advance of planting to ensure decomposition. Maintain soil moisture at or near field capacity during tuber formation. Keeping the pH low to discourage scab development is more valuable than seed treatment. In cases where a higher pH is required, some improvement in scab control can be achieved from using seed piece treatments (mancozeb) to suppress seed-borne inoculum.

**Verticillium wilt.** Use certified seed and seed treatments to minimize introduction of *Verticillium* into clean fields. Rotate to small grains or other grasses to slow population buildup. Control weeds during rotations. The presence of other root pests, such as nematodes, may favor *Verticillium* wilt. Nematodes must be controlled if this wilt pathogen is present. Preplant soil fumigation is also an option for heavily infested fields (see "Soil Fumigants for Control of Nematodes and Soilborne Diseases" on page 16).

**Viruses.** A high level of control is possible with use of high-quality, certified seed. The potential of potatoes serving as a source of viruses for tobacco is an important thing to consider if both are being planted on the same farm. The nearer the two crops are planted, the greater the risk of potato virus Y and tobacco etch. Keep potatoes 150 to 200 yards away from other solanaceous crops, and control insect vectors (aphids, leafhoppers). The level of common strains of PVY associated with Kentucky tobacco crops has also increased markedly. Therefore, when selecting certified seed, one should also consider the certification standards being used. Speak to local suppliers about this issue before they contract to buy seed potatoes. Consider more than the price of the seed—also consider the benefit to other crops when seed potatoes with lower virus incidence are used.

**INSECT CONTROL: Potatoes<sup>1</sup>**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>PREPLANT INCORPORATED</b>			
<b>Wireworms, Cutworms</b>			
Diazinon 50 W	4 to 8 lb	-	Incorporate immediately.
<b>AT PLANTING</b>			
<b>Wireworms, Flea Beetles, Colorado Potato Beetle, Aphids:</b> Do not use a foliar spray of Actara, Assail, Belay, Provado, or Venom following a soil application of Admire, Belay, Platinum, or Venom.			
Admire Pro	5.7 to 8.7 fl oz	8.7 fl oz	For Colorado potato beetle, aphids, and flea beetles.
Belay 2.13 SC	9 to 12 fl oz	12 fl oz	At planting or cultivation.
Brigade 2 EC	9.6 to 19.2 fl oz	32 fl oz	Limit 2 applications. Allow 7 days between applications.
Platinum 2 SC	5 to 8 fl oz	8 fl oz	For Colorado potato beetles and flea beetles.
Regent 4 SC	3.2 fl oz	3.2 fl oz	In-furrow use only as a 5 to 7 inch band for wireworm. Do not band on surface.
Thimet 20 G	11.3 oz/ 1,000 row-feet	-	-
Scorpion 35 SL	11.5 to 13.25 fl oz	13.25 fl oz	For Colorado potato beetle and flea beetles.
Venom 70 SG	6.5 to 7.5 oz	7.5 oz	For Colorado potato beetle and flea beetles.
<b>FOLIAR TREATMENTS</b>			
<b>Grasshoppers</b>			
Asana XL	5.8 to 9.6 fl oz	67.2 fl oz	-
Dimethoate 4 E	0.5 to 1 pt	2 pt	Allow 7 days between applications.
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 4 days between applications.
Warrior II	1.28 to 1.92 fl oz	7.68 fl oz	Allow 7 days between applications.
<b>European Corn Borer</b>			
Asana XL	5.8 to 9.6 fl oz	67.2 fl oz	-
Battalion 1.5 EC	1.5 to 2.4 fl oz	12 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	16.8 fl oz	Allow 5 days between applications.
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	-
Mustang Max	1.76 to 4 fl oz	24 fl oz	Allow 4 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	64 fl oz	-
Radiant SC	6 to 8 fl oz	32 fl oz	Allow 7 days between applications.
Rimon 0.83 EC	6 to 12 fl oz	24 fl oz	-
Warrior II	1.28 to 1.92 fl oz	7.68 fl oz	Allow 7 days between applications.
<b>Colorado Potato Beetle, Flea Beetle:</b> Colorado Potato Beetle is the key insect pest of potato. This pest has the ability to develop resistance to all major classes of insecticides. Do not tank mix insecticides with the same mode of action and frequently rotate among insecticides with different modes of action to discourage resistance. Treat when an average of more than 1 larva/adult is found per plant on plants less than 6 inches tall or when 2 or more larvae/adults are found on larger plants. [PB] IRAC Codes: Insecticides followed by the same number share the same mode of action.			
Actara 25 WDG (4A)	1.5 oz	3 oz	Allow 7 days between applications.
Admire Pro (4A)	1.3 fl oz	5.6 fl oz	Allow 7 days between treatments.
Agri-Mek 0.15 EC (6)	8 to 16 fl oz	32 fl oz	Make no more than two consecutive applications.
Assail 30 SG (4A)	1.5 to 4 oz	16 oz	Limit 4 applications. Allow 7 days between applications.
Avaunt 30 WDG (22)	3.5 to 6 oz	24 oz	Allow 5 days between applications.
Battalion 1.5 EC (3)	1.5 to 2.4 fl oz	12 fl oz	-
Baythroid XL (3)	1.6 to 2.8 fl oz	16.8 fl oz	Allow 5 days between applications.
Belay 2.13 SC (4A)	2 to 3 fl oz	12 fl oz	Allow 7 days between applications.
Coragen 1.67 SC (28)	3.5 to 5 fl oz	15.4 fl oz	-
Imidan 70 W (1B)	1.33 lb	-	Machine harvested potatoes only.
Radiant SC (5)	6 to 8 fl oz	32 fl oz	Allow 7 days between applications.
Rimon 0.83 EC (15)	9 to 12 fl oz	24 fl oz	-
Scorpion 35 SL	2 to 2.75 fl oz	8 fl oz	Allow 14 days between applications.
Sevin 80 S (1A)	1.25 to 2.5 lb	6 applications	Allow 7 days between applications.
Sivanto 1.67 SL	10.5 to 14 fl oz	28 fl oz	Allow 7 days between applications.
Venom 70 SG (4A)	1 to 1.5 oz	4.5 oz	Allow 14 days between applications.
<b>Leafhoppers</b>			
Actara 25 WDG	1.5 oz	3 oz	Allow 7 days between applications.
Admire Pro	1.3 fl oz	5.6 fl oz	Allow 7 days between treatments.
Asana XL	2.9 to 5.8 fl oz	67.2 fl oz	-
Assail 30 SG	1.5 to 4 oz	16 oz	Limit 4 applications. Allow 7 days between applications.
Battalion 1.5 EC	1.5 to 2.4 fl oz	12 fl oz	-
Baythroid XL	0.8 to 1.6 fl oz	16.8 fl oz	Allow 5 days between applications.
Belay 2.13 SC	2 to 3 fl oz	12 fl oz	Allow 7 days between applications.
Dimethoate 4 E	0.5 to 1 pt	2 pt	Allow 7 days between applications.
Mustang Max	1.76 to 4 fl oz	24 fl oz	Allow 4 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	96 fl oz	-
Scorpion 35 SL	2 to 2.75 fl oz	8 fl oz	Allow 14 days between applications.
Sevin XLR	0.5 to 1 qt	6 applications	Allow 7 days between applications.
Sivanto 1.67 SL	7 to 10.5 fl oz	28 fl oz	Allow 7 days between applications.
Transform 50 WG	1.5 to 2.25 oz	8.5 oz	Allow 7 days between applications.
Venom 70 SG	1 to 1.5 oz	4.5 oz	Allow 14 days between applications.
Warrior II	0.96 to 1.6 fl oz	7.68 fl oz	Allow 7 days between applications.

<sup>1</sup> Generic products available (Appendix E).

**WEED CONTROL: Potato**

Product Amt/A	Lb A.I./A	Comments
1.5-2.9 pt Boundary 6.5 EC	0.98-1.9 s-metolachlor + 0.23-0.43 metribuzin	For control of most annual grasses and certain broadleaf weeds and yellow nutsedge. Apply after planting or after drag-off but before crop emergence. See Dual Magnum label for rotational crops restrictions. Dual Magnum may delay maturity and/or reduce yield of Superior and other early maturing potato varieties if cold, wet soil conditions occur after treatment. PHI = 60 days.
1-2 pt Dual II Magnum 7.6 E	0.95-1.9 s-metolachlor	For control of most annual grasses and certain broadleaf weeds and yellow nutsedge. Apply preplant incorporated, pre-emergence. Dual Magnum may delay maturity and/or reduce yield of Superior and other early maturing potato varieties if cold, wet soil conditions occur after treatment. See label for incorporation directions. 60-day pre-harvest interval.
3.5 pt Eptam 7 E	3 EPTC	For control of annual grasses and broadleaf weeds and suppression of yellow nutsedge. Apply before planting. Incorporate immediately 2 to 3 inches. Superior variety is sensitive to Eptam under stress conditions.
1-2 pt Goal 2XL	0.25-0.5 oxyfluorfen	For pre-emergence and post-emergence control of certain annual grasses and most broadleaves. For fallow bed preparation only. Best if used with glyphosate for control of winter annual broadleaf weeds. Min. 60 days between application and planting.
1-2 pt Gramoxone Inteon	0.69-1.38 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply up to ground cracking to emerged weeds but before crop emergence; may be used instead of drag-off operation for emerged weeds and before using pre-emergence herbicides. Add non-ionic surfactant 0.25% v/v.
1.5-2.5 lb Lorox 50 DF	0.75-1.25 linuron	For control of annual grasses and broadleaf weeds. Apply after planting but before crop emerges. Plant seed at least 2 inches deep. Best results if rainfall or irrigation is applied within 2 weeks of application.
1-1.5 oz Matrix 25 WSG	0.016-0.023 rimsulfuron	For pre-emergence control of broadleaves and grasses. Apply immediately after hilling, drag-off, or reservoir tillage. 1/3 to 1 inch rainfall or irrigation is needed for activation. Do not use on potato grown for seed. Matrix can also be applied chemigation. See label for details.
14-18 fl oz Outlook 6 E	0.6-0.8 dimethenamid-p	For pre-emergence control of broadleaves and grasses. Apply after planting or after drag-off or as chemigation. Leave a 35 foot untreated buffer and avoid applying near endangered plant populations in and around the following counties: Barren, Boone, Hardin, Laurel, Rockcastle, Wolfe. PHI = 40 days.
0.5-2.5 pt Poast	0.09-0.48 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 30 days. Max. rate of 2.5 pt/application and 5 pt/season.
1.5-3.0 pt Prowl H2O	0.71-1.43 pendimethalin	For control of annual grasses and broadleaf weeds. Can be applied pre-emergence after planting or after drag-off. Can be applied early post-emergence to plants up to 6 inches tall only if plants are not under stress from cold/wet or hot/dry conditions.
16-22 fl oz Roundup WeatherMax 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
9-32 fl oz Select Max	0.07-0.24 clethodim	For selective post-emergence control of annual grasses and suppression of perennial grasses. Add crop oil 1% v/v or 1 to 2 qt/A liquid fertilizer or AMS to enhance control of difficult grasses. PHI = 30 days.
0.3-1.3 lb TriCor 75 DF	0.2-1 metribuzin	For control of annual grasses and broadleaf weeds. Apply pre-emergence broadcast after planting. Do not incorporate. Can be used post-emergence (0.3 to 0.6 lb/A) or as a split-application not to exceed 1.3 lb/A per season on white-skinned varieties (except Atlantic, Chip Belle, Bel Chip, and Shepody) that are not early maturing. Do not use on early maturing or red-skinned varieties. PHI = 60 days.
1.25-2 pt Treflan HFP 4 E	0.62-1 trifluralin	For pre-emergence control of annual grasses and broadleaf weeds. Apply and incorporate after planting but before emergence, following drag-off, or after potato plants have fully emerged.
2.3 fl oz Weedone LV4 3.84 EC	0.07 2,4-D	For selective post-emergence control of broadleaf weeds. This is a low volatility formulation of 2,4-D. Still, caution should be exercised near sensitive crops such as tomato and grape. For use on fresh market red potatoes only. Crop response depends on variety. Apply in 5 to 25 gal water/A to plants in the pre-bud stage (about 7 to 10 inches high) and a second application about 10 to 14 days later.

**Pre-Harvest Vine Killing**

10 lb Copper Sulfate Crystal	10 copper sulfate	To enhance vine-kill, use in 10 to 100 gal water. Can be mixed with diquat to enhance vine kill.
3.2 qt Defol 750	6 sodium chlorate	To defoliate plants, apply 10 days before harvest in 10 to 20 gal water/A. Do not apply under conditions of extreme heat during the middle of the day.
1-2 pt Reglone	0.25-0.5 diquat	For non-selective contact kill of grasses and broadleaf weeds and top-kill of perennial weeds. Apply to mature potato vines as a pre-harvest desiccation treatment in 20 gal water/A. Make a second application within 5 days if necessary. Include non-ionic surfactant 0.25% v/v. PHI = 7 days.
29 fl oz Rely 200	0.38 glufosinate	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Do not use on potatoes grown for seed. Apply in 20 to 100 gal water/A. Max. 1 application/season. PHI = 9 days.

**DISEASE CONTROL: Potatoes**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Black leg, Seed-piece Rots, Tuber-borne Diseases</b>					
Ag Streptomycin, Agri-Mycin 17, Harbour	25	n/a	8 oz/100 gal	1 app	Soak seed pieces in solution for several minutes and treat with fungicide.
Mancozeb4					Products include Dithane, Koverall, Manzate, Penncozeb.
Dry formulations only	M	14	2.5 lb/100 gal	1 app	Soak seed pieces in solution for several minutes and place in clean container following treatment. Plant as soon as possible.
Maxim MZ	12/M	14	0.5 lb/cwt	1 app	Dust seed pieces and plant as soon as possible.
Maxim Potato Seed Protectant	12	0			
<b>Black Scurf, Rhizoctonia Stem Canker</b>					
Azoxystrobin <sup>4</sup>					Can be applied in-furrow or post-emergence. Post-emergence applications are counted as foliar treatments. See label for specific instructions.
Azoxy 2SC	11	14	0.4 to 0.8 fl oz <sup>4</sup>	6 foliar apps	
AzoxyStar	11	14	0.4 to 0.8 fl oz <sup>4</sup>	6 foliar apps	
Quadris	11	14	0.4 to 0.8 fl oz <sup>4</sup>	6 foliar apps	
Satori	11	14	0.4 to 0.8 fl oz <sup>4</sup>	6 foliar apps	
Blocker Flowable, Blocker 4F	14	0	5.2 to 10.4 fl oz <sup>4</sup>	1 app	Use as an In-furrow spray at planting. Actual rate is dependent on row spacing; see label for directions.
Headline	11	3	0.4 to 0.8 fl oz <sup>4</sup>	6 foliar apps	Apply in-furrow for control of Rhizoctonia diseases. See label for specific instructions.
Headline SC	11	3			
Moncut 70 DF	7	0	0.7 to 1.1 lb	1 app	Apply in-furrow in 3 gal/A of water. Direct spray over seed piece and surrounding soil before covering.

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**DISEASE CONTROL: Potatoes (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Vertisan	7	7	0.7 to 1.6 fl oz <sup>4</sup>	1 app	Apply in-furrow for control of Rhizoctonia diseases. See label for specific instructions.
<b>Early Blight, Late Blight, White Mold (Sclerotinia Blight)</b>					
Aftershock	11	7	2 to 3.8 fl oz	22.8 fl oz	Apply before onset of disease and continue applications every 7 to 10 days as needed.
Ariston	M/27	14	2.0 pt	17.5 pt	Apply before disease onset, continue every 5 to 7 days.
Azoxystrobin <sup>4</sup>					Early/late blight only. Apply before disease onset, continue every 7 to 14 days.
Azoxy 2SC	11	14	6 to 15.5 fl oz <sup>5</sup>	6 apps	
AzoxyStar	11	14	6 to 15.5 fl oz <sup>5</sup>	6 apps	
Quadris	11	14	6 to 15.5 fl oz <sup>5</sup>	6 apps	
Satori	11	14	6 to 15.5 fl oz <sup>5</sup>	6 apps	
Cabrio Plus	11/M	14	2 to 2.9 lb	17.4 lb	Apply before onset of disease and continue applications every 7 to 14 days as needed.
Chlorothalonil <sup>5</sup>					Early/late blight only. Apply before disease onset; continue every 5 to 10 days.
Bravo Ultrex	M	7	0.7 to 1.36 lb	13.6 lb	
Bravo WeatherStik	M	7	0.75 to 1.5 pt	15 pt	
Bravo ZN	M	7	1.25 to 2.25 pt	21.5 pt	
Curzate 60 DF	27	14	3.2 oz	7 apps	Late blight only. Must be tank-mixed with a fungicide from FRAC Group M. Apply before disease onset, continue every 5 to 7 days.
Endura	7	30	2.5 to 10 oz	20.5 oz or 4 apps	Early blight and white mold only. Apply before disease onset, continue every 7 to 14 days.
Evito 480 SC	11	7	3.8 fl oz	6 apps	Early/late blight only. Apply before onset of disease and continue applications every 7 to 10 days as needed.
Fixed coppers					Early/late blight only. Apply when plants are 6 inches tall and continue every 5 to 10 days, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1 to 3 pt	-	
Badge X2	M	0	1 to 4 lb	-	OMRI-listed.
Basic Copper 53	M	0	3 to 4.7 lb	-	OMRI-listed.
C-O-C-S WDG	M	0	1.5 to 4 lb	-	
Champ DP	M	0	0.67 to 2.67 lb	-	
Champ Formula 2 FL	M	0	0.67 to 2.67 pt	-	
Champ WG	M	0	1 to 4 lb	-	OMRI-listed.
COC DF	M	0	3 to 4 lb	-	
COC WP	M	0	3 to 4 lb	-	OMRI-listed.
Copper-Count-N	M	0	3 to 6 pt	-	
Cueva	M	0	0.5 to 2 gal	-	OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	0.75 to 3 lb	-	
Kentan DF	M	0	1 to 4 lb	-	
Kocide 2000	M	0	0.75 to 3 lb	-	
Kocide 3000	M	0	0.5 to 1.75 lb	-	
Kocide DF	M	0	1 to 4 lb	-	
Mastercop	M	0	0.5 to 1.5 pt	-	
Nordox 75 WG	M	0	0.66 to 4 lb	-	OMRI-listed.
Nu-Cop 50 WP	M	0	1 to 4 lb	-	OMRI-listed.
Nu-Cop 3 L	M	0	0.66 to 4 pt	-	
Nu-Cop 50 DF	M	0	1 to 4 lb	-	OMRI-listed.
Nu-Cop HB	M	0	0.5 to 2 lb	-	
Forum SC	40	4	4 to 6 fl oz	30 fl oz	Late blight only. Must be tank-mixed with another <i>Phytophthora</i> fungicide. Apply before disease onset, continue every 5 to 10 days.
Gavel 75 DF2	22/M	14	1.5 to 2 lb	6 apps	Early/late blight only. Apply when conditions favor disease and continue every 5 to 10 days.
Gem	11	7	6 to 8 oz	6 apps	Early/late blight only. Apply before disease onset, continue every 7 to 10 days.
Headline	11	3	6 to 12 fl oz <sup>6</sup>	6 apps	Apply before disease onset, continue every 7 to 14 days.
Headline SC	11	3			
Luna Tranquility	7/9	7	11.2 fl oz	33.6 fl oz	Early blight, white mold only. Apply every 7 to 14 days.
Mancozeb <sup>4</sup>					Products include Dithane, Koverall, Manzate, Penncozeb.
Dry formulations	M	14	0.5 to 2 lb	14-15 lb	Early/late blight only. Apply when plants reach 4 to 6 inches and continue every 5 to 10 days as needed. Limit 11.2 lb ai/A per season.
Liquid formulations	M	14	0.4 to 1.6 qt	11.2 qt	
ManKocide <sup>3</sup>	M	14	1.5 to 5 lb	see footnote	Early/late blight only. Apply before disease appears and continue every 3 to 10 days as needed.
Omega 500F	29	14	5.5 to 8 fl oz	56 fl oz	Late blight, white mold only. Begin when plants are 8 to 10 inches tall, reapply every 7 to 10 days.
Polyram 80 DF	M	14	1.5 to 2 lb	14 lb	Early/late blight only. Apply before disease appears and continue every 5 to 10 days as needed.
Presidio	43	7	4 fl oz	12 fl oz	Late blight. Apply before disease onset, continue every 7 to 10 days.
Previcur Flex	28	14	0.7 to 1.2 pt	6 pt	Early/late blight only. Apply before disease appears and continue every 7 to 10 days as needed.
Priaxor	7/11	7	4 to 8 fl oz	24 fl oz	Apply prior to development of disease, continue every 7 to 14 days.
Quadris Opti	11/M	14	1.6 pt	6 apps	Early blight/late blight. Apply before disease onset, continue every 5 to 14 days.
Quadris Top	11/3	14	8 to 14 fl oz	55.3 fl oz	Early blight. Apply before disease onset, continue every 7 to 10 day schedule.
Quash	3	1	2.5 to 4 oz	4 apps	Early blight, white mold only. Apply before disease onset, reapply every 7 to 10 days.
Ranman SC	21	7	1.4 to 2.75 fl oz	10 apps	Late blight. Apply before disease onset, continue every 7 to 10 days.

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**DISEASE CONTROL:** *Potatoes (continued)*

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Reason	11	14	5.5 to 8.2 fl oz	24.6 fl oz	Early blight/late blight. Apply before disease onset, continue every 5 to 10 days.
Revus	40	14	5.5 to 8 fl oz	32 fl oz	Late blight only. Apply every 7 to 10 days. Use a spreader/penetrant surfactant. Must be tank-mixed with a fungicide NOT in FRAC Group 40.
Revus Top	40/3	14	5.5 to 7 fl oz	28 fl oz	Early/late blight only. Apply every 7 to 10 days. Use a spreader/penetrant surfactant.
Ridomil Gold Bravo SC	4/M	14	2.5 pt	3 apps	Early/late blight only. Apply before disease onset, continue every 14 days. Rotate to another mode of action between applications of RG Bravo. Observe seasonal limits for chlorothalonil.
Ridomil Gold Copper	4/M	14	2 lb		Late blight only. Apply before disease onset, continue every 14 days. Rotate to another mode of action between applications of RG Copper.
Ridomil Gold MZ2	4/M	14	2.5 lb		Early/late blight only. Apply before disease onset, continue every 14 days. Rotate to another mode of action between applications of RG MZ.
Iprodione <sup>5</sup>					Early blight/white mold only. Apply before disease onset, continue every 7 to 21 days.
Rovral 4 Flowable	2	14	1 to 2 pt	4 apps	
Scala	9	7	7 fl oz	35 fl oz	Early blight only. Apply before disease onset, continue every 7 to 14 days. Tank-mix with another fungicide labeled for early blight.
Tanos	11/27	14	6 to 8 oz	6 apps	Early/late blight only. Tanos must be tank-mixed with a fungicide from FRAC Group M appropriate for the target disease. Apply before disease onset, continue every 5 to 10 days.
Thiophanate-methyl <sup>5</sup>					White mold only. Apply before row closure and continue every 7 to 14 days.
Topsin 4.5 FL	1	21	20 to 30 fl oz	80 fl oz	
Topsin M 70 WP	1	21	1 to 1.5 lb	4 lb	
Topsin M WSB	1	21			
Vertisan	7	7	10 to 24 fl oz	72 fl oz	Early blight, white mold only. Apply before disease onset, reapply every 7 to 14 days.
Zampro	40/45	4	11 to 14 fl oz	3 apps	Apply before disease onset and repeat every 5 to 7 days.
Zing!	M/22	7	32 to 34 fl oz	8 apps	Apply before disease onset and repeat every 5 to 14 days. Alternate with another FRAC code.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Observe seasonal limits for mancozeb.

<sup>4</sup> Per 1,000 row-feet.

<sup>5</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>6</sup> Use higher rate when pressure is severe.

## Rhubarb

Buckwheat family (Polygonaceae): *Rheum rhubarbarum*

### Planting and Culture

Rhubarb is a cool-season crop. It thrives on a well-drained soil that is deep and fertile.

Rhubarb plants (pieces of the crown) should be transplanted in rows 4 to 5 feet apart with plants spaced 3 feet apart in the row. The crown pieces should be planted so that there are 2 to 3 inches of soil covering the pieces. Transplant crowns in early March or in late August (see Appendix J).

### Harvesting

Rhubarb may be harvested for a short period during the second year and a full harvest period (eight to 10 weeks) during the third growing season and thereafter. Pull the stalks rather than cut them.

#### VARIETIES: *Rhubarb*

Variety	Comments
Canada Red	Hardy, with cherry-red tender stalks.
Tilden Strain	Thin, very red tender stalks.
MacDonald Strain	Vigorous, very productive, some root rot resistance.

#### PESTICIDE SAFETY: *Rhubarb*

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>INSECTICIDES</b>			
Actara 25 WDG	C	12	7
Admire Pro	C	12	45
Assail 30 SG	C	12	7
Avaunt 30 DG	C	12	3
Belay 2.13 SC	C	12	21
Confirm 2 F	C	4	7
Coragen 1.67 SC	-	4	1
Fulfill 50 WDG	C	12	7
Intrepid 2 F	C	4	1
Movento 2	C	24	3
Platinum 2 F	C	12	30
Radiant SC	C	4	1
Requiem 25 EC	C	4	0
Sevin XLR	C	12	14
Trigard 75 WP	C	12	7
Venom 70 SG	C	12	7/21 <sup>3</sup>
<b>Restricted Use</b>			
Agri-Mek 0.15 EC	W	12	7
Baythroid XL	W	12	0
Brigade WSB	W	12	7
Mustang Max	W	12	1
Permethrin 3.2 EC	C	12	1
Proclaim 5 WDG	C	48	7

#### INSECT CONTROL: *Rhubarb*

Stalk Borer and Rhubarb Curculio are controlled by cultivating field margins to keep weed populations low. Remove all curly dock, the normal host of the curculio. For various leaf- and stalk-feeding insects, use Mustang or Permethrin as needed.

#### PESTICIDE SAFETY: *Rhubarb*

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>FUNGICIDES</b>			
Aliette WDG <sup>4</sup>	C	12	3
Cabrio EG	C	12	0
Evito 480 SC	C	12	3
Fixed coppers <sup>2</sup>	D	24/48	0
Fontelis	C	12	3
Gem	C	12	7
Meta Star 2EC AG	W	48	0
Presidio	C	12	2
Propiconazole <sup>2</sup>	W	12	14
Quadris	C	4	0
Reason	C	12	2
Revus	C	4	1
Ridomil Gold SL/GR	C	48	0
Ultra Flourish	W	48	0
Zampro	C	12	0

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

<sup>3</sup> PHI depends on the type of application, see label.

<sup>4</sup> The use of Aliette in the following Kentucky counties has certain restrictions to protect endangered freshwater mollusks and their habitat, so read labels carefully: Campbell, Green, Hart, Kenton, Logan, Marshall, Rockcastle, Todd, Warren, and Wayne.

**FERTILIZER:** *Rhubarb*

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
<b>Phosphorus</b>	<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>	
Low	<31	240
Medium	31-60	180
High	61-80	120
Very High	>80	60
<b>Potassium</b>	<b>Potash (K<sub>2</sub>O)</b>	
Low	<201	200
Medium	201-300	150
High	>300	100
<b>Nitrogen</b>	<b>N</b>	

If 15 to 20 tons of manure have been applied/A and worked into the soil before transplanting crowns, apply an additional 50 lb of nitrogen.

**Common Diseases/Management**

**Crown rot.** Use disease-free transplants and plant into well-drained soils high in organic matter. This disease is stress related, so maintain optimal soil fertility; do not over-harvest. At harvest, pulling stalks rather than cutting them reduces entry sites and the food base for pathogens.

**Damping-off.** Mefenoxam or metalaxyl can be applied preplant to manage damping-off and root rots caused by *Pythium*. Planting into well-drained soils is an important control measure.

**Leaf spots and blights.** Rhubarb is generally disease-free; however, fungicides are labeled for a number of foliar diseases. Control weeds in and around the field. Remove yellowed leaves promptly during the season. *Fall maintenance is important*—remove all leaf material in the fall to reduce pathogen populations and use fall fertilization to encourage spring growth.

**WEED CONTROL:** *Rhubarb*

Product Amt/A	Lb A.I./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
6.0 fl oz Callisto	0.19 mesotrione	For post-emergent and pre-emergent control of select species. Apply prior to crop emergence in established rhubarb. If weeds are emerged at time of application use a non-ionic surfactant at 0.25% v/v. Do not apply to rhubarb that is not dormant. Limit 1 application/season. PHI = 21 days.
0.67-1.33 pt Dual Magnum	0.64-1.27 s-metolachlor	Apply as a broadcast or banded to soil prior to crop emergence for pre-emergent control of select weed species. Make only one application per season. PHI = 62 days.
2.5-4.0 pt Gramoxone Inteon	0.86-1.38 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply during dormant season before buds in crown begin to grow in min. 10 gal water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v.
0.5-1.5 pt Poast	0.09-0.27 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 30 days. Max. rate of 1.5 pt/application and 3 pt/season.
16-22 fl oz Roundup Weather-Max 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
9-16 fl oz Select Max	0.07-0.12 clethodim	For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. Max. 16 fl oz/application. Min. 14 days between applications. PHI = 30 days.

**DISEASE CONTROL:** *Rhubarb*

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Damping-off (Pythium)</b>					
MetaStar 2E AG	4	0	4 to 8 pt	1 app	Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil mechanically (preplant) or with irrigation (pre- and at-planting) if rainfall is not expected within 24 hours of treatment.
Ridomil Gold SL	4	0	1 to 2 pt		
Ultra Flourish	4	0	2 to 4 pt		
Ridomil Gold GR	4	0	20 to 40 lb	1 app	Apply pre- or at-planting; refer to label.
<b>Downy Mildew</b>					
Aliette WDG <sup>4</sup>	33	3	2 to 5 lb	7 apps	Apply when conditions favor disease and continue every 7 to 21 days. Do not tank-mix with copper compounds.
Cabrio	11	0	12 to 16 oz	4 apps	Use highest rate for downy mildew. Apply before disease onset, continue every 7 to 14 days.
Presidio	43	2	3 to 4 fl oz	12 fl oz	Apply every 7 to 14 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Reason 500 SC	11	2	5.5 to 8.2 fl oz	24.6 fl oz	Apply before disease onset, continue every 5 to 10 days.
Revus	40	1	8 fl oz	32 fl oz	Apply every 7 to 10 days. Use a spreader/penetrant surfactant.
Zampro	40/45	0	14 fl oz	3 apps	Apply before disease onset and repeat every 7 days.

**Leaf Spots (Alternaria, Anthracnose, Cercospora), Powdery Mildew**

Azoxystrobin <sup>3</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Azoxystrobin	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Cabrio	11	0	12 to 16 oz	4 apps	Apply before disease onset, continue every 7 to 14 days.
Evito 480 SC	11	3	5.7 fl oz	4 apps	Apply before disease onset, continue applications every 7 to 10 days as needed.
Fixed coppers					Apply before disease onset, continue every 5 to 10 days, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1 to 2.25 pt		-
Badge X2	M	0	1 to 2.25 lb		OMRI-listed.
Fontelis	7	3	14 to 24 fl oz	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Gem 500SC	11	7	1.9 to 2.9 fl oz	4 apps	Apply before disease onset, continue every 14 days.
Propiconazole <sup>3</sup>	3	14			Cercospora only. Apply before disease onset, continue every 7 days.
Tilt	3	14	4 fl oz	16 fl oz	

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>4</sup> Restricted in some Kentucky counties. See fungicide safety table on page 20.

# Root Crops

(Beets, Carrots, Parsnips, Radishes, Turnips)

## Planting and Culture

**Beets.** Plant in rows 18 to 24 inches apart and ½ inch deep. Seed 8 to 10 pounds per acre for bunching. Seed will germinate between 40° and 85°F. Optimum temperature is 65° to 75°F. Color and quality are best when the plant develops during cool temperatures (50° to 60°F, see Appendix J). The sugar content of beets will be lower when grown in warm weather, and they will have a lighter color. Hot weather produces white bands in the roots. Beets are sensitive to soil acidity and should be grown at a pH between 6.2 and 7.0.

**Carrots.** Plant in rows 18 to 24 inches apart and ¼ to ½ inch deep. Seed 2 to 4 pounds per acre. Seed are often variable in germination and emergence, resulting in non-uniform stands. Seed germinate slowly, and it is necessary to maintain adequate moisture. Select deep, sandy loam soils for best results. Carrots generally are misshapen when grown on heavy or rocky soils. Prepare soil deeply. Use low raised beds.

**Parsnips.** Plant in rows 18 to 24 inches apart and ¼ to ½ inch deep. Seed 2 to 3 pounds per acre. Prepare soil similarly to that for carrots. Always use new seed, because germination of seed 1 year or older is poor.

**Radishes.** Plant seed in rows 15 inches apart and ¼ to ½ inch deep. Plant 12 to 15 seed per foot of row. Seed 10 to 15 pounds per acre. Seed germinate in three to four days at a soil temperature of 65°F or above. Best quality and shape of roots are attained when the crop grows and matures at 50° to 65°F.

**Turnips.** Plant seed in rows 14 to 18 inches apart with seed 2 to 3 inches apart in the rows and ¼ to ½ inch deep. Plant 1 to 2 pounds of seed per acre. Best quality and yields are obtained under moderately cool temperatures. See also the “Greens” chapter.

## Fertilizing

The soil pH should be between 6.0 and 6.8. Boron may become a limiting element for root crops. Apply Borax at the rate of 20 pounds per acre (2 pounds actual Boron) if necessary as indicated by soil test results.

Carrots tend to develop forked roots on heavy or rocky soils.

## Harvesting

All root crops should be harvested when mature but before they become woody and tough. Wash roots carefully and package according to market requirements.

## VARIETIES: Root Crops

Variety	Days to Maturity	Comments
<b>BEETS<sup>1</sup></b>		
Solo (hybrid)	49	Excellent appearance and taste of cooked and raw roots and cooked greens, uniform shape and size, monogerm.
Red Ace (hybrid)	53	Early maturing, attractive, very smooth skin, excellent quality roots and greens, very sweet, heat resistant.
Kestrel (hybrid)	53	Excellent appearance and taste of cooked and raw roots and cooked greens, uniform size and shape.
Red Cloud (hybrid)	53	Excellent appearance and sweet taste raw, good roasted taste, excellent cooked greens.
Red Titan (hybrid)	52-54	Excellent appearance and taste of cooked and raw roots, uniform shape and size.
Merlin (hybrid)	55	Excellent appearance and taste of cooked and raw roots and cooked greens, uniform size and shape, lower Cercospora leaf spot incidence.
Chioggia	55	Attractive red and white zoned interior.
Excalibur	60	Excellent appearance and taste of cooked and raw roots and cooked greens.
Ruby Queen	60	Attractive, excellent quality, very sweet, excellent for processing.
Touchstone Gold	60	Specialty gold fleshed beet, excellent flavor, lower germination percentage, low Cercospora leaf spot incidence.
Taurus	65	Very uniform smooth skinned, attractive long cylindrical beet for slicing, excellent flavor cooked, easy cleaning, low Cercospora leaf spot incidence.
<b>CARROTS<sup>2</sup></b>		
Choctaw (hybrid)	55	Early, Emperor hybrid, with a deep orange interior.
Nelson (hybrid)	56	Early, Nantes type, very sweet, good for smaller 4 to 6 inch carrots
Navajo (hybrid)	57	Emperor hybrid, widely adapted and uniform.
Sugarsnax (hybrid)	68	Mid-season, Emperor hybrid, with a deep orange interior.
Purple Haze	73	Purple exterior, orange interior, Emperor hybrid good for markets, AAS winner.
<b>PARSNIPS<sup>3</sup></b>		
Lancer (hybrid)	110	Slim, smooth roots, high quality (for trial).
Harris Model	120	Smooth, white roots.
<b>RADISHES<sup>4</sup></b>		
<b>Small round types</b>		
Cherry Belle	24	-
Scarlet Globe	24	-
<b>Oriental Radishes</b>		
Fancy Free Altari	30-35	Small; short thin top with bulbous base; tender, fall crop.
Minowase Summer Cross	50	Long white daikon, mild flavor, juicy and tender, fusarium resistant, stands heat, fall crop.
April Cross	60	Long white daikon, slow to bolt.
Misato Rose Flesh or Red Meat	60	Round, 4 inches in diameter, white with light green shoulders and a dark pink interior; very tender, pungent skin, mild and sweet interior, excellent for eating fresh, garnishing, and pickling. Fall production only, plant in August or September.
Tae-Baek	70	Short white barrel-shaped roots with a green shoulder, somewhat pungent, for heavier soils, highly disease tolerant, fall crop.
<b>TURNIPS<sup>5</sup></b>		
Hakurei (hybrid)	38	Early, all white, best harvested young (2 inch diameter).
Purple Crown	45-50	Smooth, purple topped, globe shaped roots, mild flavor.
Just Right	50-70	All white roots, moderate turnip flavor, excellent tasting greens.

<sup>1</sup> (*Chenopodiaceae*) goosefoot family: *Beta vulgaris* Crassa group.

<sup>2</sup> (*Apiaceae*) carrot family: *Daucus carota* var. *sativa*.

<sup>3</sup> *Pastinaca sativa*.

<sup>4</sup> (*Brassicaceae*) mustard family: *Raphanus sativus*.

<sup>5</sup> *Brassica rapa Rapifera* group.

Store at 32°F and 90 to 95 percent relative humidity.

## Common Diseases/Management

Most of the crops covered in this section are not related botanically, and they have few diseases in common. However, fungicide labels often include these minor-use crops as a group or exempt certain crops from the group because they pose similar residue issues, so read labels carefully. See the “Greens” chapter for turnip diseases. For all of these crops, use well-shaped raised beds in sites with good air and soil drainage.

## FERTILIZER: Root Crops

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)
<b>Phosphorus</b>	
Low	<31
Medium	31-60
High	61-80
Very High	>80
<b>Potassium</b>	
Low	<201
Medium	201-300
High	301-450
Very High	>450
<b>Nitrogen</b>	
N	
Apply 50 lb of actual nitrogen (N)/A. Broadcast all fertilizer and disk into soil thoroughly before seeding.	

## Beets

**Damping-off and seed rot.** Sow seed in a well-prepared seed bed—raised beds will improve disease control. Purchase seed treated with thiram or dust with 1 level teaspoon per pound of seed. For damping-off diseases caused by *Pythium* and *Phytophthora*, apply a fungicide at planting.

**Leaf spots, blights, and rust.** Rotate to grasses for three to four years between beet crops. For leaf spots/blights and rust, apply fungicides weekly. Ensure good air movement by keeping tall plants away from beets.

## Carrots/Parsnips

**Damping-off, seed rot, and root rots.** Use fungicide-treated seed or treat seed with Captan WP at 1 teaspoon per pound of seed, then plant into well-drained, well-prepared, raised beds. Apply fungicides to the soil at 0.5 to 1 pound per treated acre for control of *Pythium* diseases (damping-

off, forking, cavity spot), and those caused by *Rhizoctonia*.

**Leaf spots and blights.** Practice rotation to unrelated crops for two or more years. Spray fixed copper if bacterial blight is involved as part of the complex. If bacterial blight is not involved, apply fungicides at regular intervals. Varieties resistant to some leaf diseases are available.

**White mold and southern blight.** Long-term crop rotation to corn or grasses for three to four years, deep plowing to bury sclerotia, and pre-emergence weed control are key preventive practices. Soil-applied fungicides can also help suppress southern blight.

**Root-knot nematodes.** Practice crop rotation to fescue for two years prior to carrots. Avoid fields with high populations of root-knot nematodes. If these fields must be used, preplant fumigation can be helpful (see “Soil Fumigants for Control of Nematodes and Soilborne Diseases” on page 16).

**Aster yellows.** Adult leafhoppers are the overwintering host and vector of the aster yellows pathogen. Control leafhoppers by using a recommended insecticide early in the season.

## Radish

**Black rot.** This bacterial disease is seed-borne and best controlled by using hot-water seed treatment. See “Vegetable Seed Treatments” in Appendix F. Avoid cole crops in the rotation.

**Damping-off.** Use Captan 50 WP at 1 teaspoon per pound of seed, or buy fungicide-treated seed. Fungicides are effective when applied to soil before planting.

**Leaf spots, downy mildew, white rust.** Take steps to ensure good air movement, such as using an open row spacing and avoiding taller plants nearby. A number of fungicide products can be used to manage foliar diseases.

### PESTICIDE SAFETY: Root Crops

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)				
			Beets	Carrots	Parsnips	Radishes	Turnips
<b>INSECTICIDES</b>							
Actara 25 WDG	C	12	7	7	7	7	7
Admire Pro	C	12	7/21 <sup>2</sup>				
Beleaf 50 SG	C	12	3	3	3	3	3
Blackhawk 36 WG	C	4	3	3	3	3	3
Coragen 1.67 SC	-	4	1	1	1	1	1
Intrepid 2 F	C	12	1	1	1	1	1
Knack 0.83 EC	C	12	3	3	3	3	3
Lorsban 75 WG	W	24	-	-	-	AP	30
Lorsban 4 E	W	24	-	-	-	AP	30
Lorsban 15 G	C	12	-	-	-	7	14
Malathion 8	C	12	7	7	7	7	7
Platinum 2 SC	C	12	AP	AP	AP	AP	AP
Radiant SC	C	4	7	3	3	3	3
Sevin XLR	W	12	7	7	7	7	7
Sivanto 1.67 SL	C	12	7	7	7	7	7
Transform 50 WG	DP	24	7	7	7	7	7
<b>Restricted Use</b>							
Asana XL	W	12	-	7	-	7	-
Battalion 1.5 EC	DP	12	3	3	3	3	3
Baythroid XL	W	12	0	0	0	0	0
Brigade 2 EC	W	12	1	21	21	21	21
Diazinon AG500	C	24	14	14	-	14	-
Diazinon 50 W	C	24	3	3	-	3	-
Hero 1.24 EC	C	12	21	21	21	21	21
Lannate 90 SP	DP	48	0/10 <sup>2</sup>	1	-	-	-
Leverage 2.7	W	12	7	7	7	7	-
Mustang Max	W	12	1	1	1	1	1
Renounce 20 WP	C	12	0	0	0	0	0

- Indicates crop does not appear on label.

<sup>1</sup> W: Warning, C: Caution, D: Danger; P: Poison.

<sup>2</sup> PHI depends on the method of application.

### PESTICIDE SAFETY: Root Crops

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>FUNGICIDES</b>			
<b>Beets</b>			
Cabrio EG	C	12	0
Fixed coppers <sup>2</sup>	D	12/24	1
Fontelis	C	12	0
Gem	C	12	7
Meta Star 2EC AG	W	48	0
Presidio	C	12	7
Quadris	C	4	0
Ridomil Gold SL	C	48	0
Reason 500 SC	C	12	14
Sulfur <sup>2</sup>	C	24	0
Switch 62.5WG	C	12	7
Tebuconazole <sup>2</sup>	C	12	7
Ultra Flourish	W	48	0
<b>Carrots</b>			
Cabrio EG	C	12	0
Chlorothalonil <sup>2</sup>	D	12	0
Fixed coppers <sup>2</sup>	D	12/24	0
Endura	W	12	0
Fontelis	C	12	0
Gem	C	12	7
Iprodione 4L AG	C	24	0
Meta Star 2EC AG	W	48	0
Meteor	C	24	0
Nevado	C	24	0
Omega	W	48	7
Presidio	C	12	7
Pristine	C	12	0
Propiconazole <sup>2</sup>	W	12	14
Quadris	C	4	0
Quadris Opti	W	12	0
Quadris Top	C	12	7
Quilt	C	12	14

### PESTICIDE SAFETY: Root Crops

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
Quilt Xcel	W	12	14
Ridomil Gold Bravo SC	W	48	7
Ridomil Gold Copper	D	48	7
Ridomil Gold SL	C	48	0
Rovral 4 Flowable	C	24	0
Sulfur <sup>2</sup>	C	24	0
Switch 62.5WG	C	12	7
Ultra Flourish	W	48	0
<b>Parsnips</b>			
Cabrio EG	C	12	0
Chlorothalonil <sup>2</sup>	D	12	10
Fontelis	C	12	0
Gem	C	12	7
Meta Star 2EC AG	W	48	0
Presidio	C	12	7
Quadris	C	4	0
Ridomil Gold SL	C	48	0
Switch 62.5WG	C	12	7
Ultra Flourish	W	48	0
<b>Radish</b>			
Cabrio EG	C	12	0
Fontelis	C	12	0
Gem	C	12	7
Meta Star 2EC AG	W	48	0
Presidio	C	12	7
Quadris	C	4	0
Reason 500 SC	C	12	14
Ridomil Gold Copper	D	48	7
Ridomil Gold SL	C	48	0
Switch 62.5WG	C	12	7
Ultra Flourish	W	48	0

<sup>1</sup> W: Warning, C: Caution, D: Danger; P: Poison

<sup>2</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

**INSECT CONTROL:** *Root Crops*<sup>1</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>Aphids</b>			
Actara 25 WDG	1.5 to 3 oz	8 oz	Allow 7 days between applications.
Admire Pro	1.2 fl oz	3.7 fl oz	Allow 5 days between applications.
Malathion 8	2 pt	3 applications	Allow 7 days between applications.
Tranform 50 WG	0.75 to 1.5 oz	8.5 oz	Allow 7 days between applications.
Sivanto 1.67 SL	7 to 10.5 fl oz	28 fl oz	Allow 10 days between applications.
<b>Armyworms</b>			
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Allow 3 days between applications.
Intrepid 2 F	4 to 10 fl oz	64 fl oz	Allow 14 days between applications.
Lannate 90 SP	0.5 to 1 lb	4 lb	-
<b>Cutworms</b>			
Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Battalion 1.5 EC	1 to 2.4 fl oz	12 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	14 fl oz	Allow 7 days between applications.
Brigade 2 EC	5.12 to 6.4 fl oz	25.6 fl oz	Allow 7 days between applications.
Mustang Max	1.24 to 4 fl oz	24 fl oz	Allow 4 days between applications.
<b>Flea Beetles</b>			
Actara 25 WDG	1.5 to 3 oz	8 oz	Allow 7 days between applications.
Admire Pro	1.2 fl oz	3.7 fl oz	Allow 5 days between applications.
Asana XL	5.8 to 9.6 fl oz	9.2 fl oz	Radishes only.
Battalion 1.5 EC	1.5 to 2.4 fl oz	12 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	14 fl oz	Allow 7 days between applications.
Blackhawk 36WG	1.7 to 3.3 oz	14.4 oz	Allow 7 days between applications.
Brigade 2 EC	5.12 to 6.4 fl oz	25.6 fl oz	Allow 7 days between applications.
Mustang Max	1.76 to 4 fl oz	24 fl oz	Allow 4 days between applications.
Sevin XLR	0.5 to 1 qt	6 qt	Limit 6 applications. Allow 7 days between sprays.
<b>Leafhoppers:</b> Treat fields and field margins to control these disease vectors. Beginning when plants are 3 inches tall.			
Actara 25 WDG	1.5 to 3 oz	8 oz	Allow 7 days between applications.
Admire Pro	1.2 fl oz	3.7 fl oz	Allow 5 days between applications.
Battalion 1.5 EC	1.5 to 2.4 fl oz	12 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	28 fl oz	-
Lannate 90 SP	0.5 to 1 lb	7 lb	-
Mustang Max	1.76 to 4 fl oz	24 fl oz	Allow 4 days between applications.
Sevin XLR	0.5 to 1 qt	6 qt	Allow 7 days between sprays. Limit 6 qt/A.
Sivanto 1.67 SL	7 to 10.5 fl oz	28 fl oz	Allow 10 days between applications.
Tranform 50 WG	1.5 to 2.25 oz	8.5 oz	Allow 7 days between applications.
<b>Stink Bugs, Plant Bugs</b>			
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 4 days between applications.
Sevin XLR	1 to 2 qt	6 qt	Limit 6 applications. Allow 7 days between sprays.
Tranform 50 WG	0.75 to 1.5 oz	8.5 oz	Allow 7 days between applications.
<b>Crickets, Sowbugs</b>			
Baythroid XL	1.6 to 2.8 fl oz	14 fl oz	Allow 7 days between applications.
<b>Root Maggots</b>			
Lorsban 15 G	3.3 oz/ 1,000 row-feet	-	Furrow application at planting.
Lorsban 4 E	1 oz/ 1,000 row-feet	-	Use at least 40 gallons per acre.

<sup>1</sup> Generic products available (Appendix E).

**WEED CONTROL:** *Root Crops*

Product Amt/A	Lb A.I./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
6-14 lb Dacthal W-75	4.5-10.5 DCPA	Radish only. For pre-emergence control of annual grasses and small-seeded broadleaves. For radish apply at seeding or up to 3-leaf stage. Soil should be clean-cultivated before application. Apply in 20 to 30 gal water/A. PHI = 25 days.
1pt Fusilade-DX 2E	0.25 fluazifop-p	Carrot only. For selective post-emergence control of annual grasses and suppression of perennial grasses. Include 1% v/v crop oil or 0.25% v/v non-ionic surfactant/A. PHI = 45 days. Max. rate is 48 fl oz/A.
2-4 pt Gramoxone Inteon	0.67-1.35 paraquat salt	Carrot only. For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply preplant, pre-emergence, or before transplanting in min. 10 gal water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v.
1.5-3 lb Lorox 50 DF	0.75-1.5 linuron	Carrot and parsnip only. For control of annual grasses and broadleaf weeds. Apply post-emergence as a non-directed spray to carrots > 3 inches tall. Apply before annual grasses exceed 2 inches high and before broadleaves exceed 6 inches high. Check label regarding varietal tolerance. Do not apply when temperature is above 85°F. PHI = 14 days.
0.5-2.5 pt Poast	0.09-0.49 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 60 days. Max. rate of 2.5 pt/ap- plication and 5 pt/season.
2.0 pt Prowl H2O	0.95 pendimethalin	Carrot only. For pre-emergent control of most annual grasses and some broadleaf weeds. Apply as a broadcast application as a post plant treatment prior to crop and weed emergence. May be applied at layby at 2.0 pt/A as a di- rected spray between rows. Do not allow to come in contact with plants or severe injury will result. PHI = 60 days.

(continued on next page)

**WEED CONTROL: Root Crops (continued)**

Product Amt/A	Lb A.I./A	Comments
16-22 fl oz Roundup Weather-Max 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
9-16 fl oz Select Max	0.07-0.12 clethodim	For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. Max. 16 fl oz/application. Min. 14 days between applications. PHI = 30 days.
1.25-2 pt Treflan HFP 4 E	0.6-1 trifluralin	Carrot and radish only. For control of annual grasses and broadleaf weeds. Apply and incorporate in spring before planting.
0.3 lb TriCor 75 DF	0.2 metribuzin	Carrot only. For control of annual grasses and broadleaf weeds. Apply broadcast over the tops to plants with 5-6 true leaves but before weeds are 1 inch tall. A second application can be made 3 weeks later. Do not apply within 3 days of stress conditions such as cool, wet and cloudy weather or hot days or after any other chemical to avoid injury. PHI = 60 days.

**DISEASE CONTROL: Root Crops**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>BEETS, RADISH, TURNIPS, PARSNIPS</b>					
<b>Damping-off (Pythium)</b>					
MetaStar 2EC AG	4	0	4 to 8 pt	1 app	Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil mechanically (preplant) or with irrigation (pre- and at-planting) if rainfall is not expected within 24 hours of treatment. Will control white rust on radish.
Ridomil Gold SL	4	0	1 to 2 pt		
Ultra Flourish	4	0	2 to 4 pt		
Presidio	43	7	3 to 4 fl oz	12 fl oz	Can be applied as a drench or through drip irrigation at planting; soil-directed applications can be made during the season.
<b>Downy Mildew</b>					
Chlorothalonil <sup>4</sup>					Parsnip only. Apply before disease onset; continue every 7 to 10 days.
Bravo Ultrex	M	0	1.4 to 1.8 lb	7.3 lb	Beets only. Apply every 7 to 10 days when conditions favor disease. See label for mixing instructions and tank-mix precautions.
Bravo WeatherStik	M	0	1.5 to 2 pt	8 pt	
Fixed coppers					Beets only. Apply every 7 to 10 days when conditions favor disease. See label for mixing instructions and tank-mix precautions.
Basic Copper 53	M	0	2 to 4 lb		OMRI-listed.
C-O-C-S WDG	M	0	3 to 4 lb		-
COC DF	M	0	2 to 4 lb		-
COC WP	M	0	2 to 4 lb		OMRI-listed.
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Kentan DF	M	0	2 to 3.27 lb		-
Nordox 75 WG	M	0	0.66 to 2 lb		OMRI-listed.
Nu-Cop 50 DF	M	0	1 to 2 lb		OMRI-listed.
<b>Leaf Spots (Alternaria, Anthracnose, Cercospora), Rust, White Rust</b>					
Azoxystrobin <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxy 2SC	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
AzoxyStar	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Cabrio	11	0	8 to 16 oz	3 apps	Apply before disease onset, continue every 7 to 14 days.
Chlorothalonil <sup>4</sup>					Parsnip only. Apply before disease onset; continue every 7 to 10 days.
Bravo Ultrex	M	0	1.4 to 1.8 lb	7.3 lb	Beets only. For control of Cercospora leaf spot, apply every 7 to 10 days after seeding/transplanting or when conditions favor disease. See label for mixing instructions and tank-mix precautions.
Bravo WeatherStik	M	0	1.5 to 2 pt	8 pt	
Fixed coppers					Beets only. For control of Cercospora leaf spot, apply every 7 to 10 days after seeding/transplanting or when conditions favor disease. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1 to 4 pt		-
Badge X2	M	0	0.75 to 2 lb		OMRI-listed.
Basic Copper 53	M	0	2 to 4 lb		OMRI-listed.
C-O-C-S WDG	M	0	3 to 4 lb		-
Champ DP	M	0	1.33 to 2.67 lb		-
Champ Formula 2 FL	M	0	1.33 to 2.67 pt		-
Champ WG	M	0	2 to 5 lb		OMRI-listed.
COC DF	M	0	2 to 4 lb		-
COC WP	M	0	2 to 4 lb		OMRI-listed.
Copper-Count-N	M	0	3 to 6 pt lb		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 3 lb		-
Kentan DF	M	0	2 to 3.27 lb		-
Kocide 2000	M	0	1.5 to 3.75 lb		-
Kocide 3000	M	0	0.75 to 2 lb		-
Kocide DF	M	0	2 to 5 lb		-
Mastercop	M	0	0.5 to 1.5 pt		-
Nordox 75 WG	M	0	0.66 to 2 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	2 to 5 lb		OMRI-listed.
Nu-Cop 3 L	M	0	1.33 to 6.66 pt		-
Nu-Cop 50 DF	M	0	2 to 5 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	1 to 2.5 lb		-
Fontelis	7	0	16 to 30 fl oz	61 fl oz	Apply before disease onset, continue every 7 to 14 days.
Gem 500SC	11	7	1.9 to 2.9 fl oz	4 apps	Apply before disease onset, continue every 14 days.

(continued on next page)

**DISEASE CONTROL: Root Crops (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Reason 500 SC	11	14	8.2 fl oz	24.6 fl oz	Not for radish. For Alternaria leaf spot, apply before disease onset, continue every 14 days.
Ridomil Gold Copper	4/M	0	2 lb	4 apps	Radish only. For control of white rust, apply 45 to 50 days after preplant application of Ridomil Gold EC or Ultra Flourish. Make up to three additional applications every 14 days.
Sulfur <sup>4</sup>	M				Beets only. Apply every 14 to 30 days, beginning when symptoms are first observed or when conditions favor disease. Phytotoxicity may occur when sulfur is applied when temperatures exceed 90°F.
Switch 62.5WG	9/12	7	11 to 14 oz	56 oz	For Alternaria, apply every 7 to 10 days. Make only two applications on radish.
Tebuconazole <sup>4</sup>		7			Beet and turnip only. Apply preventively for control of Cercospora. Use lowest listed rate of surfactant to improve coverage.
<b>CARROTS</b>					
<b>Damping-off, Seed Rot, Root Rots, Southern Blight</b>					
Azoxytrobilin <sup>4</sup>					
Azoxy 2SC	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 foliar apps	Post-emergence. Apply broadcast in a 7-inch band with spray directed at lower stems and surrounding soil. In-furrow. Apply in 5 to 15 gal/A, with nozzle directed to spray in-furrow just before seed are covered. In-furrow treatment does not count as a foliar application.
AzoxyStar	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 foliar apps	
Quadris	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 foliar apps	
Satori	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 foliar apps	
			0.4 to 0.7 fl oz <sup>3</sup>	1 app	
Presidio	43	7	4 fl oz	12 fl oz	Pythium diseases. Can be applied in-furrow or side-dressed after emergence.
MetaStar 2EC AG	4	7	4 to 8 pt	1 app	Pythium diseases only. Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil mechanically (preplant) or with irrigation (pre- and at-planting) if rainfall is not expected within 24 hours of treatment.
Ridomil Gold SL	4	0	1 to 2 pt		
Ultra Flourish	4	7	2 to 4 pt		
Ridomil Gold Bravo SC	4/M	7	1.5 to 2.5 pt	4 apps	Pythium diseases only. Apply 45 to 50 days after preplant application of Ridomil Gold EC or Ultra Flourish. Make up to three additional applications every 14 days. Observe seasonal limits for chlorothalonil.
Ridomil Gold Copper	4/M	7	2 lb		Pythium diseases only. Apply 45 to 50 days after preplant application of Ridomil Gold EC or Ultra Flourish. Make up to three additional applications every 14 days.
<b>Foliar Diseases (Alternaria, Cercospora Leaf Spots, Leaf Blights)</b>					
Azoxytrobilin <sup>4</sup>					
Azoxy 2SC	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
AzoxyStar	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>4</sup>	4 apps	
Cabrio	11	0	8 to 12 oz	3 apps	
Chlorothalonil <sup>4</sup>					
Bravo Ultrex	M	0	1.4 to 1.8 lb	18.2 lb	Apply before disease onset; continue every 7 to 10 days as needed.
Bravo WeatherStik	M	0	1.5 to 2 pt	20 pt	
Endura	7	0	4.5 oz	5 apps	For Alternaria, apply before disease onset, continue every 7 to 14 days.
Fixed coppers					
Apply every 7 to 14 days after seeding/transplanting or when conditions favor disease. See label for mixing instructions and tank-mix precautions.					
Badge SC	M	0	1 to 1.8 pt		-
Badge X2	M	0	0.75 to 1.5		OMRI-listed.
Basic Copper 53	M	0	2 to 4 lb		OMRI-listed.
C-O-C-S WDG	M	0	2 to 4 lb		-
Champ DP	M	0	1.33 lb		-
Champ Formula 2 FL	M	0	1.33 pt		-
Champ WG	M	0	2 lb		OMRI-listed.
COC DF	M	0	3 to 6 lb		-
COC WP	M	0	3 to 6 lb		OMRI-listed.
Copper-Count-N	M	0	4 to 6 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Dispers	M	0	1.25 lb		-
Kentan DF	M	0	2 lb		-
Kocide 2000	M	0	1.5 lb		-
Kocide 3000	M	0	0.75 lb		-
Kocide DF	M	0	2 lb		-
Mastercop	M	0	0.5 to 1.5 pt		-
Nordox 75 WG	M	0	1.25 to 2.5 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	2 lb		OMRI-listed.
Nu-Cop 3 L	M	0	1.33 to 2.66 pt		-
Nu-Cop 50 DF	M	0	2 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	1 lb		-
Fontelis	7	0	16 to 30 fl oz	61 fl oz	Apply before disease onset, continue every 7 to 14 days.
Omega 500F	29	7	1 pt	4 apps	Apply when conditions favor disease, continue every 7 days.
Pristine	7/11	0	8 to 10.5 oz	6 apps	Apply before disease onset, continue every 7 to 14 days. Will suppress southern blight.
Propiconazole <sup>4</sup>					
Tilt	3	14	4 fl oz	16 fl oz	Apply before disease onset, continue every 7 to 10 days.
Quadris Opti	11/M	0	2.4 pt	6 apps	Carrot only. Apply before disease onset, continue every 7 to 14 days. Observe seasonal limits for chlorothalonil.

(continued on next page)

**DISEASE CONTROL:** *Root Crops (continued)*

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Quadris Top	11/3	7	12 to 14 fl oz	56 fl oz	Apply before disease onset, continue every 7 to 10 day schedule.
Quilt	11/3	14	14 fl oz	55 fl oz	Premix of azoxystrobin and propiconazole. Use higher rates for rust and gray leaf spot. Apply before disease onset, continue every 7 to 14 days.
Quilt Xcel	11/3	14			Premix of azoxystrobin and propiconazole. Use higher rates for rust and gray leaf spot. Apply before disease onset, continue every 7 to 14 days.
Iprodione <sup>4</sup>					Carrot only. For control of Alternaria, apply when conditions favor disease. Repeat applications can be made at 7 to 14 days.
Rovral 4 Flowable	2	0	1 to 2 pt	4 apps	
Sulfur <sup>4</sup>	M				Carrot only. Apply every 14 days, beginning when symptoms are first observed or when conditions favor disease. Phytotoxicity may occur when sulfur is applied when temperatures exceed 90°F.
Switch 62.5 WG	9/12	7	11 to 14 oz	56 oz	For Alternaria, apply every 7 to 10 days. Make only two applications on radish.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Per 1,000 row-feet.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

## Southernpeas (Cowpeas)

Pea family (Fabaceae): *Vigna unguiculata*

### Planting and Culture

Southernpeas (cowpeas) may be grown on a wide variety of soils with good success. Soils should be well drained. Southernpeas require a rather low level of soil fertility more comparable to snap beans and soybeans. Prepare a good seedbed as for other vegetable crops.

Plant seed after danger of frost in the spring and after soil temperature has warmed to 65°F (see Appendix J). Thirty to 40 pounds of seed is required per acre when seeding in rows 36 to 42 inches apart. Space seed 4 inches apart in rows.

There are no known detrimental effects on plant growth associated with inoculating the seed with nitrogen-fixing *Rhizobium* prior to planting. However, there are many different strains of *Rhizobium* and many factors involved in determining if this will increase nitrogen fixation and help your crop. There will be no effect if the field has a recent history of being planted with southernpeas because a large population of *Rhizobium* will already be present in the field.

### Fertilizing

A general fertilizer rate would be 500 to 600 pounds per acre of a complete fertilizer such as a 5-20-20 or similar analysis fertil-

### FERTILIZER: *Southernpeas*

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
<b>Phosphorus</b>	<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>	
Low	<31	96-145
Medium	31-60	51-95
High	61-80	1-50
Very High	>80	0
<b>Potassium</b>	<b>Potash (K<sub>2</sub>O)</b>	
Low	<201	81-120
Medium	201-300	41-80
High	301-450	1-40
Very High	>450	0
<b>Nitrogen</b>	<b>N</b>	
Poor soils	50	
Fertile soils	20-30	

izer; however, a soil test is the best method to determine proper fertilization rate.

### Harvesting and Handling

For fresh market sales, pods should be well filled and harvested before they dry. Varieties differ in their "over" color; some are purple and others are yellow. Harvest when some green has disappeared from the pod. For peas to be stored as dry peas, the pods should be thoroughly dry before harvesting.

### Common Diseases/Management

**Damping-off, seed rots, and root rots.** Rotation away from legumes for two years (mainly to corn, small grains, or grass) is recommended. Purchase treated seed or apply Captan WP at 1 teaspoon per pound of seed. Plant seed into warm, well-drained soils to ensure rapid germi-

### PESTICIDE SAFETY: *Southernpeas*

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>INSECTICIDES</b>			
Acramite 50 WS	C	12	3
Admire Pro	C	12	7/21 <sup>5</sup>
Assail 30 SG	C	12	7
Avaunt 30 DG	C	12	7
Belt SC	C	12	1/14 <sup>5</sup>
Blackawk 36 WG	C	4	3/28 <sup>3</sup>
Coragen 1.67 SC	-	4	1
Intrepid 2 F	C	4	7
Movovento 2 SC	C	24	1
Radiant 1 SC	C	4	3
Sevin XLR	W	12	3/21 <sup>3</sup>
Sivanto 1.67 SL	C	12	7/21 <sup>3</sup>
<b>Restricted Use</b>			
Asana XL	W	12	21
Baythroid XL	W	12	3
Brigade 2 EC	W	12	3
Hero 1.24 EC	C	12	3
Mustang Max	W	12	1/21 <sup>3</sup>
Proaxis 0.5 EC	C	24	7/21 <sup>3</sup>
Warrior II	W	24	7/21 <sup>3</sup>
<b>FUNGICIDES</b>			
Aproach	C	12	14
Blocker Flowable/4F	C	12	0
Bravo ZN	W	48	14
Chlorothalonil <sup>2</sup>	D	12	14
Fixed coppers <sup>2</sup>	D	24/48 <sup>4</sup>	24
Endura	W	12	7/21 <sup>3</sup>
Fontelis	C	12	0
Headline	W	12	21
Meta Star 2EC AG	W	48	0
Priaxor	C	12	7/21 <sup>3</sup>
Proline 480 SC	C	12	7
Quadris	C	4	0
Quadris Opti	W	12	14
Quilt	W	12	7/14 <sup>3</sup>
Quilt Xcel	W	12	7/14 <sup>3</sup>
Ridomil Gold SL	C	48	0
Ridomil Gold/Copper	D	48	3
Sulfur <sup>2</sup>	C	24	0
Tebuconazole <sup>2</sup>	C	12	14
Thiophanate-methyl <sup>2</sup>	C	12	14/28 <sup>3</sup>
Tilt	W	12	7

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

<sup>3</sup> Dependent on type of peas, see label.

<sup>4</sup> Re-entry varies by product and formulation.

<sup>5</sup> PHI dependent on type of application.

### VARIETIES: *Southernpeas*

Variety	Days to Maturity	Comments
Top Pick Brown	60	Brown color, bush, a crowder type
Mississippi Silver	64	Peas are large, light green to cream in color; semi-vining; a crowder type.
Mississippi Purple	69	Large seeded disease resistant, a crowder type
Queen Anne	75	A blackeye type; bush type plant.

nation and emergence. See the “Beans” chapter for information on controlling root rots that are common to both beans and southernpeas.

**Powdery mildew, rust, and leaf spots.** Practice crop rotation to non-legumes for at least two years prior to planting. Fungicides are labeled to control a num-

ber of foliar diseases (leaf spots, rust, and powdery mildew). The first spray should be made at early flowering.

**INSECT CONTROL:** *Southernpeas*<sup>1</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>PREPLANT INCORPORATED</b>			
<b>Wireworms, Cutworms:</b> Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites. Wireworms can be a potential problem where southernpeas follow grass or grass-legume sod.			
<b>FOLIAR TREATMENTS</b>			
<b>Aphids</b>			
Assail 30 SG	2.5 to 5.3 oz	3 applications	-
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	-
Movento 2 SC	4 to 5 fl oz	10 fl oz	Allow 7 days between applications.
Sivanto 1.67 SL	7 to 10.5 fl oz	28 fl oz	Allow 10 days between applications.
<b>Plant Bugs, Stink Bugs, Leaf-feeding Caterpillars</b>			
Baythroid XL	2.1 fl oz	10.5 fl oz	Limit 2.1 fl oz per 5-day interval.
Belt 2 SC	2 to 3 fl oz	6 fl oz	For caterpillars only. Allow 5 days between applications.
Blackhawk 36 WG	1.7 to 3.3 oz	20 oz	For caterpillars only. Allow 5 days between applications.
Brigade 2 EC	2.1 to 6.4 fl oz	12.8 fl oz	-
Intrepid 2 F	8 to 16 fl oz	64 fl oz	For caterpillars only.
Mustang Max	2.72 to 4 fl oz	24 fl oz	-
Proaxis 0.5 EC	2.56 to 3.84 fl oz	15.36 fl oz	-
Sevin XLR	1 to 1.5 qt	4 applications	Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	7.68 fl oz	-

<sup>1</sup> Generic products available (Appendix E).

**WEED CONTROL:** *Southernpeas*

Product Amt/A	Lb A.I./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
5-12 fl oz Assure II 0.88L	0.033-0.08 quizalofop	For selective post-emergence control of annual grasses and suppression of perennial grasses. Apply to actively growing grasses in 10 to 15 gal water/A. Include 1% v/v crop oil concentrate or 0.25% v/v non-ionic surfactant. Pre-harvest interval is 30 days for succulent peas and 60 days for dry peas. Maximum 14 fl oz/A per season.
1.3-1.7 pt Dual II Magnum 7.6 E	1.3-1.6 s-metolachlor	For control of most annual grasses and certain broadleaves. Apply preplant surface or incorporated or pre-emergence. Small grains may be planted 4½ months following this treatment. See label for other rotational crops.
1.2-2.0 pt Gramoxone Inteon	0.4-0.67 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Can be used as a harvest aid as well. Use with non-ionic surfactant 0.25% v/v. Max. 2 applications/season. PHI = 7 days.
0.5-2.5 pt Poast	0.09-0.48 sethoxydim	For control of actively growing grasses only. Use high rate on Johnson grass. Dry and succulent peas. Max. rate 4 pt/A per year. Include 1% v/v crop oil. PHI = 15 days for succulent peas and 30 days for dry peas.
1.8-3.6 pt Prowl 3.3 E	0.74-1.49 pendimethalin	For control of annual grasses and broadleaf weeds. Apply before planting and incorporate 1 to 2 inches up to 60 days before planting and incorporate within 7 days of application. Do not apply surface pre-emergence, or serious crop injury can result.
4 oz Pursuit 2L	0.07 imazethapyr	For control of annual grasses and broadleaf weeds. Can be applied preplant incorporated within 1 week before planting. Can be applied pre-emergence within 3 days after planting. Can be applied post-emergence to plants at least 3 inches tall but before 5 nodes and before flowering. Add non-ionic surfactant 0.25% v/v.
4 fl oz Raptor 1AS	0.031 imazamox	For control of annual grasses and broadleaf weeds. Some varieties are sensitive and injury can occur. Apply post-emergence to actively growing dry southernpeas with at least 3 pairs of leaves and before bloom. Max. 1 application/season.
16-22 fl oz Roundup WeatherMax 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
0.5-1 oz Sanda 75 DF	0.023-0.046 halosulfuron	For pre-emergence and post-emergence control of broadleaves and yellow nutsedge. Apply to row middles before or after weeds emerge. PHI = 30 days.
9-32 fl oz Select Max	0.07-0.24 clethodim	For post-emergence control of grasses. Apply higher rate for hard-to-control perennial grasses. Do not apply more than 32 oz/A in a single application or 64 oz/A for a season. Use a non-ionic surfactant at 0.25% v/v. PHI = 30 days.
7.5 lb Sonalan 10G	0.75 ethalfuralin	For pre-emergence control of annual grasses and broadleaves. For use on dry peas only. Apply and incorporate before planting.
1.25-2 pt Treflan HFP 4 E	0.62-1 trifluralin	For pre-emergence control of annual grasses and broadleaf weeds. Apply as preplant soil incorporated.

**DISEASE CONTROL:** *Southernpeas*

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Anthraxnose, Leaf Spots, Powdery Mildew, Downy Mildew</b>					
Aproach	11	14	6 to 12 fl oz <sup>5</sup>	24 fl oz	Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin <sup>4</sup>					Not for downy or powdery mildew. Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin 25C	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Azoxystrobin Star	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	

(continued on next page)

**DISEASE CONTROL: Southernpeas (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Chlorothalonil<sup>4</sup></b>					
Bravo Ultrex	M	14	1.25 to 1.8 lb	7.3 lb	Dry pea production only. Apply at early bloom or when conditions favor disease.
Bravo WeatherStik	M	14	1.375 to 2 pt	8 pt	
Bravo ZN	M	14	2 to 3 pt	11.5 pt	
<b>Fixed coppers</b>					
Badge X2	M	0	0.5 to 1.25 lb		Downy mildew. Apply every 5 to 10 or 7 to 14 days, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Basic Copper 53	M	0	2 to 4 lb		OMRI-listed.
Champ Formula 2 FL	M	0	0.67 to 2 pt		-
C-O-C-S WDG	M	0	2 to 4 lb		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	0.75 to 2 lb		-
Kentan DF	M	0	2 lb		-
Kocide 3000	M	0	0.5 to 1.25 lb		-
Nordox 75 WG	M	0	0.66 to 2.5 lb		OMRI-listed.
Fontelis	7	0	14 to 30 fl oz <sup>5</sup>	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Headline	11	21	6 to 9 fl oz <sup>5</sup>	2 apps	Apply before disease onset, continue every 7 to 14 days as needed.
Headline SC	11	21			
Priaxor	7/11	7/21	4 to 8 fl oz <sup>5</sup>	2 apps	Apply every 7 to 14 days.
Quadris Opti	11/M	14	1.6 to 2.4 pt <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
Quilt	11/3	7/14	14 fl oz	42 fl oz	Premix of azoxystrobin and propiconazole. Make up to three applications every 7 to 14 days.
Quilt Xcel	11/3	7/14	10.5 to 14 fl oz		-
Ridomil Gold/Copper	4/M	3	2 lb	4 apps	Begin treatment at disease onset and continue every 7 days during favorable conditions.
<b>Sulfur<sup>4</sup></b>					
	M				Apply when powdery mildew is first observed; continue every 7 to 14 days as needed. Phytotoxicity may occur if applications are made when temperatures exceed 90°F.
<b>Thiophanate-methyl<sup>4</sup></b>					
Topsin 4.5 FL	1	14/28	20 to 40 fl oz	80 fl oz	Apply when 10 to 30% of plants have at least one open bloom OR when conditions favor disease, continue every 4 to 7 days (no later than peak bloom).
Topsin M 70 WP	1	14/28	1 to 2 lb	4 lb	
Topsin M WSB	1	14/28			
<b>Rust</b>					
Approach	11	14	6 to 12 fl oz <sup>5</sup>	24 fl oz	Apply before disease onset, continue every 7 to 14 days.
<b>Azoxystrobin<sup>4</sup></b>					
Azoxystrobin	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
Azoxystar	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
Satori	11	0	6 to 15.5 fl oz <sup>5</sup>	4 apps	
<b>Chlorothalonil<sup>4</sup></b>					
Bravo Ultrex	M	14	1.25 to 1.8	7.3 lb	Dry pea production only. Apply at early bloom or when conditions favor disease.
Bravo WeatherStik	M	14	1.375 to 2 pt	8 pt	
Bravo ZN	M	14	2 to 3 pt	11.5 pt	
Fontelis	7	0	14 to 30 fl oz <sup>5</sup>	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Headline	11	21	6 to 9 fl oz <sup>5</sup>	2 apps	Apply before disease onset, continue every 7 to 14 days as needed.
Headline SC	11	21			
Priaxor	7/11	7/21	4 to 8 fl oz <sup>5</sup>	2 apps	Apply every 7 to 14 days.
Proline 480 SC	3	7	5.7 fl oz	17.1 fl oz	Rust. Apply at first symptoms, make up to three applications every 5 to 14 days.
Quadris Opti	11/M	14	1.6 to 2.4 pt <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
Quilt	11/3	7/14	14 fl oz	42 fl oz	Premix of azoxystrobin and propiconazole. Make up to three applications every 7 to 14 days.
Quilt Xcel	11/3	7/14	10.5 to 14 fl oz		-
<b>Sulfur<sup>4</sup></b>					
	M				Apply when rust is first observed; continue every 7 to 14 days as needed. Phytotoxicity may occur if applications are made when temperatures exceed 90°F.
<b>Tebuconazole<sup>4</sup></b>					
	3	14			Rust on dry beans only. Apply preventively and repeat every 14 days. Use lowest listed rate of surfactant to improve coverage.
Tilt	3	7	4 fl oz	12 fl oz	Make up to three applications every 7 to 14 days. May cause leaf crinkling or increased greening of leaves.
<b>Pythium Damping-off, Seedling Disease, Root Rot</b>					
MetaStar 2EC AG	4	0	2 to 4 pt	1 app	Apply pre- or post-planting as a broadcast or banded spray (7-inch band) in sufficient water to provide uniform coverage. Incorporate into the upper 2 inches of soil mechanically or by rainfall/irrigation. Can be tank-mixed with azoxystrobin or PCNB to provide additional protection against Rhizoctonia.
Ridomil Gold SL	4	0	0.5 to 1 pt		
<b>Rhizoctonia Damping-off, Seedling Disease, Stem And Root Rot</b>					
<b>Azoxystrobin<sup>4</sup></b>					
Azoxystrobin	11	0	0.4 to 0.7 fl oz <sup>3</sup>	1 app	At-planting treatment. Apply at planting as an in-furrow spray in 0.3 to 1 gal water/1,000 row-feet (5 to 15 gal/A). Spray should be applied to the furrow just before seed are covered. Post-emergence. For post-emergence treatments, apply in a 7-inch (or less) band directed at the soil at the base of the plant. Arrange nozzles to provide good coverage of lower stems and soil at base of plants. Incorporation following application will improve distribution in soil. Foliar contact may occur; post-emergence sprays are considered foliar applications for resistance management purposes.
Azoxystar	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 foliar apps	
Quadris	11	0	0.4 to 0.8 fl oz <sup>3</sup>	4 foliar apps	
Satori	11	0	0.4 to 0.8 fl oz <sup>3</sup>	see label	

(continued on next page)

**DISEASE CONTROL:** *Southernpeas* (continued)

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Blocker 4F, Blocker Flowable	14	0	2.2 to 3.3 fl oz <sup>3</sup>	1 app	Use as an In-furrow spray at planting. Actual rate is dependent on row spacing; see label for directions.
Headline	11	21	0.1 to 0.8 fl oz <sup>3</sup>	1 app	Use as an In-furrow spray at planting; see label for directions.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Per 1,000 row-feet.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>5</sup> Use higher rate when pressure is severe.

## Sweetpotatoes

Bindweed family (Convolvulaceae): *Ipomoea batatas*

### Planting and Culture

Sweetpotatoes grow best on medium to light sandy soils that are well drained and relatively low in nitrogen, although they can be grown successfully on heavier soils. Regardless, sweetpotatoes should not be grown on the same land more often than once every three years.

Good soil preparation is important for successful production of sweetpotatoes. The soil organic matter content should be maintained by turning under small grain cover crops.

The commercial grower often produces his own transplants (slips) by bedding 10 to 12 bushels of sweetpotatoes for each acre of plants to be set. The sweetpotatoes are usually bedded about seven weeks before the field setting date in early June (see Appendix J). Use only disease-free sweetpotatoes. They should be treated to reduce surface-borne disease problems before being placed in the bed. Do not cut sweetpotato seed pieces as you would potatoes. Cutting will often result in disease and will not result in a greater number of slips.

In preparing the bed, the roots are usually placed by hand so they are close together but not touching. Ordinarily, one bushel will cover 16 to 20 square feet of bed surface. The roots should be covered with 3 to 4 inches of sand or fine soil, then watered.

Soil preparation begins with deep plowing and repeated disking until a fine plant bed is prepared. Sandy soil should be ridged about 10 inches high before planting. On heavier soils that do not drain quickly, the ridges should be 12 to 14 inches high.

The best transplanting results are obtained by using freshly pulled plants. True "slips" will have been pulled from the sweetpotato and may have some roots.

### VARIETIES: *Sweetpotatoes*

Variety	Days to Maturity	Comments
Beauregard	90	Copper skin, deep orange flesh, slow to sprout, moist flesh, very high yield, must harvest on time or roots will get too large.
Hernandez	90-100	Bright orange skin, orange moist flesh, long tapered root.
O'Henry	90-100	White skin, cream flesh, uniform shape, very high yield.
Covington	110	Rose colored skin, orange flesh, very uniform and high quality roots, strong vines.
Japanese/Murasaki	100-105	Purple skin, dry-white flesh, good yields, strong skin, for farmers markets.

Often, to reduce risk of soilborne diseases, cuttings of vines are used instead of slips. Cuttings are taken 1 to 2 inches above the soil line and will have no roots when set. Slips may be set by hand, but most commercial Kentucky growers use a one-row tobacco setter that applies about ½ pint of water with each slip. Large commercial growers use a two-row plant setter. A starter solution is preferred to water. Add 3 pounds of 10-52-17 fertilizer to 50 gallons of water and use about ½ pint of this starter solution per slip (plant).

Rows should be spaced 40 to 44 inches apart and plants should be spaced in the row every 10 to 12 inches. A spacing of 10 inches apart within row and 44 inches between rows requires about 13,400 plants to set an acre. Replace missing plants to avoid oversized roots.

### Fertilizing

Sweetpotatoes grow well at a soil pH of 5.0 to 6.0. Broadcast all fertilizer and disk into soil well before transplanting.

### Harvesting

Sweetpotatoes continue to grow until the vines are killed by frost. Therefore, you should harvest the crop when the greatest number of 8- to 10-ounce potatoes are found in the hill. Sample digging will provide this information. A good practice is to mow the vines before harvesting. The crop can then be harvested with less damage to the potatoes. Use a turn plow or a potato digger to expose the roots with the least possible injury. Plow out one row at a time and pick up the potatoes. Grade potatoes in the field and place them in containers

### FERTILIZER: *Sweetpotatoes*

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
Phosphorus	Phosphate (P <sub>2</sub> O <sub>5</sub> )	
Low	<31	121-180
Medium	31-60	61-120
High	61-80	1-60
Very High	>80	0
Potassium	Potash (K <sub>2</sub> O)	
Low	<201	251-275
Medium	201-300	101-250
High	301-450	51-100
Very High	>450	50
Nitrogen	N	
Apply 30 to 50 lb/A of actual nitrogen (N).		

that are to be put in storage. For large-scale production, mechanical harvesting machinery can be used economically.

### Curing and Storing

Stack crates or baskets in the storage space. Place them 6 to 8 inches off the floor and 12 to 15 inches from the walls to allow for adequate ventilation. Curing requires seven to 10 days if the temperature can be maintained at 80° to 85°F with 70 to 90 percent relative humidity. After curing is completed, the potatoes should be kept in a place as near 55°F as possible with a relative humidity of 85 percent. Higher market prices occur during the winter months and usually permit the grower with a stored crop to increase profits substantially.

### Preparing for Market

If the crop is to be sold, the potatoes should be graded to meet the buyer's requirements. They should be prepared for market by cleaning, either by brushing or washing, and waxing before packing in

crates or baskets. A box of sweetpotatoes on the wholesale market often weighs 40 to 44 pounds.

## Common Diseases/Management

### Transplant production beds

Purchase either certified transplants or produce your own plants. Start with certified, disease-free roots planted in a commercial growing mix or in new sand for best results. If this is not possible, consider the following measures: Sanitize beds or greenhouses; if bedding material is reused or if soil is used, then work up the material to a depth of 8 to 10 inches and steam-sterilize (180°F for 30 minutes) or fumigate. Fumigants for this use include chloropicrin and metam-sodium applied as a drench or injected. See “Soil Fumigants for Control of Nematodes and Soilborne Diseases” on page 16 for more information.

Before bedding, dip “seed” roots for two minutes into a solution of a labeled seed-treatment fungicide and plant immediately. Soil or media temperatures in the beds should be maintained at around 80°F to encourage rapid plant growth and reduce rotting. Using sprouts that are cut above the soil line is a great aid in reducing certain transplant-borne diseases.

**Black rot, Sclerotinia blight, and scurf.** Removing slips above the soil line and re-rooting will adequately control scurf but not black rot. Use crop rotations of three to four years away from sweetpotatoes. Carefully handle roots during harvest to avoid bruising. Follow all harvesting and post-harvest handling guidelines, including proper curing, to reduce the incidence of the post-harvest phases of these diseases.

**Fusarium wilt.** Use resistant varieties and only nitrate forms of nitrogen on

problem fields. High soil pH will improve control of Fusarium wilt but will also favor soil pox. Rotation for three years away from sweetpotatoes is also helpful. Use certified, disease-free seed roots and transplants. Sweetpotatoes and tobacco are susceptible to the same strains of *Fusarium*, so avoid growing them in rotation. If they must be grown in rotation, use Fusarium wilt-resistant varieties for both crops and control nematodes.

**Nematodes.** Use rotation for two or more years to tall fescue. Preplant nematicides are options. See “Soil Fumigants for Control of Nematodes and Soilborne Diseases” on page 16 for more information.

**Post-harvest rot.** Harvest and handling conditions greatly influence susceptibility to post-harvest decays. Avoid chilling injury. Roots exposed at any time to temperatures below 50°F can become very susceptible to rots. Follow proper curing protocols to ensure adequate wound healing. Store only blemish-free roots; discard damaged or rotted roots. Botran 75 WP at 1 pound per 100 gallons of water or Scholar SC at 16 to 32 fl ounces per 100 gallons of water is labeled as a post-harvest dip or spray (after cleaning roots but before packing) to control these rots. Calcium hypochlorite 65% at 10 ounces per 100 gallons of water also is labeled as a post-harvest spray for general sanitation.

**Pox.** To prevent pathogen buildup, practice crop rotation as recommended for black rot and maintain acid soils (below pH 5.5) for fields routinely used for sweetpotatoes. Use disease-free roots and transplants. Soil fumigation may be necessary for serious cases—see “Nematodes” above for information on fumigants.

## PESTICIDE SAFETY: Sweetpotatoes

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days) <sup>2</sup>
<b>INSECTICIDES</b>			
Actara 25 WDG	C	12	14
Admire Pro	C	12	12 <sup>3</sup>
Assail 30 SG	C	12	7
Avaunt 30 DG	C	12	14
Belay 21.3 SC	C	12	14
Beleaf 50 SG	C	12	7
Coragen 1.67 SC	-	4	14
Fulfill 50 DF	C	12	14
Intrepid 2 F	C	4	7
Lorsban 4 E	W	24	125
Lorsban 15 G	C	12	125
Lorsban 75 WP	W	48	125
Malathion 8	W	12	3
Miteus 0.42 EC	W	12	7
Movento 2	C	24	7
Oberon 2 SC	C	12	7
Platinum 2 F	C	12	AP
Rimon 0.83 EC	W	12	14
Scorpion 35 SL	C	12	7 <sup>4</sup>
Sevin XLR	W	12	7
Sivanto 1.67 SL	C	12	7
<b>Restricted Use</b>			
AgriMek 0.15 Ec	W	12	14
Battalion 1.5 EC	DP	12	3
Baythroid XL	W	12	0
Brigade 2 EC	W	12	21
Hero 1.24 EW	C	12	21
Mustang Max	W	12	1
Renounce 20 WP	C	12	0
Vydate L	DP	48	AP
Warrior II	W	24	7
<b>FUNGICIDES</b>			
Aftershock	C	12	7
Botran 75 W	C	12	0
Botran 5F	C	12	0
Endura	W	12	10
Evito 480 SC	C	12	7
Headline EC/SC	W	12	3
Maxim 4 FS	C	0	0
Mertect 340 F	C	12	0
Meta Star 2EC AG	W	48	0
Presidio	C	12	7
Quadris	C	4	14
Quadris Top	C	12	14
Reason 500 SC	C	12	14
Ridomil Gold EC/SL	C	48	0
Scala SC	C	12	17
Scholar SC	C	0	0
Switch 62.5 WDG	C	12	7
Ultra Flourish	W	48	0

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison

<sup>2</sup> AP: At planting.

<sup>3</sup> PHI dependent on application method.

## INSECT CONTROL: Sweetpotatoes<sup>1</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>SOIL APPLICATION</b>			
<b>Wireworms</b>			
Belay 2.13 SC	6 to 12 fl oz	12 fl oz	At transplanting or cultivation.
Brigade 2 EC	3.2 to 9.6 fl oz	32 fl oz	At cultivation.
Brigade 2 EC	9.6 to 19.2 fl oz	32 fl oz	Preplant only.
Lorsban 15 G	13.5 lb	1 application	Preplant incorporated. Note extended PHI.
Lorsban 4 E	4 pt	1 application	Preplant incorporated. Note extended PHI.
<b>FOLIAR APPLICATION</b>			
<b>Flea Beetles, Tortoise Beetles</b>			
Battalion 1.5 EC	1.5 to 2.4 fl oz	12 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	16.8 fl oz	Limit 2.8 fl oz per 5-day interval. For flea beetles.

(continued on next page)

**INSECT CONTROL: Sweetpotatoes<sup>1</sup> (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Brigade 2 EC	2.1 to 6.4 fl oz	32 fl oz	Limit 2 applications. Allow 21 days between applications.
Mustang Max	1.76 to 4 fl oz	24 fl oz	Allow 4 days between applications.
Sevin XLR	1 to 2 qt	8 qt	Limit 8 applications. Allow 7 days between sprays.
Warrior II	1.28 to 1.92 fl oz	7.68 fl oz	-

**Leafhoppers**

Actara 25 WDG	1.5 to 3 oz	6 oz	Allow 7 days between applications.
Battalion 1.5 EC	1.5 to 2.4 fl oz	12 fl oz	-
Baythroid XL	0.8 to 1.6 fl oz	16.8 fl oz	Limit 2.8 fl oz per 5-day interval.
Malathion 8	1 to 1.75 pt	2 applications	Allow 7 days between applications.
Miteus 0.42 EC	2 pt	4 pt	Allow 7 days between applications.
Mustang Max	1.76 to 4 fl oz	24 fl oz	Allow 4 days between applications.
Sivanto 1.67 SL	7 to 10.5 fl oz	28 fl oz	Allow 7 days between applications.
Warrior II	0.96 to 1.6 fl oz	7.68 fl oz	-

**Sweetpotato Weevil:** Prior to planting, dip sweetpotato cuttings in suspension of Sevin XLR at a rate of 2.6 fl oz/gal water.

Baythroid XL	1.6 to 2.8 fl oz	16.8 fl oz	Limit 2.8 fl oz per 5-day interval.
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<sup>1</sup> Generic products available (Appendix E).

**WEED CONTROL: Sweetpotatoes**

Product Amt/A	Lb A.I./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 11.6 fl oz/A. PHI = 7 days.
1.3-4 pt Command 3ME	0.48-1.5 clomazone	For preplant incorporated or pre-emergence control of annual grasses and broadleaves. Use a maximum of 1.5 pt/A in a single application after transplanting and before weed emergence. PHI = 95 days, 125 days if more than 3.3 pt was applied.
6-14 lb Dacthal W-75	4.5-10.5 DCPA	For pre-emergence control of annual grasses and small-seeded broadleaves. May be sprayed over transplants (slips). Layby applications can be made up to 6 weeks after transplanting.
2-4 lb Devrinol 50 DF	1-2 napropamide	For control of annual grasses and broadleaf weeds. Apply before transplanting and water-in or incorporate to a depth of 1 to 2 inches in 10 to 50 gal water/A. Can be applied immediately after transplanting. To avoid injury, do not replant with crops not specified on the label for 12 months if using the 4-lb rate. Only herbicide approved for slip (transplant) beds.
1 pt Fusilade-DX 2E	0.25 fluazifop-p	For selective post-emergence control of annual grasses and suppression of perennial grasses. Include 1% v/v crop oil or 0.25% v/v non-ionic surfactant/A. PHI = 55 days. Max. rate is 48 fl oz/A.
16-22 fl oz Roundup WeatherMax 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop.
9-32 fl oz Select Max	0.07-0.24 clethodim	For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. PHI = 30 days.
0.5-1 oz Valor 51DG	0.024-0.032 flumioxazin	For post-emergence control of broadleaf weeds and yellow nutsedge. For use on 'Beauregard' variety only. Apply 2 to 5 days before transplanting. Do not use greenhouse-grown transplants. Max. rate 2.5 oz/A.

**DISEASE CONTROL: Sweetpotatoes**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Damping-off (Pythium)</b>					
MetaStar 2EC AG	4	0	4 to 8 pt	1 app	Apply-soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil mechanically (preplant) or with irrigation (pre- and at-planting) if rainfall is not expected within 24 hours of treatment.
Ridomil Gold SL	4	0	1 to 2 pt		
Ultra Flourish	4	0	2 to 4 pt		
Presidio	43	7	3 to 4 fl oz	12 fl oz	Can be applied as a drench or through drip irrigation at planting; soil-directed applications can be made during the season.
<b>Foliar Diseases</b>					
Aftershock	11	7	2 to 3.8 fl oz	6 apps	Apply before disease onset, continue every 7 to 10 days.
Azoxystrobin <sup>3</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin <sup>3</sup>	11	14	6 to 15.5 fl oz <sup>3</sup>	4 apps	
Azoxystrobin <sup>3</sup>	11	14	6 to 15.5 fl oz <sup>3</sup>	4 apps	
Quadris	11	14	6 to 15.5 fl oz <sup>3</sup>	4 apps	
Satori	11	14	6 to 15.5 fl oz <sup>3</sup>	4 apps	
Evito 480 SC	11	7	3.8 fl oz		-
Headline	11	3	6 to 12 fl oz <sup>3</sup>	72 fl oz	Apply before disease onset, continue every 7 to 14 days as needed.
Headline SC	11	3	6 to 12 fl oz <sup>3</sup>	72 fl oz	Apply before disease onset, continue every 7 to 14 days as needed.
Quadris Top	11/3	14	8 to 14 fl oz	55.3 fl oz	Apply before disease onset, continue every 7 to 10 days.
Reason	11	14	5.5 to 8.2 fl oz	16.4 fl oz	Apply before disease onset, continue every 5 to 10 days.
Scala	9	17	7 fl oz	35 fl oz	Apply before disease onset, continue every 7 to 14 days.
Switch 62.5 WG	9/12	7	11 to 14 oz	56 oz	Apply every 7 to 10 days. Make only two applications on radish.
<b>Scurf, Black Rot, Sclerotinia Blight, Post-harvest Rot</b>					
Botran 75 W	14	0	2 lb/15 gal water	1 app	Seed dip. For control of scurf, dip seed in solution for 10 to 15 seconds and plant immediately. Discard unused solution daily.
Botran 5F	14	0	2.4 pt/15 gal water		
Botran 75 W	14	0	4.8 oz/1,000 row-feet	1 app	Plant bed application. For control of Sclerotinia blight, spray or sprinkle solution over bedded seed before covering.
Botran 5F	14	0	5.73 fl oz/1,000 row-feet		

(continued on next page)

**DISEASE CONTROL: Sweetpotatoes (continued)**

Product	FRAC Code	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Botran 75 W	14	0	0.5 to 1 lb/100 gal water	1 app	Post-harvest dip. Dip harvested tubers in solution, or spray; do not rinse after treatment. Use low rate for dip. For suppression of rhizopus rot.
Botran 5F	14	0	1.2 pt/100 gal water		
Endura	7	10	5.5 to 10 oz	20 oz	Sclerotinia. Apply before disease onset, continue every 7 to 14 days.
Maxim 4 FS	12	0	0.08 to 0.16 oz/cwt	1 app	Dip seed pieces in a water-based slurry; spread and allow to dry.
Mertect 340 F	1	0	3.3 qt/100 gal water	1 app	Dip seed pieces in solution for 1 to 2 minutes; plant immediately afterward. Discard solution when it becomes dirty or volume becomes too low to treat.
Scholar SC		0	16 to 32 fl oz/100 gal	1 app	Use as a post-harvest dip and low volume application. Dip for approximately 30 seconds and allow fruit to drain. Add 8 fl oz of Scholar SC to 100 gals. of treating suspension after 500 bushels are treated. After each 1,000 bushels treated, drain and flush the tank. Refill with fresh dip suspension.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Use higher rate when pressure is severe.

# Tomatoes

Nightshade family (Solanaceae): *Solanum esculentum*

## Planting and Culture

Staked tomatoes for fresh market sales have been most profitable when planted and given protection for the very early market or when planted for a late fall crop and harvested just before frost. Tomatoes are usually transplanted during the latter part of April or early May for the spring crop and in mid-July for the fall crop (see Appendix J). A well-drained soil that warms up quickly in the spring is most desirable. Be careful following corn or soybeans because common herbicides used in these crops can be very damaging to tomatoes (see the “Herbicide Label Restrictions” table on page 10). Also be wary of plantings close to your neighbor’s corn, soybeans, or small grains, because tomatoes are very sensitive to herbicide drift from these crops. If possible, avoid low-lying fields subject to late frosts and high humidity.

Think twice about locating your tomato planting on land used for tobacco. Although tobacco ground may represent some of the best land on a farm, it is not advisable to grow tomatoes (or peppers or potatoes) after tobacco for a period of at least three years because these crops are susceptible to many of the same diseases. Tomatoes should also not follow tomatoes on the same land for a period of at least three years. Tomatoes should not be grown in short rotation with crops in the same family (tobacco, peppers, potatoes, eggplant, etc.) nor with any of the vine crops (cucumbers, squash, pumpkins, melons, etc.) as all of these are susceptible to *Phytophthora* blight. Tomatoes do well when transplanted to fields where fescue sod was plowed under the previous fall. Soil should be plowed 8 to 10 inches deep

## VARIETIES: Tomatoes—Fresh Market

Variety	Days to Maturity	Comments
<b>LARGE RED</b> (all are determinate hybrids)		
Sunshine	65	Sunshine is among the earliest commercial varieties available, for shipping or local sales. Plants are small and should not be pruned; should receive at least 50 lb preplant nitrogen; early blight susceptible. Fruit quality deteriorates after peak harvest. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Verticillium Wilt 1
Red Deuce	71	Very large smooth fruit. Fruit size holds with average fruit weight 1 lb. Good for high tunnels production as well. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Verticillium Wilt 1, Alternaria stem canker, Gray Leaf Spot.
Rocky Top	76	Large smooth uniform fruit averaging 3/4 lb. Good for high tunnels production as well. <b>Disease resistance:</b> Fusarium Wilt 1, 2, 3, and Gray Leaf Spot.
Mountain Spring	72	Earliest of “Mountain” series; crack-resistant fruits; excellent for shipping. Spring and summer planting. Highly susceptible to early blight. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Verticillium Wilt 1
Florida 47 R	75	Good yield and nice uniform 10-12 oz fruit. <b>Disease resistance:</b> Alternaria stem canker, fusarium wilt race 1 and 2, verticillium race 1, and gray leaf spot.
Mountain Glory	72	Disease resistance: Fusarium Wilt 1, 2, Verticillium Wilt 1, TSWV
BHN 543	72	High yielding but less crack tolerant than “Mountain” series varieties. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Verticillium Wilt 1, Nematodes
Phoenix	72	Good for later plantings, sets well in high temperatures. <b>Disease resistance:</b> Alternaria stem canker, Fusarium Wilt 2, Verticillium Wilt 1
Amelia	75	Resistant to nematodes and intermediate resistance to tomato spotted wilt virus (TSWV). <b>Disease resistance:</b> Fusarium Wilt 1, 2, 3, Verticillium Wilt, TSWV
Crista	75	Good yields, long shelf life, firm 10 to 12 oz fruit. <b>Disease resistance:</b> Fusarium Wilt 1, 2, 3, Verticillium Wilt, TSWV
Nico	76	Medium (8 to 9 oz) fruit, midseason beefsteak type, very uniform, produces over a short period of time. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Nematodes, Verticillium Wilt 1, TSWV, Alternaria Stem Canker
Mountain Fresh Plus	77	Crack-resistant fruit, mid-season; excellent flavor; for local sales or shipping. resistant. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Verticillium Wilt 1, Nematodes, Early Blight tolerance
Red Defender	77	Good midseason variety, mostly large and extra large fruits, uniform. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Verticillium Wilt 1, TSWV, Alternaria Stem Canker
BHN 602	77	10-12 oz globe fruit with high yields good mid- and late-season tomato. <b>Disease resistance:</b> Fusarium Wilt 1, 2, 3, Verticillium Wilt 1, TSWV
<b>ROMA/PEAR/PASTE</b>		
Pony Express	69	Concentrated early fruit set allows for short harvest window, 4 oz fruit, good performer in Kentucky. <b>Disease resistance:</b> Fusarium Wilt 1, 2, 3, Verticillium Wilt, TMV, Nematodes
Plum Crimson	80	Determinate hybrid; contains gene for early dark red interior color, high lycopene content, productive and early blight tolerant. <b>Disease resistance:</b> Fusarium Wilt 1, 2, 3, Verticillium Wilt 1
Plum Regal	80	Pear/plum-shaped, high yielding variety, 4 oz. fruits. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Verticillium Wilt, TSWV, Late blight, Early Blight
<b>YELLOW/GOLD FRUIT</b>		
Carolina Gold	72	Determinate; large, tangerine-colored, smooth, crack-resistant fruit for shipping or local sales. Early to midseason with resistance to gray wall; also excellent for fried green tomatoes. Tangerine color. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Verticillium Wilt 1, susceptible to early blight and bacterial leaf spot.
<b>GRAPE</b>		
Golden Sunshine	59	Yellow color, large indeterminate plant.
Tami G	60	Indeterminate; ½ to ¾ oz oval fruit, vigorous, yields well and picks for an extended season.

(continued on next page)

**VARIETIES: Tomatoes—Fresh Market (continued)**

Variety	Days to Maturity	Comments
Smarty	68	Small 1/2 to 1 oz fruit, compact plant. <b>Disease resistance:</b> Fusarium Wilt 1, Verticillium Wilt
<b>CHERRY</b>		
BHN 268	65-68	1 oz fruit, good shipper and shelf life. <b>Disease resistance:</b> Fusarium Wilt 2, Verticillium Wilt
Cherry Grande	65	Strong determinate—1¼ inch diameter, very sweet fruit. Shipping and local sales. <b>Disease resistance:</b> Fusarium Wilt, Verticillium Wilt
Sweet Chelsea	65	Indeterminate—1½ inch diameter very sweet fruit. Shipping and local sales. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Verticillium Wilt, Nematodes, TMV
Mountain Magic	72	Larger saledette type, indeterminate, excellent flavor. <b>Disease resistance:</b> Fusarium Wilt 1, 2, Early Blight, Late Blight, Verticillium Wilt
<b>HYDROPONIC</b>		
Big-Beef (see comments)	70	Not a true hydroponic variety, but successfully grown for spring-early summer hydroponic production, not for full season (10 month) production (yields decline after 6 months). <b>Disease resistance:</b> Fusarium Wilt 2, Verticillium Wilt, Nematodes, Alternaria Stem Canker
Trust	78	The most popular hydroponic tomato grown, very reliable, will split in adverse conditions. Disease resistance: Fusarium Wilt 1, 2, Verticillium Wilt, Fusarium Crown and Root Rots, TMV, leaf mold races A-E (may not adequately control disease, see page 99).
Geronimo	78	Extremely vigorous plants, high yields, small stem scar, good performer. <b>Disease resistance:</b> Fusarium Wilt 2, Verticillium Wilt, TMV
Big Dena	73	Large to extra-large fruit, uniform shape, good shelf life. <b>Disease resistance:</b> Leaf mold, Fusarium wilt 0,1, ToMV, and TMV
Arbason	76	7-9 oz fruit with good yields and quality. <b>Disease resistance:</b> Fusarium wilt 1,2, Verticillium wilt, ToMV
<b>INDETERMINATE, SPECIALTY, AND HEIRLOOM<sup>1</sup></b>		
Better Boy	72	Indeterminate, large fruit. On-farm and local sales only. Spring planting. <b>Disease resistance:</b> Fusarium Wilt 1, Verticillium Wilt, Root-knot Nematode
Buck's County Hybrid	72	Hybrid; for local sales. Deep red, round fruit.
Lemon Boy	72	Yellow, indeterminate F1 hybrid for local sales; spring and summer planting. <b>Disease resistance:</b> Verticillium Wilt 1, Fusarium Wilt, Nematodes
Pink Girl	76	Hybrid; for local sales. <b>Disease resistance:</b> Verticillium Wilt 1, Fusarium Wilt 1
Odoriko	76	Pink hybrid; great taste but susceptible to cracking. <b>Disease resistance:</b> Verticillium Wilt 1, Fusarium Wilt 1, Nematodes
Delicious	77	Very large 1 1/2 to 2 1/2 lb fruit; solid red with small seed cavities; resists cracking.
San Marzono	78	Hybrid, small oblong 5 to 6 oz fruit, meaty flesh, good for canning, high quality fruit. <b>Disease resistance:</b> Fusarium Wilt 2, Verticillium Wilt
Mortgage Lifter	85	Large 1 lb fruit, pink, smooth and uniform in size, very meaty with few seeds; very heavy producer.
Arkansas Traveler	85	Medium 1/2 lb fruit, pink, smooth and uniform, good producer in hot weather.
Kentucky Beefsteak	90	Medium 1/2 lb fruit, yellow-orange with deep ridges at stem end; retains green shoulders on stem end when ripe.
Giant Belgium	90	Large 1 to 2 lb and larger fruit; solid dark pink flesh; very sweet; less cracking than other heirlooms; heavy producer.
German Johnson	80-90	Large-fruited "heirloom;" for local sales. Susceptible to cracking and roughness.
Big Rainbow	90-100	Large 1 to 2 lb fruit, meaty, golden orange-yellow with red stripes radiating from blossom end; prone to cracking.

<sup>1</sup> "Heirloom" tomato varieties have become popular for farm market and local sales. Growers should be aware that seed of some of these varieties may have become contaminated with TMV, *clavibacter* (canker), and *Xanthomonas* (bacterial spot), and should not be grown adjacent to plantings of other commercial varieties. Indeterminate varieties are best grown using wider in-row spacings of 24 to 36 inches and longer stakes (6 feet) or cages. UK trials of two popular varieties, "Brandywine" and "Cherokee Purple," have shown that fruit quality and appearance are highly variable from year to year; this variability likely stems from different seed sources. Growers are encouraged to test varieties from different sources before large-scale plantings.

and disked well in the spring to produce a firm plant bed.

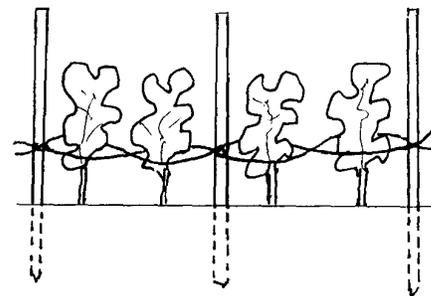
Stocky, container-grown plants are most desirable for transplanting. Although it is possible to use bare root plants on bare ground plantings, higher early yields will be obtained from container-grown plants. Larger cell trays or containers (up to 3 inches) produce higher early yields than small containers or bare root plants. Early tomatoes generally command higher prices, which usually more than offset the higher cost of good quality, container-

grown plants. During transplant production, the greenhouse temperature should not be allowed to drop below 60°F, or the fruit in the first few clusters may become cat-faced.

Most growers use approximately 4,200 to 5,000 plants per acre. Plants are usually grown in rows 6 feet apart with plants 18 to 22 inches apart in the row. Most varieties should be pruned, staked, and trellised to obtain higher and earlier yields. A satisfactory trellis (Figures 1a and 1b) may be constructed using 1-inch-square, 5-foot-long

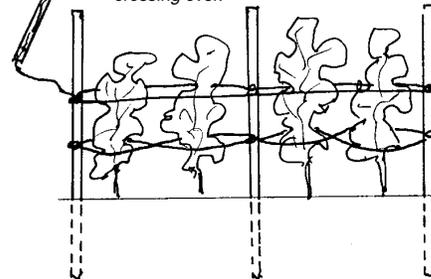
**Figure 1a.**

Cross over between plants when weaving the first row.

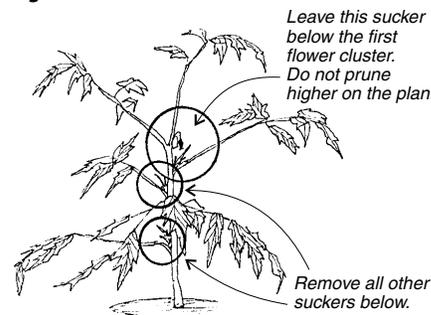


**Figure 1b.**

Second, third, and fourth rows of twine are pulled along sides of plants without crossing over.



**Figure 2.**



stakes driven 10 to 12 inches into the soil between every other plant (approximately 2,100 to 2,500 stakes per acre). A simple, hand-operated stake-driving tool can be made from a 36-inch length of 2½-inch galvanized pipe with a cap screwed or welded on one end. Slide the pipe down over the stake, striking down repeatedly with force to drive stakes.

The first stringing should be about 10 inches above the soil and should be done when the plants are 12 to 15 inches high. A simple stringing tool can be made by drilling holes in each end of a short length of broomstick. Tomato twine is passed through the holes in the tool, which is used to pass the string along one side of the row, looping the string around each stake. It is important to keep the twine pulled tight. Proceed to the end of the row and return on the opposite side passing the string along the other side of the plants, again looping each stake. It is helpful at the first stringing to cross the string

between plants (Figure 1a). To maintain a well-trained system, subsequent strings should be put up as the plants grow. Three to four stringings are desirable, each about 6 to 10 inches higher than the preceding one. "Crossing over" or weaving with twine between plants, is not necessary after the first stringing (Figure 1b).

Pruning will help maintain the desired balance between vegetative growth and fruit production. Little or no pruning results in more vine growth with a heavier load of smaller fruit. Moderate pruning results in a smaller vine and larger fruit that mature earlier. Except for small-vined, very early-maturing tomato varieties such as 'Sunshine' (which should not be pruned at all), remove all suckers up to the one immediately below the first flower cluster (Figure 2). Leave this lateral shoot to form a fork just below the first fruit cluster. A single pruning when basal suckers are no longer than 3 or 4 inches will usually be adequate (especially on large fruited cultivars).

At transplanting, apply 1/2 pint of a starter fertilizer to each plant. Prepare the starter fertilizer by mixing 3 pounds of a 10-52-17 or similar analysis fertilizer in 50 gallons of water.

Higher yields and profits will be obtained using a system of producing tomatoes on 6- to 8-inch raised beds covered with black plastic mulch with drip irrigation and fertiga-

tion. Most growers prefer embossed plastic mulch, which seems to be more durable and tear-resistant than smooth plastic. When using the plasticulture system, it is extremely important to monitor moisture levels under the plastic. Many Kentucky growers have substantially reduced their yields and fruit size by incorrectly assuming that if the field is muddy between the rows, there is sufficient moisture beneath the plastic. Use tensiometers to monitor soil moisture levels and check them daily to determine irrigation intervals. Two tensiometers are recommended, one at a 6-inch depth and one at 12 inches. Contact your county Extension agent or irrigation supply sales representative for more information on setting up a drip irrigation/fertigation system.

### Efficient Fertilizing

Growing a high-investment, high-dollar crop such as staked tomatoes requires that the best information available be used whenever possible. Soil testing is an important tool that should always be used to determine fertilizer needs. Apply lime if needed to raise the pH to 6.5 to 6.8. Apply phosphate, potash, magnesium, and calcium as required based on soil test results. Soil test magnesium levels should be at least 200 pounds per acre (see Appendix B). Potassium and especially phosphorus are likely to accumulate in most Kentucky soils following several years of heavy applications for vegetable crops or tobacco.

Consider the previous crop when deciding how much N to apply; there will probably be some residual N following a crop that received heavy doses of N fertilizer during the previous season. Apply 50 pounds of N per acre preplant regardless

of the type of irrigation system used. Simple, handheld electronic meters are available that growers can use to quickly determine the nitrogen status of soils and plants. These Cardy meters can be used to determine residual nitrate levels in soils prior to planting as well as measure N levels in plant sap in order to assess the efficiency of fertigation.

The fertigation recommendations have worked well for growers in Kentucky when tomatoes are grown on black plastic mulch with drip irrigation. This schedule is based on a standard plant population of 4,200 plants per acre (five-row blocks, beds on 6-foot centers and 18 inches between plants within rows) using the 'Mountain Spring' variety. Fertigation should begin about 10 days after transplanting and continue throughout the season. A grower may need to modify the recommendations slightly depending on length of harvest period, soil type, previous crop, weather conditions, etc.

Calcium nitrate and potassium nitrate are commonly used water-soluble sources of nitrogen. The simplest system that has worked well on medium-textured soils in Kentucky uses calcium nitrate or potassium nitrate injected into the drip irrigation water.

**Soil tests and ripening disorders.** A soil test should always be done prior to planting for every site used for fresh market tomatoes. The University of Kentucky soil test reports for tomatoes now also include a Hartz ratio calculation. Based on the nutrient balance in your soil, the Hartz ratio indicates if your site is at risk for certain types of fruit-ripening disorders

#### FERTILIZER: Tomatoes

The following fertilizer rates are to be used only as guidelines. Research at the University of Kentucky and at the University of Tennessee indicates that there is no yield increase from using more than 60 lb/A K<sub>2</sub>O or 60 lb/A of P<sub>2</sub>O<sub>5</sub> when soil test P and K levels are high.

Soil Test Results (lb/A)	Fertilizer Needed (lb/A)	
<b>Phosphorus</b>	<b>Phosphate (P<sub>2</sub>O<sub>5</sub>)</b>	
Low	<31	181-240
Medium	31-60	61-180
High	61-80	1-60
Very High	>80	0
<b>Potassium</b>	<b>Potash (K<sub>2</sub>O)</b>	
Low	<201	121-250
Medium	201-300	61-120
High	301-450	1-60
Very High	>450	0

Basal nitrogen where tomatoes:	N
1. follow grass-legume or legume sod	30
2. follow grass sod	50
3. are grown on continually cropped land	60

**Supplemental applications:** On bare ground plantings, apply an additional 30 lb of nitrogen/A as a sidedressing when the first fruits are golf-ball size. A second sidedress application of 30 lb N may also be desirable two or three weeks later, depending on the crop's growing condition. For plasticulture with drip on medium-textured soils, apply all recommended phosphorus and potassium requirements prior to laying plastic mulch. See "Fertigation" table for N application rates.

#### FERTIGATION: Staked Tomatoes<sup>1</sup>

Moderate Rate	
Actual N/week:	7 lb 8 oz/A
Calcium	48 lb 6 oz/A
Nitrate	11 lb 8 oz/1,000 plants

High Rate	
Actual N/week:	10 lb/A
Calcium	64 lb 8 oz/A
Nitrate	15 lb 6 oz/1,000 plants

#### AT-RISK SITES

Moderate Rate	
Actual N/week:	7 lb 8 oz/A
Potassium	57 lb 11 oz/A
Nitrate	13 lb 12 oz/1,000 plants

Potassium	25 lb 6 oz/A
Nitrate:	6 lb 1 oz/1,000 plants
K provided	

High Rate	
Actual N/week:	10 lb/A
Potassium	76 lb 15 oz/A
Nitrate	18 lb 5 oz/1,000 plants
Potassium	33 lb 14 oz/A
Nitrate:	8 lb 1 oz/1,000 plants
K provided	

Total amount/season:	125 lb/A (moderate rate) 150 lb/A (high rate)
Preplant amount:	50 lb/A
Fertigated amount:	75 lb/A (moderate rate) 100 lb/A (high rate)
Growing season:	10 weeks

Fertigation can begin 10 to 14 days after transplanting.

The doses for 1,000 plants are based on a plant population of 4,200 plants/A (i.e., rows on 6 foot centers in 5-row blocks and plants 18 inches apart).

For harvest seasons extending beyond 10 weeks from transplanting, a maintenance dose of 1 to 1.5 N (6.5 to 9.7 lbs of calcium nitrate, or 11.5 lbs of potassium nitrate for "at risk" sites) per week is adequate.

**IMPORTANT:** If a UK soil test indicates your site is "at risk" for ripening disorders (Hartz ratio), you should alternate the fertigations listed above with those listed at left.

Potassium nitrate supplies both nitrogen and potassium and can be used as a substitute for calcium nitrate.

<sup>1</sup> All recommendations assume starter fertilizer was used.

such as blotchy ripening, yellow shoulder, and internal white tissue. This information helps determine the type of fertigation program that should be followed to help reduce your risk of having these disorders.

More often than not, ripening problems are associated with low levels of soil potassium and occur most often on soils with low cation exchange capacities (CECs). If the Hartz ratio indicates your soil is at risk, we recommend fertigation with a potassium source such as water-soluble muriate of potash (0-0-60) or potassium nitrate (14-0-45). See the "Fertigation" table for recommended rates. This is in addition to any preplant potassium.

Ripening disorders have also been associated with excess nitrogen and any conditions that restrict the tomato plant's root system (soil compaction, waterlogging, drought, etc.). During hot, dry years every other fertigation should contain potassium nitrate. More blotchy ripening occurs after extended periods of cloudy weather. Some tomato varieties are much more susceptible to blotchy ripening than others. Typically varieties recommended in this publication, while not immune to blotchy ripening, are less susceptible.

**Magnesium deficiencies.** Mild magnesium deficiencies sometimes appear at midseason on plants with very heavy fruit loads. A typical symptom is yellowing between the veins (veins remain green) on the lower leaves of the plant. Magnesium deficiency problems are more likely to occur on sandstone-derived soils and in very dry years. High rates of ammonium nitrate during fertigation also contribute to Mg deficiency.

Frequent fertigations with potassium or calcium nitrate could make the problem worse by competing with and displacing magnesium in soils. Mild symptoms are not generally a problem, and corrective measures are not necessary; however, symptoms may become severe and appear on the entire lower portion of the plant. In such cases, and especially on low CEC soils, preventive and/or corrective measures are required.

In general, it is recommended to have at least 200 pounds per acre of magnesium on soil tests for staked tomatoes prior to planting. Magnesium sources include dolomitic lime (11 to 12% Mg), epsom salts (= magnesium sulfate, 10 to 16% Mg), magnesium nitrate (6.3% Mg), and magnesium oxide (45 to 55% Mg). Epsom salts and magnesium oxide can be fertigated through the drip system: make weekly applications of 1 to 2 pounds actual

magnesium per acre (10 to 20 pounds per acre epsom salts or 2 to 4 pounds per acre magnesium oxide). Application rates may vary with solubility of the materials (check with the manufacturer). A better long-term solution is to raise soil test magnesium levels with dolomitic lime prior to planting.

**PESTICIDE SAFETY: Tomatoes**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>INSECTICIDES</b>			
Acramite 50 WS	C	12	3
Actara 25 W	C	12	0
Admire Pro	C	12	0/21 <sup>3</sup>
Assail 30 SG	C	12	7
Avaunt 30 DG	C	12	3
Azera	C	12	0
Belay 2.13 SC	C	12	7/21 <sup>3</sup>
Beleaf 50 SG	C	12	0
Belt SC	C	12	1
Bt products	C	4/12	0
Closer 2 SC	C	12	1
Confirm 2 F	C	4	7
Coragen 1.67 SC	-	4	1
Courier 40 SC	W	12	1
Dimethoate 4 E	W	48	7
Entrust 2 SC	C	4	1
Exirel 0.83 SE	C	21	1
Fulfill 50 DF	C	12	0
Grandevo 30 W	C	12	1
Intrepid 2 F	C	4	1
Kanemite 15 SC	C	12	1
Knack 0.86 EC	C	12	1
Malathion 8	C	12	1
Movento 2	C	24	1
Nealta 1.67 SC	C	12	3
Oberon 2 SC	C	12	1
Platinum 2 SC	C	12	30
Portal 0.4 EC	W	12	1
Pyganic 5 EC	C	12	0
Radiant SC	C	4	1
Requiem 25 EC	C	4	0
Rimon 0.83 EC	W	12	1
Scorpion 3.5 SL	C	12	1/21 <sup>3</sup>
Sevin XLR	W	12	3
Sivantop 1.67 SL	C	12	1/45 <sup>3</sup>
Trigard 75 WP	C	12	0
Venom 70 SG	C	12	1/21 <sup>3</sup>
<b>Restricted Use</b>			
AgriMek 0.15 EC	W	12	7
Asana XL	W	12	1
Battalion 1.5 EC	DP	12	1
Baythroid XL	W	12	0
Brigade 2 EC	W	12	1
Brigadier 2	W	12	1
Danitol 2.4 EC	W	24	3
Diazinon AG 500	C	24	1
Diazinon 50 W	C	24	1
Endigo ZC	W	24	5
Hero 1.24 EC	C	12	1
Lannate 90 SP	DP	48	1
Leverage 2.7	W	12	0
Mustang Max	W	12	1
Permethrin 3.2 EC	C	12	0
Proaxis 0.5 EC	C	24	5
Proclaim 5 WDG	C	48	7
Renounce 20 WP	C	12	0
Voliam xpress	W	24	5
Vydate L	DP	48	3
Warrior II	W	24	5

**Harvesting, Grading, and Marketing**

Tomatoes are easily damaged and should be handled as carefully as possible in all picking, grading, packing, and hauling operations. Tomatoes should be grasped in the hand with the thumb and

**PESTICIDE SAFETY: Tomatoes**

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)
<b>FUNGICIDES</b>			
Actigard 50 WG	C	12	14
Aftershock	C	12	3
Ag Streptomycin, Agri-Mycin 17, Harbour	C	12	n/a
Aliette WDG <sup>5</sup>	C	12	14
Ariston	C	12	3
Blocker Flowable/4F	C	12	0
Botran 75 W	C	12	10
Cabrio EG	C	12	0
Chlorothalonil <sup>2</sup>	D	12	0
Fixed coppers <sup>2</sup>	D	24/48 <sup>4</sup>	0
Curzate 60 DF	W	12	3
Endura	W	12	0
Evito 480 SC	C	12	3
Flint	C	12	3
Fontelis	C	12	0
Forum SC	C	12	4
Fracture	C	4	0
Gavel 75 DF	C	48	3
Inspire Super	C	12	0
Mancozeb <sup>2</sup>	C	24	5
ManKocide	D	24	5
Meta Star 2EC AG	W	48	28
Priaxor	C	12	7
Quadris	C	4	0
Quadris Opti	W	12	0
Quadris Top	C	12	0
Presidio	C	12	2
Previcur Flex	C	12	5
Rally 40 WSP	W	24	0
Ranman	C	12	0
Reason 500 SC	C	12	14
Revus	C	4	1
Revus Top	C	12	1
Ridomil Gold Bravo SC	W	48	14
Ridomil Gold SL/GR	W	48	28
Ridomil Gold GR	C	48	7
Ridomil Gold Copper	D	48	14
Ridomil Gold MZ	C	48	5
Scala	C	12	1
Switch 62.5 WG	C	12	0
Tanos	C	12	3
Ultra Flourish	W	48	28
Vivando	C	12	0
Zampro	C	12	4
Zing!	C	12	5
Ziram <sup>2</sup>	D	48	7

<sup>1</sup> W: Warning, C: Caution, D: Danger, P: Poison  
<sup>2</sup> Several formulations are marketed. See the general introduction for more details on fungicides.  
<sup>3</sup> Dependent on application rates and types, see label.  
<sup>4</sup> Varies by formulation; consult labels carefully.  
<sup>5</sup> The use of Aliette in the following Kentucky counties has certain restrictions to protect endangered freshwater mollusks and their habitat, so read labels carefully: Campbell, Green, Hart, Kenton, Logan, Marshall, Rockcastle, Todd, Warren, and Wayne.

forefinger pressing against the stem, forcing the stem from the fruit.

When to harvest depends on what market you are growing for. "Vine-ripe" tomatoes that are to be shipped moderate distances are usually harvested at the "breaker" stage or at the "turning" stage. The breaker stage occurs when pink color first becomes noticeable, that is, when the white "star" at the blossom end of the fruit has turned pink, tannish-yellow, or red. In this case, 10 percent or less of the fruit surface shows the color change. Fruits harvested at the breaker stage can be handled and shipped with less damage than those with more color. "Turning" tomatoes are those with more than 10 percent but less than 30 percent of the fruit surface showing a color change from green to tannish-yellow, pink, or red.

Vine-ripe tomatoes must be harvested often (normally twice a week) to avoid having too many red fruit. Tomatoes for local markets should be harvested with much more color, according to customer preferences. Mature green tomatoes for distant markets are picked when the white "star" first appears on the blossom end. This indicates that seed are mature and that fruit will develop normal color when exposed to ethylene gas in a ripening room. Mature green tomatoes are normally harvested only three or four times during the season. Mature green tomatoes should be stored at 55° to 70°F and 85 to 90 percent relative humidity. Firm, ripe fruit should be stored at 45° to 50°F and 85 to 90 percent relative humidity.

All tomatoes must be sorted or graded before going to market. Tomatoes received at Kentucky's larger markets are often graded in the presence of a federal inspector. The USDA's Agricultural Marketing Service has established precise standards for grades of tomatoes. These are available on the Internet at [ams.usda.gov/AMSV1.0/freshmarketvegetablestandards](http://ams.usda.gov/AMSV1.0/freshmarketvegetablestandards). Size classifications for both No. 1 and No. 2 grade tomatoes are shown in the table above (the USDA "small" category is not shown because there is little market for tomatoes of this size). Growers should be aware that some buyers may have their own size classifications that differ from these. "U.S. Combination" grade consists of a combination of Nos. 1 and 2, provided that at least 60 percent by count meet the requirements of No. 1 grade.

All grades must be free from decay, freezing injury, and sunscald and be reasonably well formed. No. 2 grade tomatoes differ from No. 1 grade in that they may be "slightly rough" and "reasonably well formed," whereas No. 1's must be "well

formed" and "smooth." Some buyers will also consider fruits with 60 percent or more color a No. 2 grade.

Pack in the type and size container your market requires. Tomatoes are usually packed in 20 or 25 pounds cardboard cartons and are packed as tightly as possible without bruising. Packs must be of uniform size, color, and quality.

Growers should evaluate their marketing opportunities before the first seed is sown. Roadside stands, U-pick, delivery to local grocers, cooperatives, farmers' markets, and independent buyers are potential channels for selling produce. Contacts need to be made before planting. Beginners should consider the low-volume retail sales opportunities at farmers' markets or roadside stands. Large-scale production usually requires knowledge of wholesale marketing channels that can handle larger volumes of produce. Research at the University of Kentucky has shown that all marketing channels in the state are currently underused.

### Common Diseases/Management General Practices

Control of foliar and stem diseases requires routine sprays of both bactericides and fungicides for most of the season. Timing of sprays and good coverage are critical to disease control (see Introduction for tips on sprayer setup and calibration). A sample fungicide spray program is included below. In addition to regular sprays, start with disease-free transplants and locate production fields away from potatoes and tobacco. Choose sites that have good air and soil drainage and have been rotated out of solanaceous (nightshade family) and cucurbit crops to grasses (fescue, small grains, or corn).

**Anthracnose (ripe rot).** The following recommendations for anthracnose are written for processing crops. With fresh-market tomatoes, the program used for early blight should be sufficient to control anthracnose. Susceptibility increases rapidly in over-mature fruit, especially after applications of ethephon or other fruit ripening agents. Hot-water seed treatment will reduce the potential for anthracnose. A two- to four-year rotation to crops not related to tomatoes, together with good weed control during the rotation, will prevent pathogen buildup in soil. Fungicide sprays are needed on a seven- to 10-day schedule from fruit set through harvest.

**Bacterial canker.** Canker is difficult to control; no single, effective control measure is available. Management of this disease requires an integrated approach. Prevention is the only practical control

### TOMATO SIZE CLASSES

The numbers in parentheses after each category indicate the number of rows and columns of fruit in a box: 6 x 7, for example indicates that in most cases a box of tomatoes in this size category will consist of an arrangement of 6 rows by 7 columns of fruits in one layer.

Size Class	Minimum Diameter <sup>1</sup> (in)	Maximum Diameter <sup>2</sup> (in)
Medium (6 x 7)	2 ¼	2 17/32
Large (6 x 6)	2 ½	2 25/32
Extra Large (5 x 5)	2 ¾ and above	
Maximum Large/ Jumbo <sup>3</sup> (4 x 4 or 4 x 5)	3 ½ and above	

<sup>1</sup> Will not pass through a round opening of this diameter when tomato is placed with its greatest traverse diameter across the opening.

<sup>2</sup> Will pass through a round opening of this diameter in any position.

<sup>3</sup> The USDA no longer lists the Maximum Large or Jumbo classification, however, many buyers require this size pack (4 x 4's or 4 x 5's). The old USDA Extra Large class had a range of 2 7/8 minimum to 3 15/32 maximum.

strategy. The keys to prevention are avoidance, rotation, sanitation, and slowing the buildup of epiphytic populations (those present on plant surfaces) of the canker pathogen.

- **Avoidance, sanitation, and rotation.** In fields where bacterial canker has occurred, all items associated with tomato production (transplant and field operations), such as stakes, twine, and tools, should be either discarded, sanitized with steam, or washed with a 10% bleach solution. Fields with a history of canker should be planted for at least three years to crops other than tomatoes, tobacco, eggplant, peppers, or potatoes. Control broadleaf weeds (especially members of the nightshade family) during the rotation and around field borders. Chop or disk all crop residues into the soil promptly after harvest to encourage more rapid decline of the bacterium.

### SAMPLE FUNGICIDE PROGRAM:

#### Staked Tomatoes

Refer to the "Fungicide" table in this chapter for product rates; read product labels carefully before application.

#### WEEKS AFTER TRANSPLANTING

1	mancozeb + copper + Actigard 50W
2	mancozeb + copper
3	Quadris or Cabrio + mancozeb + Actigard 50W
4	mancozeb + copper
5	Priaxor or Fontelis + mancozeb + Actigard 50W
6	mancozeb + copper
7	Quadris or Fontelis + mancozeb + Actigard 50W
8	mancozeb + copper

#### WEEKS DURING HARVEST

9	chlorothalonil + copper
10	Priaxor or Fontelis + copper
11	chlorothalonil + copper
12	Priaxor or Fontelis + copper
13	chlorothalonil + copper
14	chlorothalonil + copper

Finish season with chlorothalonil + copper

Plants with canker should be carefully rogued out and destroyed, avoided, or worked last when conducting field operations. Removal of infected plants is helpful in reducing spread if disease incidence is low (about 100 plants per acre or fewer); little benefit occurs when the incidence is higher. Less disease develops in fields where suckers are removed when very small or in those where no pruning has been practiced. Avoid working in fields while foliage is wet, especially early in the season.

- **Seeds and transplants.** Setting infected transplants is the main cause of canker epidemics in Kentucky; therefore, planting clean transplants is the most important control measure. Buy transplants from certified, disease-free operations. If producing your own plants, follow sanitary practices. All greenhouse materials (flats, tables, containers, hoses, etc.) should be disinfected prior to use. Use only sterilized potting mix. Handle items only when dry and do not clip plants. Check plants regularly for symptoms. If canker is found in even one seedling in the greenhouse, it is very likely that many more are infected—even if they show no symptoms. *In these cases, all transplants in the affected house should be destroyed.* If symptomatic plants are culled, and the remaining, asymptomatic plants are planted or sold, an epidemic of canker in the field will be the likely outcome. Do not water excessively, as the splash will favor dispersal and development of the canker bacterium and other pathogens.
- **Use certified, disease-free seed.** Hot-water treatment of seed will reduce seed populations of the canker bacterium (see Appendix H). In the greenhouse, use a spray program with fixed coppers one to two weeks after emergence. Mancozeb can be added to the mix for older plants. If transplants are being produced in an outdoor bed, agricultural streptomycin (Agri-Mycin 17) at 1.25 teaspoons/gallon of water can be alternated with or substituted for copper. *Streptomycin is not labeled for greenhouse use.* It is, however, possible to make at least one application (24-hour re-entry) after transplants have been removed from the greenhouse, but before transplanting (during the hardening-off period, for example).
- **Fixed coppers.** In staked tomatoes, begin applications of fixed copper + mancozeb immediately after transplanting and continue at seven-day intervals during wet weather.

**Bacterial speck, bacterial spot.** The incidence and severity of bacterial diseases

(spot, speck, and canker) have markedly increased recently. Follow the steps listed previously under bacterial canker for control of these diseases in transplant production. Use only disease-free seedlings and plant into land that has been actively rotated away from solanaceous crops for at least 2 years. Actigard 50WG has performed well in the control of bacterial speck and spot in many tests around the country. Actigard can be applied on a seven- to 14-day schedule (eight applications maximum) beginning one week after transplanting or emergence. Use the lowest rate on smaller plants and increase the dosage as plants grow; apply in a minimum of 30 gallons per acre of water initially and increase volume as the rate increases (see label for specifics). A 14-day interval will provide acceptable disease control with fewer negative effects on plant growth or yields. Fixed coppers are effective against bacterial populations that are still sensitive to these materials. In addition, copper is needed on most tomato crops for prevention of bacterial canker. Coppers are more effective when combined with mancozeb. Premixed materials such as ManKocide and Cuprofix Disperss MZ are available. Maneb (Maneb 80, Manex) is no longer produced and existing supplies cannot be used legally on tomato.

**Blossom end rot.** The most effective control is to maintain uniform soil moisture conditions throughout the growing season and to avoid damaging roots during cultivation, fertilization, or by diseases. Foliar calcium sprays are not an effective treatment as a rule, but proper soil calcium levels should be maintained.

**Buckeye fruit rot (*Phytophthora*), Phytophthora root and stem rot, and Pythium stem and fruit rot.** Avoid low areas and fields with poor drainage or heavy soils. Use well-shaped, raised beds with plastic mulch to reduce surface moisture and stake plants to reduce contact with soil. Rotate at least three years away from crops in the nightshade family (tobacco, peppers, potatoes, eggplants, and cucurbits). Fungicides can be helpful in control of this disease if applied preventively.

**Damping-off and stem rots of transplants.** Transplants (greenhouse or outside plant beds) should be grown in commercial soilless mixes or in fumigated or sterilized soil. Avoid excessive watering and maintain adequate ventilation. Most commercial seed is pretreated with fungicides for damping-off; if not treated (dust, pellet, slurry as per label), use Captan WP at 1 teaspoon per pound of seed. Pre-fungicide treatment with hot water, bleach, or trisodium phosphate (TSP)

may also improve disease control. Several fungicides can be used in the greenhouse for stem rots caused by *Botrytis* and *Sclerotinia*. Mefenoxam or metalaxyl can be used in the field to control seedling diseases caused by *Pythium*. Ranman and Previcur Flex can be used in transplant production for control of *Pythium*.

**Early blight, leaf mold (gray leaf mold), gray leaf spot, Septoria leaf spot.** Management of foliar diseases begins with disease-free transplants. A sound foliar fungicide program is essential for control of these diseases during wet years. Varieties with some resistance or tolerance will reduce, but not eliminate, the need for fungicides. In general, early maturing varieties are more susceptible to early blight than later maturing ones. It is possible to lengthen spray intervals from seven days to 10 days for early blight control with resistant varieties such as 'Mountain Fresh Plus' (see "Varieties" table) assuming *Septoria* is not also active. Rotate away from solanaceous crops for two or more years, and control weeds during the rotation. A routine fungicide program is needed in most years to manage Early blight and Septoria leaf spot. Rotation of certain protectant fungicides (chlorothalonil, mancozeb, or fixed copper) is a must. During wet seasons or with fall crops, start sprays within three days of transplanting and repeat at seven- to 10-day intervals; closer intervals are needed during wet seasons or with high disease pressure. During dry seasons, it is possible to wait until first symptoms before starting sprays; however, applications should be started by mid- to late June for spring plantings, regardless of weather conditions. Maintain rapid growth through proper fertilization to minimize disease. Crop rotations used for other diseases are an aid to control.

**Fusarium wilt, Verticillium wilt.** Plant varieties with "VF" resistance (see "Varieties" table). Avoid fields with a history of Verticillium wilt. Preplant soil fumigation is economical only with high-value, fresh-market tomatoes (see "Soil Fumigants for Control of Nematodes and Soilborne Diseases" on page 16). If wilt disease occurs in a resistant variety, have it correctly diagnosed by the UK Diagnostic Lab.

**Late blight.** This disease is an infrequent problem; however, notable outbreaks occurred in 2009, 2010, and 2013. A fungicide program designed for early blight should be adequate to manage late blight. Under very strong disease pressure, chlorothalonil will perform better than fixed coppers and mancozeb. Forum, Gavel, Presidio, Ranman, Revus, Tanos, or Zampro may be needed under severe disease pressure.

Mefenoxam-resistant (tolerant) strains of the late blight fungus have been found in Kentucky, so products containing this active ingredient (Ridomil Gold Bravo, Ridomil Gold/Copper, and Ridomil Gold MZ) are less likely to be effective than some of the other materials that are available.

**Nematodes.** Some root-knot-resistant varieties are available. Rotate away from tomatoes and related crops frequently; two years to tall fescue provides excellent control of root-knot. Soil samples can be submitted for quantification of nematode populations where nematode problems have been diagnosed. Submit samples to either a commercial lab or a university lab in another state, as this service is not provided by the University of Kentucky (diagnostic services only are available). Use preplant soil fumigation where nematode populations are moderate to high and where rotation is not practical. See “Soil Fumigants for Control of Nematodes and Soilborne Diseases” on page 16 for more information.

**Sclerotinia stem rot (timber rot) and Botrytis fruit and stem rot.** Avoid setting infected transplants into the field, and do not use fields with a history of *Sclerotinia*. Take steps to improve air movement in the planting. Cabrio and Priaxor are labeled for suppression of of timber rot. Endura and Fontelis are labeled for *Botrytis* but have significantly reduced *Sclerotinia*, too, in some tests when used soon after transplanting.

**Powdery mildew.** This disease is most likely to occur in greenhouses and high tunnels, but can be found on field-grown tomatoes in drought years. Fungicide programs typically suppress powdery mildew.

**Southern blight.** Avoid fields with a history of this disease and rotate problem fields with sod crops. *Sclerotium rolfsii*, the causal agent, has a wide host range and is common in Kentucky on tobacco, soybeans, white clover, peppers, and tomatoes. Deep plow to bury sclerotia and crop debris. Remove and destroy infected plants promptly. Fungicides may be applied to soil before planting or at planting, or as a stem-directed spray after planting depending on the product.

**Viruses.** The virus diseases commonly seen in Kentucky in tomato are tomato spotted wilt, tobacco mosaic, tomato mosaic, Potato Virus X, tobacco etch, cucumber mosaic, Potato Virus Y, and alfalfa mosaic. Viruses can be difficult to control, but the following guidelines are helpful in managing virus diseases. Produce transplants in isolation from thrips and their weed and ornamental crop hosts. Control weeds in tomato fields and maintain a weed-free zone around fields. To prevent spread of TMV, do not use tobacco products during seedling production or transplanting. Washing hands with soap and water before handling tomatoes should be mandatory. Production of heirloom tomatoes in conjunction with other fresh market cultivars increases the chances of TMV infection, since some heirloom seed sources are contaminated with TMV. Planting TMV-resistant tobaccos will greatly reduce the amount of available inoculum on farms where tomato and tobacco are grown together. Plant certified disease-free seed. Questionable seed lots should be treated with 10% trisodium phosphate (TSP) or bleach (see Appendix H). To avoid PVX in greenhouses, do not handle potatoes before working with tomato plants. Control weeds around fields or plant into sites surrounded by small grains or corn. Do not plant tomatoes near or adjacent to tobacco, potatoes, or peppers—the farther away, the better. Great disease reduction can be achieved by planting at least 200 yards away from these crops. The risk of TEV, PVY, and CMV is higher for fall plantings.

## Greenhouse Tomato Diseases

### Foliar Diseases

**Bacterial diseases, powdery mildew, leaf mold (gray leaf mold), Botrytis gray mold, early blight, and late blight.** A number of foliar diseases common in field-grown tomatoes also occur in the greenhouse. Maintain temperatures of at least 65°F in the greenhouse, along with good ventilation (air movement). Water plants so as to avoid long periods of leaf wetness. Scout plants regularly for symptoms. Resistant varieties are available for leaf mold, but results are variable because

of the ability of the leaf mold pathogen to mutate and no longer be affected by host resistance. Growers should rely on cultural practices and fungicides to control leaf mold. A spray program is necessary at the onset of the first symptoms of disease or during cool, overcast, or foggy conditions. See the table on page 18 for a list of greenhouse fungicides.

### Stem Diseases

**Botrytis stem canker and Sclerotinia timber rot.** Ensure adequate ventilation, and spray fungicides when conditions favor disease. Botran 75W at 1 pound per 100 gallons of water per treated acre, sprayed on the stems from the ground up to a height of 24 inches, can be used to control cankers caused by *Botrytis*. This treatment will also suppress stem cankers caused by *Sclerotinia*. Fontelis will also suppress these diseases. See the table on page 18 for a list of greenhouse fungicides.

**Fusarium crown and root rot.** Control of *Fusarium* is achieved primarily through the use of sanitation and planting resistant varieties (see “Varieties” table). Sanitize the greenhouse and everything in it by solarization, steam, or fumigation. Bleach treatment of seed will reduce seed-borne inoculum. This disease is worse on stressed tomato plants.

**Tobacco/tomato mosaic virus.** See “Viruses” heading under field tomatoes for more details. Use bleach-treated seed as indicated in Appendix H. On known TMV suspects, use the TSP treatment. Dip hands in milk before handling plants. Use resistant varieties.

### Root Diseases

**Pythium and Phytophthora root rots.** These diseases are common in hydroponic systems, and can be difficult to control once established. Sanitation is crucial in avoiding the introduction of *Pythium* and *Phytophthora* into the production system, and keeping field soil out is perhaps the most important consideration. Previcur Flex and Terramaster EC can be applied via irrigation or as drenches for suppression of root rots caused by either *Pythium* or *Phytophthora*. See the table on page 18 for a list of greenhouse fungicides.

## INSECT CONTROL: Tomatoes<sup>1,2</sup>

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>SOIL APPLICATION</b>			
<b>Aphids, Flea Beetles, Colorado Potato Beetle:</b> Do not use foliar sprays of Actara, Assail, Belay, Provado, or Venom following soil applications of Admire, Belay, Platinum, or Venom.			
Admire Pro	7 to 10.5 fl oz	10.5 fl oz	See label for application methods.
Belay 2.13 SC	9 to 12 fl oz	12 fl oz	At planting only.
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Soil and foliar applications possible for CPB. See label for limitations.
Platinum 2 SC	5 to 8 fl oz	8 fl oz	See label for application alternatives. Also helps to control thrips.
Sivanto 1.67 SL	21 to 28 fl oz	28 fl oz	For aphids and whiteflies.
Venom 70 SG	5 to 6 oz	12 oz	

(continued on next page)

**INSECT CONTROL: Tomatoes<sup>1,2</sup> (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>FOLIAR APPLICATION</b>			
<b>Aphids:</b> Treat if aphids are found on 50% of leaves.			
Actara 25 WDG	2 to 3 oz	11 oz	Allow 5 days between applications. Not during bloom. Field use only.
Admire Pro	1.3 to 2.2 fl oz	6.7 fl oz	Allow 7 days between applications. Not during bloom.
Assail 30 SG	2 to 4 oz	16 oz	Limit 4 applications. Allow 7 days between applications.
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Beleaf 50 WDG	2 to 2.8 oz	8.4 oz	Allow 7 days between applications.
Closer 2 SC	1.5 to 2 fl oz	17 fl oz	Allow 7 days between applications.
Dimethoate 4 E	8 to 16 fl oz	16 fl oz	Allow 6 days between applications.
Exirel 0.83 SE	13.5 to 20 fl oz	61.5 fl oz	Allow 5 days between applications.
Fulfill 50 DF	2.75 oz	5.5 oz	Allow 7 days between applications.
Lannate 90 SP	0.5 to 1 lb	8 lb	-
Malathion 8	1.5 pt	4 applications	Allow 5 days between applications.
Movento 2 SC	4 to 5 fl oz	10 fl oz	Allow 7 days between applications. Field use only.
Requiem 25 EC	2 to 3 qt	-	-
Sivanto 1.67 SL	7 to 12 fl oz	28 fl oz	Allow 7 days between applications.
<b>Beet Armyworm:</b> First detected in Kentucky in 1993, this insect can cause serious losses when present. A southern insect that occur sporadically in Kentucky. Large larvae are difficult to control effectively with insecticides.			
Avaunt 30 DG	3.5 oz	14 oz	Allow 5 days between applications.
Belt 2 SC	1.5 fl oz	4.5 fl oz	Allow 3 days between applications.
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Soil and foliar applications possible. See label for limitations.
Exirel 0.83 SE	7 to 13.5 fl oz	61.5 fl oz	Allow 5 days between applications.
Intrepid 2 F	4 to 16 fl oz	64 fl oz	-
Proclaim 5 WDG	2.4 to 4.8 oz	28.8 oz	Allow 7 days between applications.
Radiant SC	5 to 10 fl oz	34 fl oz	Allow 4 days between applications.
Rimon 0.83 EC	9 to 12 fl oz	36 fl oz	Allow 7 days between applications.
<b>Colorado Potato Beetle:</b> This is a pest of tomato transplants. This pest has the ability to develop resistance to all major classes of insecticides. Do not tank mix insecticides with the same mode of action and frequently rotate among insecticides with different modes of action to discourage resistance. Treat for Colorado potato beetle if an average of 1 adult larva or egg mass per plant is found and plants are less than 12 inches tall (staked). IRAC Codes: Insecticides followed by the same number share the same mode of action.			
Actara 25 W (4A)	2 to 3 oz	11 oz	Allow 5 days between applications. Not during bloom.
Admire Pro (4A)	1.3 to 2.2 fl oz	6.7 fl oz	Allow 5 days between applications. Not during bloom.
AgriMek 0.15 EC (6)	8 to 16 fl oz	48 fl oz	Allow 7 days between applications.
Asana XL (3)	5.8 to 9.6 fl oz	96 fl oz	-
Assail 30 SG (4A)	1.5 to 2.5 oz	16 oz	Limit 4 applications. Allow 7 days between applications.
Battalion 1.5 EC (3)	1.5 to 2.4 fl oz	14.4 fl oz	-
Baythroid XL (3)	1.6 to 2.8 fl oz	16.8 fl oz	Allow 7 days between applications.
Belay 2.13 SC (4A)	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Coragen 1.67 SC (28)	3.5 to 5 fl oz	15.4 fl oz	Soil and foliar applications possible. See label for limitations.
Exirel 0.83 SE	13.5 to 20 fl oz	61.5 fl oz	Allow 5 days between applications.
Mustang Max (3)	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC (3)	2 to 8 fl oz	48 fl oz	Not for use on cherry tomatoes.
Proaxis 0.5 EC (3)	2.56 to 3.84 fl oz	46 fl oz	Allow 5 days between applications.
Radiant SC (5)	5 to 10 fl oz	34 fl oz	Allow 4 days between applications.
Rimon 0.83 EC (15)	9 to 12 fl oz	36 fl oz	Allow 7 days between applications.
Sivanto 1.67 SL	10.5 to 14 fl oz	28 fl oz	Allow 7 days between applications.
Venom 70 SG (4A)	1 to 4 oz	6 oz	For foliar applications.
Warrior II (3)	1.28 to 1.92 fl oz	23 fl oz	Allow 5 days between applications.
<b>Cutworms:</b> Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites.			
Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Belt 2 SC	1.5 fl oz	4.5 fl oz	Allow 3 days between applications.
Brigade 2 E	2.1 to 5.2 fl oz	4 applications	Allow 10 days between applications.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Proaxis 0.5 EC	1.92 to 3.2 fl oz	46 fl oz	Allow 5 days between applications.
Sevin XLR	2 qt	8 qt	Limit 7 applications. Allow 7 days between applications.
Warrior II	0.96 to 1.6 fl oz	23 fl oz	Allow 5 days between applications.
<b>Fruitworms:</b> Carefully monitor plants for eggs on undersides of leaves, often near flower clusters. Treat if an average of more than 1 egg or larvae per 40 plants is found.			
Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Avaunt 30 DG	3.5 oz	14 oz	Allow 5 days between applications.
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	16.8 fl oz	Allow 7 days between applications.
Belt 2 SC	1.5 fl oz	4.5 fl oz	Allow 3 days between applications.
Brigade 2 E	2.1 to 5.2 fl oz	4 applications	Allow 10 days between applications.
Coragen 1.67 SC	3.5 to 5 fl oz	15.4 fl oz	Soil and foliar applications possible. See label for limitations.
Danitol 2.4 EC	10.67 fl oz	42.6 fl oz	Allow 7 days between applications.
Intrepid 2 F	4 to 16 fl oz	64 fl oz	-
Lannate 90 SP	0.5 to 1 lb	8 lb	-
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	2 to 8 fl oz	48 fl oz	Not for use on cherry tomatoes.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	46 fl oz	Allow 5 days between applications.
Radiant SC	5 to 10 fl oz	34 fl oz	Allow 4 days between applications.

(continued on next page)

**INSECT CONTROL: Tomatoes<sup>1,2</sup> (continued)**

<b>Insecticide</b>	<b>Product Amt/A</b>	<b>Seasonal Limit/A</b>	<b>Comments and Other Restrictions</b>
Rimon 0.83 EC	9 to 12 fl oz	36 fl oz	Allow 7 days between applications.
Sevin XLR	1 to 2 qt	8 qt	Limit 7 applications. Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	23 fl oz	Allow 5 days between applications.
<b>Grasshoppers</b>			
Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Brigade 2 E	2.1 to 5.2 fl oz	4 applications	Allow 10 days between sprays.
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	46 fl oz	Allow 5 days between applications.
Warrior II	1.28 to 1.92 fl oz	23 fl oz	Allow 5 days between applications.
<b>Hornworms:</b> Treat if an average of more than 1 hornworm per 5 plants is found.			
Asana XL	2.9 to 5.8 fl oz	96 fl oz	-
Avaunt 30 DG	2.5 to 3.5 oz	14 oz	Allow 5 days between applications.
Baythroid XL	1.6 to 2.8 fl oz	16.8 fl oz	Allow 7 days between applications.
Belt 2 SC	1.5 fl oz	4.5 fl oz	Allow 3 days between applications.
Bt var kurstaki products	See labels	-	-
Coragen 1.67 SC	2 to 5 fl oz	15.4 fl oz	Soil and foliar applications possible. See label for limitations.
Intrepid 2 F	4 to 16 fl oz	64 fl oz	-
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	48 fl oz	Not for use on cherry tomatoes.
Proaxis 0.5 EC	1.92 to 3.2 fl oz	46 fl oz	Allow 5 days between applications.
Radiant SC	5 to 10 fl oz	34 fl oz	Allow 4 days between applications.
Rimon 0.83 EC	9 to 12 fl oz	36 fl oz	Allow 7 days between applications.
Sevin XLR	1 to 2 qt	8 qt	Limit 7 applications. Allow 7 days between applications.
Warrior II	0.96 to 1.6 fl oz	23 fl oz	Allow 5 days between applications.
<b>Flea Beetles:</b> Maintain defoliation below 5 to 10%.			
Asana XL	5.8 to 9.6 fl oz	96 fl oz	-
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Brigade 2 E	2.1 to 5.2 fl oz	4 applications	Allow 10 days between applications.
Mustang Max	2.24 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	-
Sevin XLR	0.5 to 1 qt	8 qt	Limit 7 applications. Allow 7 days between applications.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	46 fl oz	-
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications.
<b>Mites</b>			
Acramite 50 WS	0.75 to 1 lb	1 application	For spider mites.
AgriMek 0.15 EC	8 to 16 fl oz	48 fl oz	Allow 7 days between applications. For broad, russett, and spider mites.
Brigade 2 E	2.1 to 5.2 fl oz	4 applications	Allow 10 days between applications. For end of season control. For spider mites only.
Danitol 2.4 EC	10.67 fl oz	42.6 fl oz	Allow 7 days between applications. For end-of-season control. For spider mites only.
Kanemite 15 SC	31 fl oz	62 fl oz	Allow 21 days between applications. For spider mites.
Movento 2 SC	4 to 5 fl oz	10 fl oz	For broad and russett mites. Allow 7 days between applications.
Nealta 1.67 SC	13.7 fl oz	27.4 fl oz	Allow 14 days between applications. For spider mites only.
Oberon 2 SC	7 to 8.5 fl oz	25.5 fl oz	Allow 7 days between applications. For broad, russett, and spider mites.
Portal 0.4 EC	2 pt	4 pt	Limit 2 applications. For broad, russett, and spider mites.
<b>Stink bugs, Leaf-footed bugs:</b> Treat if an average of more than 1 stink bug per 40 plants or 0.75% damaged fruit is found.			
Actara 25 WDG	3 to 5.5 oz	11 oz	Allow 5 days between applications. Not during bloom.
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Baythroid XL	1.6 to 2.8 fl oz	16.8 fl oz	Allow 7 days between applications.
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Brigade 2 E	2.1 to 5.2 fl oz	4 applications	Allow 10 days between applications.
Danitol 2.4 EC	10.67 to 16 fl oz	42.6 fl oz	Allow 7 days between applications.
Mustang Max	3.2 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Proaxis 0.5 EC	2.56 to 3.84 fl oz	46 fl oz	Allow 5 days between applications.
Rimon 0.83 EC	12 fl oz	36 fl oz	Allow 7 days between applications. For immature control only.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Warrior II	1.28 to 1.92 fl oz	23 fl oz	Allow 5 days between applications.
<b>Thrips</b>			
Assail 30 SG	4 oz	16 oz	Allow 7 days between applications.
Baythroid XL	2.1 to 2.8 fl oz	16.8 fl oz	Allow 7 days between applications.
Brigade 2 E	2.1 to 5.2 fl oz	4 applications	Allow 10 days between applications.
Radiant SC	6 to 10 fl oz	34 fl oz	Allow 4 days between applications.
Requiem 25 EC	2 to 4 qt	-	-
Rimon 0.83 EC	9 to 12 fl oz	36 fl oz	Allow 7 days between applications. For immature control only.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Venom 30 SG	1 to 4 oz	6 oz	Allow 7 days between applications.
<b>Whiteflies</b>			
Actara 25 WDG	3.0 to 5.5 oz	11 oz	Allow 5 days between applications. Not during bloom.
Admire Pro	1.3 to 2.2 fl oz	6.7 fl oz	Allow 5 days between applications. Not during bloom.
Assail 30 SG	2.5 to 4 oz	16 oz	Limit 4 applications. Allow 7 days between applications.
Courier 40 SC	9 to 13.6 fl oz	2 applications	Allow 28 days between applications.
Exirel 0.83 SE	13.5 to 20.5 fl oz	61.5 fl oz	Allow 5 days between applications. Use a spray adjuvant.

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**INSECT CONTROL: Tomatoes<sup>1,2</sup> (continued)**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Knack 0.86 EC	8 to 10 fl oz	20 fl oz	Allow 14 days between applications.
Movento 2 SC	4 to 5 fl oz	10 fl oz	Allow 7 days between applications.
Oberon 2 SC	7 to 8.5 fl oz	25.5 fl oz	Allow 7 days between applications.
Portal 0.4 EC	2 pt	4 pt	-
Requiem 25 EC	2 to 3 qt	-	-
Rimon 0.83 EC	12 fl oz	36 fl oz	Allow 7 days between applications. For immature control only.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Sivanto 1.67 SL	10.5 to 14 fl oz	28 fl oz	Allow 7 days between applications.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications.

**INSECT CONTROL: GREENHOUSE/HIGH TUNNEL GROWN TOMATOES<sup>1,2</sup>**

**Mites:** Two spotted spider mite, broad mite, and tomato russett mite

Acramite 50 WS	0.75 to 1 lb	1 application	For spider mites only.
AgriMek 0.15 EC	8 to 16 fl oz	48 fl oz	Allow 7 days between applications. For broad, russett, and spider mites.
Brigade 2 E	2.1 to 5.2 fl oz	4 applications	Allow 10 days between applications. For end of season control. For spider mites only.
Danitol 2.4 EC	10.67 fl oz	42.6 fl oz	Allow 7 days between applications. For end-of-season control. For spider mites only.
Kanemite 15 SC	31 fl oz	62 fl oz	Allow 21 days between applications. For spider mites only.
Nealta 1.67 SC	13.7 fl oz	27.4 fl oz	Allow 14 days between applications. For spider mites only.
Oberon 2 SC	7 to 8.5 fl oz	25.5 fl oz	Allow 7 days between applications. For broad, russett, and spider mites.

**Thrips**

Assail 30 SG	4 oz	16 oz	Allow 7 days between applications.
Baythoid XL	2.1 to 2.8 fl oz	16.8 fl oz	Allow 7 days between applications.
Brigade 2 E	2.1 to 5.2 fl oz	4 applications	Allow 10 days between applications.
Requiem 25 EC	2 to 4 qt	-	-
Rimon 0.83 EC	9 to 12 fl oz	36 fl oz	Allow 7 days between applications. For immature control only.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Venom 30 SG	1 to 4 oz	6 oz	Allow 7 days between applications.

**Whiteflies**

Admire Pro	1.3 to 2.2 fl oz	6.7 fl oz	Allow 5 days between applications. Not during bloom.
Assail 30 SG	2.5 to 4 oz	16 oz	Limit 4 applications. Allow 7 days between applications.
Courier 40 SC	9 to 13.6 fl oz	2 applications	Allow 28 days between applications.
Exirel 0.83 SE	13.5 to 20.5 fl oz	61.5 fl oz	Allow 5 days between applications. Use a spray adjuvant.
Knack 0.86 EC	8 to 10 fl oz	20 fl oz	Allow 14 days between applications.
Requiem 25 EC	2 to 3 qt	-	-
Rimon 0.83 EC	12 fl oz	36 fl oz	Allow 7 days between applications. For immature control only.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications.
Sivanto 1.67 SL	10.5 to 14 fl oz	28 fl oz	Allow 7 days between applications.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications.

<sup>1</sup> See an IPM Scouting Guide for Common Problems of Solanaceous Crops in Kentucky (ID-172) for photos of pests.

<sup>2</sup> Generic products available (Appendix E).

**WEED CONTROL: Tomato—Transplanted**

Product Amt/A	Lb A.I./A	Comments
0.5-1.6 fl oz Aim 1.9 EW	0.008-0.025 carfentrazone	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
6-14 lb Dacthal W-75	4.5-10.5 DCPA	For pre-emergence control of annual grasses and small-seeded broadleaves. Over-the-top application 4 to 6 weeks after transplanting is safe to plants. Plants should be well established. Do not apply if growing conditions are poor (ie. cool, wet weather)
2-4 lb Devrinol 50 DF	1-2 napropamide	For pre-emergence control of annual grasses and broadleaf weeds. Apply before transplanting and water-in or incorporate to a depth of 1 to 2 inches. Can be applied on bare ground middles between beds of plastic 24 hours before rain or if watered-in or incorporated. To avoid injury, do not replant with crops not specified on the label until 12 months if using the 4-lb rate.
1-2 pt Dual Magnum	0.95-1.90 s-metolachlor	For pre-emergent control of selected weed species. In transplanted tomatoes if applied preplant incorporated, transplant to a depth greater than incorporation and use the lower rate range to avoid injury. Do not plant when cool, wet or poor growing conditions exist. Reduce risk by applying seven or more days prior to transplant. PHI = 90 days.
1-2 pt Goal 2XL	0.25-0.5 oxyfluorfen	For pre-emergence and post-emergence control of certain annual grasses and most broadleaves. For fallow bed preparation only. Best if used with glyphosate for control of winter annual broadleaf weeds. Min. 30 days between application and transplanting.
2-4 pt Gramoxone Inteon	0.69-1.38 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply preplant, pre-emergence, or before transplanting in min. 10 gal water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v.
4-6.4 oz League	0.19-0.3 imazosulfuron	For control of certain annual broadleaf weeds and nutsedge. Rainfall or irrigation needed for activation. No more than 6.4 oz per year. No more than one application per year.
0.5-1.5 pt Poast 1.5	0.09-0.49 sethoxydim	For control of actively growing annual grasses and suppression of perennial grasses only. Use high rate on Johnson grass. PHI = 20 days. Max. rate of 1.5 pt/application and 4.5 pt/season.
1.5-2 pt Prowl H2O 3.8 E	0.7-1 pendimethalin	For pre-emergence control of broadleaves and grasses. Apply broadcast preplant incorporated or broadcast preplant surface application prior to transplanting tomato, or as a post-directed application to transplanted and established plant. PHI = 70 days.
2-4 oz Matrix 25 DF	0.031-0.062 rimsulfuron	For pre-emergence control of broadleaves and grasses. Apply pre-emergence or post-emergence to actively growing weeds. PHI = 45 days.
16-22 fl oz Roundup Weather-Max 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 30 days before planting any non-labeled crop. Do not make hooded or shielded sprayer applications to row middles because of the potential for crop injury.

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**WEED CONTROL:** *Tomato—Transplanted (continued)*

Product Amt/A	Lb A.I./A	Comments
0.5-1 oz Sanda 75 DF	0.023-0.047 halosulfuron	For control of broadleaf weeds and yellow nutsedge. For transplanted tomato: may be applied preplant under the plastic. Apply after final bed shaping but before installation of plastic. Transplant 7 days after plastic installation. As a post-transplant application, Sandea can also be applied over the top or as a directed spray or with shields, 14 days after plastic installation. Max. 2 applications/crop and 2 oz/A per season. See label for row middle applications and direct-seeded tomato.
9-32 fl oz Select Max	0.07-0.24 clethodim	For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. PHI = 20 days.
2.25-6 fl oz Spartan 4F	0.07-0.19 sulfentrazone	Only for transplanted tomato. May be applied as a broadcast or banded treatment prior to transplant.
0.3-1.3 lb TriCor DF	0.2-1 metribuzin	For control of annual grasses and broadleaves. Preplant: apply in min. 10 gal water/A immediately before transplanting and incorporate 2 to 4 inches. Best if used with Treflan to improve weed control. Transplant tomato with roots below herbicide zone. Post-emergence broadcast (0.3 to 0.6 lb/A) or post-emergence directed (0.6 to 1.3 lb/A); apply when plants have recovered from transplant shock and new growth is evident (about 2 weeks). Do not apply within 24 hours of other pesticides or within 3 days after cool, wet, or cloudy weather. Allow 14 days between applications. May be applied to plastic mulch row middles. PHI = 7 days.
1.25-2 pt Treflan HFP 4 E	0.62-1 trifluralin	For pre-emergence control of annual grasses and broadleaf weeds. Transplanted tomato: Apply and incorporate before transplanting or apply post-transplant as a directed spray to soil between rows and beneath plants and incorporate. See label for direct-seeded tomato.

**DISEASE CONTROL:** *Tomatoes*

Product	F\$RAC Code	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Anthraco</b> se, <b>Early Blight</b> , <b>Leaf Mold</b> , <b>Gray Leaf Spot</b> , <b>Botrytis Gray Mold</b> , <b>Septoria Leaf Spot</b> , <b>Powdery Mildew</b>					
Aftershock	11	3	2 to 5.7 fl oz	4 apps	Early blight. Apply before disease onset, continue every 7 to 10 days. Alternate with another FRAC code.
Ariston	M/27	3	1.9 - 3.0 pt	17.5 pt	Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin <sup>4</sup>					Not for Botrytis, gray leaf spot/mold. Apply 21 days after transplanting or 35 days after seeding and continue every 7 to 21 days.
Azoxy 2SC	11	0	6 to 15.5 fl oz <sup>3</sup>	5 apps	
AzoxyStar	11	0	6 to 15.5 fl oz <sup>3</sup>	5 apps	
Quadris	11	0	6 to 15.5 fl oz <sup>3</sup>	5 apps	
Satori	11	0	6 to 15.5 fl oz <sup>3</sup>	5 apps	
Botran 75 W	14	10	1 lb	4 apps	Botrytis stem canker. Greenhouse only. Apply when conditions favor disease and continue every 7 days during favorable periods. Spray stem of plant from ground level to a height of 18 to 24 in.
Chlorothalonil <sup>4</sup>					Prior to fruit set. Apply before disease onset; continue every 7 to 10 days. Use 1.375 to 2 pt/A rate or equivalent (dry formulations). After fruit set. Increase rate to 2 to 2.75 pt/A (or equivalent for dry formulations), apply every 7 to 14 days.
Bravo Ultrex	M	0	1.3 to 2.6 lb	18.3 lb	
Bravo WeatherStik	M	0	1.375 to 2.75 pt	20 pt	
Cabrio	11	0	8 to 16 oz	6 apps	Not for gray leaf spot/mold. Use 8 to 16 oz/A for powdery mildew and Botrytis gray mold; apply 8 to 12 oz/A for other foliar diseases. Apply before disease onset, continue every 7 to 14 days.
Endura	7	0	2.5 to 12.5 oz	6 apps	Early blight/Botrytis gray mold only. Apply before disease onset, continue every 7 to 14 days. Use higher rates for Botrytis.
Evito 480 SC	11	3	3.8 to 5.7 fl oz	4 apps	Early blight. Apply before disease onset, continue every 7 days.
Fixed coppers					Not for Botrytis, powdery mildew. Apply after transplanting or before disease appears, depending upon product and conditions. Continue every 3 to 10 days. See label for mixing instructions and tank-mix precautions. Greenhouse uses are permitted, depending upon product—refer to label.
Badge SC	M	0	1.5 to 3.5 pt		-
Badge X2	M	0	0.75 to 1.75 lb		OMRI-listed.
Basic Copper 53	M	0	0.75 to 3 lb		OMRI-listed.
C-O-C-S WDG	M	0	2 to 7 lb		-
Champ DP	M	0	1.33 to 2.67 lb		-
Champ Formula 2 FL	M	0	1.33 to 2.67 pt		-
Champ WG	M	0	2 to 4 lb		OMRI-listed.
COC DF	M	0	3 to 4 lb		-
COC WP	M	0	3 to 4 lb		OMRI-listed.
Copper-Count-N	M	0	3 to 6 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 3 lb		-
Kentan DF	M	0	1.32 lb		-
Kocide 2000	M	0	1.5 to 3 lb		-
Kocide 3000	M	0	0.75 to 1.75 lb		-
Kocide DF	M	0	2 to 4 lb		-
Mastercop	M	0	0.5 to 3 pt		-
Nordox 75 WG	M	0	1.25 to 2.5 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	2 to 4 lb		OMRI-listed.
Nu-Cop 3 L	M	0	1.33 to 5.33 pt		-
Nu-Cop 50 DF	M	0	2 to 4 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	1 to 2 lb		-
Flint	11	3	2 to 4 oz	5 apps	Begin prior to disease onset, continue every 7 to 10 days.
Fontelis	7	0	14 to 24 fl oz	72 fl oz	Anthracose, <b>Botrytis</b> , <b>early blight</b> , <b>Septoria leaf spot</b> . Apply before disease onset, continue every 7 to 14 days.
Fracture		0	24.4 to 36.6 fl oz	5 apps	Botrytis, powdery mildew. Apply every 7 to 10 days.

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**DISEASE CONTROL: Tomatoes (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Inspire Super	3/9	0	16 to 20 fl oz	47 fl oz	Begin prior to disease onset, continue every 7 to 10 days.
Mancozeb <sup>4</sup>					Products include Dithane, Koverall, Manzate, Penncozeb.
Dry formulations	M	5	0.5 to 3 lb	21-22.4 lb	Not for Botrytis, powdery mildew. Apply when plants emerge or after transplanting, and continue every 7 to 10 days until harvest. Some formulations are greenhouse-approved; see labels.
Liquid formulations	M		0.6 to 2.4 qt	16.8 qt	
ManKocide <sup>3</sup>	M	5	2.5 to 5 lb	see footnote	Not for Botrytis, powdery mildew. Apply before disease appears and continue every 3 to 10 days as needed.
Priaxor	7/11	7	4 to 8 fl oz	24 fl oz	Anthraco-nose, Botrytis, early blight, Septoria. Apply prior to development of disease, continue every 7 to 14 days.
Quadris Opti	11/M	0	1.6 pt	5 apps	Not for Botrytis, gray leaf spot/mold. Apply applications before disease onset, continue every 7 to 21 days. Observe seasonal limits for chlorothalonil.
Quadris Top	11/3	0	8 fl oz	47 fl oz	Do not apply until 21 days after transplant.
Rally 40 WSP	3	0	2.5 to 4 oz	1.25 lb	Powdery mildew. Apply when symptoms are first observed or when conditions favor disease.
Reason	11	14	5.5 to 8.2 fl oz	24.3 fl oz	Early blight, Septoria. Apply applications before disease onset, continue every 5 to 10 days.
Revus Top	40/3	1	5.5 to 7 fl oz	28 fl oz	Apply every 7 to 10 days. Use a spreader/penetrant surfactant.
Scala	9	1	7 fl oz	35 fl oz	Early blight/Botrytis gray mold. Apply before disease onset, continue every 7 to 14 days. Greenhouse use is approved.
Sulfur <sup>4</sup>	M				Powdery mildew. Apply at disease onset, continue every 7 to 14 days as needed. Phytotoxicity may occur if applications are made when temperatures exceed 90°F.
Switch 62.5 WG	9/12	0	11 to 14 oz	56 oz	Early blight, Botrytis, powdery mildew. Apply every 7 to 10 days.
Tanos	11/27	3	6 to 8 oz	5 apps	Not for Botrytis. Tanos must be tank-mixed with a fungicide from FRAC Group M appropriate for the target disease. Apply before disease onset, continue every 5 to 10 days.
Vivando	U8	0	15.4 fl oz	3 apps	Powdery mildew only. Begin applications prior to disease onset and continue every 7 to 14 days. No curative activity.
Zing!	M/22	5	36 fl oz	8 apps	Early blight and Septoria. Apply before disease onset and repeat every 7 to 14 days. Alternate with another FRAC code.
Ziram 76DF	M	7	3 to 4 lb	24 lb	Anthraco-nose, early blight, Septoria. Apply at first appearance of symptoms and continue every 7 days.
Ziram Granuflo	M	7			
<b>Bacterial Spot/Speck</b>					
Actigard	21	14	0.33 to 0.75 oz	6 apps	Apply 1 week after transplanting or emergence; begin with lowest rate and increase as plants grow. Apply every 14 days. May be applied through drip irrigation.
Ag Streptomycin, Agri-Mycin 17, Harbour	25	n/a	16 oz/100 gal	n/a	Pre-transplant treatment. Apply when seedlings are in 2-leaf stage and continue every 4 to 5 days until transplanting. Alternate with fixed copper. Not for field use.
Fixed coppers					Apply after transplanting or before disease appears, depending upon product and conditions. Continue every 3 to 10 days. See label for mixing instructions and tank-mix precautions. Tank-mix with mancozeb for maximum efficacy (observe seasonal limits for EBDC fungicides). Greenhouse uses are permitted, depending on product—refer to label.
Badge SC	M	0	1.5 to 3.5 pt		-
Badge X2	M	0	0.75 to 1.75 lb		OMRI-listed.
Basic Copper 53	M	0	2 to 4 lb		OMRI-listed.
C-O-C-S WDG	M	0	2 to 7 lb		-
Champ DP	M	0	1.33 to 2.67 lb		-
Champ Formula 2 FL	M	0	1.33 to 2.67 pt		-
Champ WG	M	0	2 to 4 lb		OMRI-listed.
COC DF	M	0	3 to 4 lb		-
COC WP	M	0	3 to 4 lb		OMRI-listed.
Copper-Count-N	M	0	3 to 6 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 3 lb		-
Kentan DF	M	0	1.32 lb		-
Kocide 2000	M	0	1.5 to 3 lb		-
Kocide 3000	M	0	0.75 to 1.75 lb		-
Kocide DF	M	0	2 to 4 lb		-
Mastercop	M	0	0.5 to 3 pt		-
Nordox 75 WG	M	0	1.25 to 2.5 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	2 to 4 lb		OMRI-listed.
Nu-Cop 3 L	M	0	1.33 to 5.33 pt		-
Nu-Cop 50 DF	M	0	2 to 4 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	1 to 2 lb		-
<b>Late Blight</b>					
Ariston	M/27	3	1.9 to 3.0 pt	17.5 pt	Apply before disease onset, continue every 7 to 14 days.
Chlorothalonil <sup>4</sup>					Prior to fruit set. Apply before disease onset; continue every 7 to 10 days. Use 1.375 to 2 pt/A rate or equivalent (dry formulations). After fruit set. Increase rate to 2 to 2.75 pt/A (or equivalent for dry formulations), apply every 7 to 14 days.
Bravo Ultrex	M	0	1.3 to 2.6 lb	18.3 lb	Increase rate to 2 to 2.75 pt/A (or equivalent for dry formulations), apply every 7 to 14 days.
Bravo WeatherStik	M	0	1.375 to 2.75 pt	20 pt	
Curzate 60 DF	27	3	3.2 to 5 oz	30 oz	Must be tank-mixed with a fungicide from FRAC Group M. Apply before disease onset, continue every 5 to 7 days.

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**DISEASE CONTROL: Tomatoes (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Fixed coppers					Apply after transplanting or before disease appears, depending upon product and conditions. Continue every 3 to 10 days. See label for mixing instructions and tank-mix precautions. Some formulations are greenhouse-approved; see labels.
Badge SC	M	0	1.5 to 3.5 pt		-
Badge X2	M	0	0.75 to 1.75 lb		OMRI-listed.
Basic Copper 53	M	0	2 to 4 lb		OMRI-listed.
C-O-C-S WDG	M	0	2 to 7 lb		-
Champ DP	M	0	1.33 to 2.67 lb		-
Champ Formula 2 FL	M	0	1.33 to 2.67 pt		-
Champ WG	M	0	2 to 4 lb		OMRI-listed.
COC DF	M	0	3 to 4 lb		-
COC WP	M	0	3 to 4 lb		OMRI-listed.
Copper-Count-N	M	0	3 to 6 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 3 lb		-
Kentan DF	M	0	1.32 lb		-
Kocide 2000	M	0	1.5 to 3 lb		-
Kocide 3000	M	0	0.75 to 1.75 lb		-
Kocide DF	M	0	2 to 4 lb		-
Mastercop	M	0	0.5 to 3 pt		-
Nordox 75 WG	M	0	1.25 to 2.5 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	2 to 4 lb		OMRI-listed.
Nu-Cop 3 L	M	0	1.33 to 5.33 pt		-
Nu-Cop 50 DF	M	0	2 to 4 lb		OMRI-listed.
Nu-Cop 50 HB	M	0	1 to 2 lb		-
Forum SC	40	4	6 fl oz	30 fl oz	Must be tank-mixed with another <i>Phytophthora</i> fungicide. Apply before disease onset, continue every 5 to 10 days.
Gavel 75 DF2	22/M	3	1.5 to 2 lb	8 apps	Apply after transplanting and continue every 7 to 10 days.
Mancozeb <sup>4</sup>					Products include Dithane, Koverall, Manzate, Penncozeb.
Dry formulations	M	5	0.5 to 3 lb	21-22.4 lb	Apply when plants emerge or after transplanting, and continue every 7 to 10 days until harvest. Limit 16.8 lb ai/A per season. Some formulations are greenhouse-approved; see labels.
Liquid formulations	M		0.6 to 2.4 qt	16.8 qt	
ManKocide <sup>3</sup>	M	5	2.5 to 5 lb	see footnote	Apply before disease appears and continue every 3 to 10 days as needed.
Presidio	43	2	3 to 4 fl oz	4 apps	Apply every 7 to 14 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Previcur Flex	28	5	0.7 to 1.5 pt	7.5 pt	Apply before disease onset, continue every 7 to 10 days. Must be tank-mixed with chlorothalonil or mancozeb.
Ranman SC	21	0	2.1 to 2.75 fl oz	6 apps	Apply before disease onset, continue every 7 to 10 days.
Revus	40	1	5.5 to 8 fl oz	32 fl oz	Apply every 7 to 10 days. Use a spreader/penetrant surfactant. Must be tank-mixed with a fungicide NOT in FRAC Group 40.
Revus Top	40/3	1	5.5 to 7 fl oz	28 fl oz	Apply every 7 to 10 days. Use a spreader/penetrant surfactant.
Ridomil Gold Bravo SC	4/M	14	2.5 pt	3 apps	Apply before disease onset, continue every 14 days. Rotate to another mode of action between applications of RG Bravo. Observe seasonal limits for chlorothalonil.
Ridomil Gold Copper	4/M	14	2 lb		Apply before disease onset, continue every 14 days. Rotate to another mode of action between applications of RG Copper.
Ridomil Gold MZ2	4/M	5	2.5 lb		Apply before disease onset, continue every 14 days. Rotate to another mode of action between applications of RG MZ. Observe seasonal limits for EBDC fungicides.
Tanos	11/27	3	8 oz	5 apps	Tanos must be tank-mixed with a fungicide from FRAC Group M appropriate for the target disease. Apply before disease onset, continue every 5 to 7 days.
Zampro	40/45	4	14 fl oz	3 apps	Apply before disease onset and repeat every 5 to 7 days.
<b>Pythium Seedling Disease</b>					
MetaStar 2EC AG	4	28	4 to 8 pt	1 app	Preplant. Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil mechanically or with irrigation if rainfall is not expected within 24 hours of treatment.
Ridomil Gold SL	4	28	1 to 2 pt		
Ultra Flourish	4	28	2 to 4 pt		
Previcur Flex	28	5	1.5 pt	7.5 pt	Field application. Can be directed at lower stems and soil, applied in transplant water, or delivered through drip irrigation. Greenhouse use. Can be applied as a drench or by chemigation—see to label for rates.
Ridomil Gold GR	4	7	20 lb	1 app	For preplant application only. Adjust equipment so that granules applied uniformly over soil surface. Incorporate mechanically or with irrigation water.
<b>Southern Blight</b>					
Aftershock	11	3	2 to 5.7 fl oz	4 apps	Apply before disease onset and continue every 7 days.
Blocker Flowable, Blocker 4F	14	0	4.5 pt/100 gal	1 app	Apply as a drench at planting. Actual rate is dependent on row spacing; see label for application instructions.
Evito 480 SC	11	3	3.8 to 5.7 fl oz	4 apps	Apply before disease onset and continue every 7 days.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Observe seasonal limits for mancozeb.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

# Vining Crops (Cucurbits)

Cucumbers, Muskmelons, Squash, Pumpkins, and Watermelons Gourd family (Cucurbitaceae): *Cucumis sativus* [Cucumber]; *Cucumis melo*, Reticulatus Group [Muskmelon]; *Citrullus lanatus* [Watermelon]

## Planting and Culture Cucumber

Cucumbers are grown in Kentucky primarily for fresh market (slicing types) rather than for processing (pickling types). Planting and cultural requirements are similar for both. Cucumbers do best in firm, deep, well-prepared seedbeds. Fall plowing is recommended. The soil should be well drained and high in organic matter for best results. Apply 10 tons of manure per acre the previous fall if available. Land that has been in sod is very desirable. The soil should be disked two or three times in early spring to prepare for seeding. Disking helps to eliminate early germinating weed seeds and prepare a fine seedbed. A cultipacker will help prepare a good seedbed. Do not plant cucumbers on land that was treated the previous year with a triazine herbicide such as atrazine, metribuzin, or Karmex.

For hand-harvested pickling or slicing cucumbers, train vines to run lengthwise in the row soon after vining starts. Cultivating in one direction will also help to train plants to run in the row. This training will enable harvesters to pick more easily and quickly, and the plants will not be damaged as seriously. Cultivation should be shallow to prevent root damage.

Start seed about the first of May in most areas of the state or when designated by the company with which you may be contracting. Continued plantings at one- or two-week intervals can be made to extend the harvest season (see Appendix J).

Slicing cucumbers are usually grown on black plastic with trickle irrigation to increase yields and earliness. Cucumbers can be direct-seeded through plastic mulch using seeders designed for that purpose, or they can be transplanted at about two to three weeks after seeding.

## Muskmelon

Muskmelons (cantaloupes) and specialty melons are warm-season crops. They require a relatively long growing season of 80 to 100 days from seeding to marketable fruit. Well-drained, lighter-textured (sandy or sandy loam) soils are considered best for cantaloupes, although medium-textured soils can be just as productive with good management practices. Lighter-textured

soils warm up faster than heavier soils. Because of potentially serious disease problems, melons are best grown on land that has not been in vine crops (cantaloupes, watermelons, squash, pumpkins, etc.) for at least three years.

The vining habit of the plant and its large leaves make it especially susceptible to wind damage. Planting cantaloupes between strips of annual rye or some similar, taller-growing plant will provide windbreak protection. In addition, growers can orient rows in the direction of prevailing winds (usually winds blow from the southwest in most parts of Kentucky) so that wind blows down rows rather than across them.

Cantaloupes can be direct-seeded to the field or grown as transplants in the greenhouse or hotbed and transplanted to the field. Generally, 2 pounds of seed is sufficient to direct-seed an acre; one quarter to one half of a pound per acre is sufficient for transplants. Plant the seed one-half to three-quarters of an inch deep after danger of frost is past (see Appendix J).

Transplants produce earlier ripening fruits that will often bring much higher early prices. With transplants, plant the seed three weeks before the plants are to be transplanted to the field. The plants should have two or three true leaves. Plant one or two 72-128 cell plug trays.

It is crucial that plants be protected from cucumber beetle feeding from the day of seedling emergence or from the day of transplanting to reduce the risk of bacterial wilt disease (vectored by the beetles). The insecticide imidacloprid has provided good early season systemic control of cucumber beetles on melons in Kentucky, reducing the potential for bacterial wilt while the plants are small. Although several soil application methods may be used with this product, the post-transplant drench is recommended for best control: a small amount of the imidacloprid solution is applied at the base of each plant immediately after transplanting. With proper calibration, this can be done quickly and accurately using a backpack sprayer with the nozzle removed (see the "Insect Control" table and current label for recommended rates). Imidacloprid should not be used in the setter tank water because of the potential for worker exposure during transplanting.

## Specialty Melons

Specialty melons (honeydews, canary, galia, and others) are excellent items for direct market sales; they are full flavored and far superior to what can be obtained through local supermarkets. These melons

are more difficult to grow than cantaloupes and require an extended spray program in Kentucky. Specialty melons are highly susceptible to bacterial wilt, and post-transplant drench application of an imidacloprid insecticide (Admire, etc.—see the "Disease Control" and "Insect Control" tables) is an absolute necessity to achieve success. A season-long weekly preventative fungicide spray schedule for Anthracnose is also critical.

These melons do best when planted around May 1 and transplanted to the field around June 1. This allows harvest to coincide with dry weather late in the season, which increases flavor and sugar content. Specialty melons need slightly wider plant spacing; see "Plant Spacing" (page 111). Some specialty melons, especially galia melons, are prone to magnesium deficiencies, and preventive measures may be required (see page 112). In addition, growers will need to gain some experience with each type to determine exactly when to harvest, as many specialty melons do not "slip" or may not change color at maturity in the same way that muskmelons do. See descriptions in the "Varieties" table for specific harvesting guidelines.

## Squash and Pumpkin

Squash and pumpkins produce best on well-drained, fertile soil. The plants produce large, shallow root systems very rapidly in the top 8 to 10 inches of soil, which should be prepared into a firm, well-fertilized seedbed. Squash and pumpkins do well in soils where 10 to 12 tons of well-rotted manure has been applied per acre. To help avoid soilborne disease problems, select fields that have not had other vine crops, tobacco, tomatoes, or peppers for at least three years. Calculate the number of days to harvest to determine when to plant pumpkins for Halloween (see Appendix J). Growers usually harvest pumpkins in mid-September to allow time for marketing.

Some Kentucky growers have successfully grown pumpkins using a no-till system by seeding into stubble of a rye or rye-vetch cover crop that has been killed with herbicide. Pumpkins can be direct-seeded into the mulch with a modified no-till corn planter. This practice can eliminate the need for washing pumpkins prior to marketing, may reduce fruit rots, and makes for an easier/cleaner field for schoolchildren or "pumpkin festival" customers to walk in. No-till has been successful on well-drained soils but may be problematic on heavier soils; problems with rodent feeding have been encountered by some growers using this system.

**VARIETIES: Cucumbers**

Variety	Days to Maturity	Comments
<b>SLICING</b>		
Intimidator	53	Early variety, CMV,scab, and angular leaf spot, Good for early and late production, smooth fruit.
Speedway	56	Early variety with CMV, powdery mildew, scab, anthracnose, and angular leaf spot tolerance.
Indy	59	Resistant or tolerant to anthracnose, angular leaf spot, powdery mildew, scab, CMV, WMV, ZYMV. All female flowering.
Cobra	60	Dark green, PRV, ZYMV, CMV, scab, anthracnose, angular leaf spot, powdery and downy mildew, good late season due to virus resistance.
Daytona	67	Dark green, ZYMV, PRV, WMV tolerant; powdery mildew, angular leaf spot, anthracnose, and scab tolerant.
Turbo	67	Small seed cavity; tolerant to CMV, downy and powdery mildew, angular leaf spot, anthracnose, and scab. All female flowering.
Marketmore 76 (open-pollinated)	67	Scab and CMV resistant, for local market or home gardens, not for commercial production.
<b>PICKLING</b>		
Calypso	52	Tolerant to scab, anthracnose, powdery and downy mildew, and CMV.

**VARIETIES: Melons**

Variety	Days to Maturity	Use	Quality <sup>3</sup>	Comments
<b>EASTERN CANTALOUPE<sup>1</sup></b>				
Lil' Loupe	76	Local	E	2.3 lb round, very small, excellent quality personal sized cantaloupe for specialty retail sales. Tolerant to powdery mildew race 1, 2 and Fusarium race 0, 2.
Minerva	77	Local, shipping	E	7 to 8 lb round to oblong with deeper sutures than Athena and heavy netting. Resistance to powdery mildew and Fusarium races 0, 1 and 2.
Athena	78	Local, shipping	E	Market standard, 5 to 7 lb melon; sutureless and fine heavy netting, small cavity, firm flesh, resistance to powdery mildew and Fusarium races 0, 1 and 2. Looks like a large Western melon.
Aphrodite	80	Local, shipping	E	6 to 8 lb; earlier, larger Athena type, resistance to powdery mildew 1, 2 and Fusarium race 0, 1, 2.
Wrangler	80-85	Local	E	4 to 5 lb small Tuscan type cantaloupe with dark green sutures, medium net, excellent flavor, Fusarium race 0, 1, 2 and powdery mildew resistance.
Atlantis	82	Local, limited shipping	E	6 to 8 lb refined net, shallow sutures, high sugar, smooth firm deep orange flesh, powdery mildew race 1, 2 and Fusarium race 0,1,2 resistance.
Orange Sherbet	83	Local	E	6 to 8 lb; very large oval densely netted with shallow sutures, resistance to powdery mildew race 2 and Fusarium race 1, 2.
Majus	83	Local	E	6 to 8 lb netted tuscan type with deep sutures. Resistance to powdery mildew 1, 2, and 3, Fusarium wilt 1, 2, 5.
Tirreno	83	Local	E	4 to 6 lb netted tuscan type with deep sutures. Similar to Majus but smaller. Resistance to powdery mildew 1, 2, and 3, Fusarium wilt 1, 2, 5.
Eclipse	85	Local, shipping	E	5 to 8 lb oval shaped with slight sutures, medium net, good shelf life, powdery mildew and Fusarium wilt race 2 tolerant.
<b>SPECIALTY MELONS<sup>2</sup></b>				
Honey Yellow	75	Local	E	2 to 2.5 lb honeydew, bright yellow skin, orange flesh, excellent sugar content and flavor.
Honey Orange	80	Local	VG	4 to 5 lb honeydew, cream colored exterior, orange flesh, very sweet.
Honey Pearl	80	Local	VG	4 lb honeydew, cream colored flesh, excellent flavor.
San Juan	85	Local	VG	3 lb honeydew, green flesh, excellent flavor.
Honey Brew	90	Local	E	4 to 6 lb honeydew, green flesh, excellent flavor; Fusarium, downy mildew and powdery mildew resistance.
Summer Dew	90	Local	E	4 to 6 lb honeydew, green flesh, excellent flavor; Fusarium 0, 2 and powdery mildew 1,2 resistance.
Sugar Nut	77	Local	E	3 to 4 lb canary melon; cream to lt. green flesh, exterior bright yellow with some checking; harvest when bright yellow.
Camposol	80	Local	E	5 to 6 lb canary melon; bright yellow exterior; cream colored flesh; very sweet, excellent quality and shelf life, harvest when rind is bright yellow, powdery mildew resistance.
Dorado	85	Local, shipping	E	5 to 6 lb canary melon; bright yellow exterior; cream colored flesh; very sweet, excellent quality and shelf life, harvest when rind is golden.
Sancho	90	Local	E	6.5 to 9 lb oval shaped Piel de Sapo melon, dark green rind, creamy-white flesh, outstanding quality, high consumer acceptance, develops dark yellow ground spot when ripe, powdery mildew tolerance.
Sensation	80	Local	O	5 to 6 lb gourmet melon, round, medium netted light yellow rind, creamy white interior, harvest when rind begins to turn yellow.
Sprite	65-75	Local, shipping	E	1.3 lb specialty melon, creamy exterior and interior, crisp flesh, reaches 16% sugar, excellent quality, high consumer demand, ripe when small checks appear around blossom end.
Napoli	72	Local	O	2.5 lb specialty melon, round, cream-colored heavily netted rind, light green melting flesh, harvest when exterior is straw-colored before full slip.
Sunrise	72	Local	O	2.5 to 3 lb specialty melon, round, cream colored heavily netted rind, orange melting flesh, harvest when exterior is straw-colored before full slip.
Pixie	80	Local	E	3 lb muskmelon X galia melon cross; very firm, very sweet, orange flesh; harvest when rind develops a yellow background.
Sweetie	85	Local	E	4 to 5 lb muskmelon X galia melon cross; very firm, very sweet, orange flesh; harvest when rind develops a yellow background.
Arava	77	Local	VG	4 lb galia melon, netted exterior, sweet green flesh, excellent flavor, harvest when just turning yellow, relatively short shelf life.
Vicar	86	Local	E	4 lb galia melon, round, greenish-yellow netted rind, lt. green flesh; harvest when rind begins developing yellowish color.
Galileo	87	Local	VG	3.3 lb galia melon, fully netted exterior, firm light green flesh, nice balance of sweet and musky flavor, harvest when just turning yellow.
Tasty Bites	75-80	Local	E	2.8 lb charentais X ananas cross, fully netted cantaloupe exterior, orange crunchy flesh with a nice after taste, harvest at slip.

<sup>1</sup> Current market demand for Kentucky is for a 5- to 7-lb eastern type cantaloupe with a firm, deeply sutured, coarse netted rind and a thick, uniformly deep-orange flesh.

<sup>2</sup> All specialty melons in this category are highly susceptible to bacterial wilt; post-transplant drench applications of Admire insecticide(see text) together with a good preventative spray program for anthracnose control are highly recommended.

<sup>3</sup> VG: Very Good; E: Excellent; O: Outstanding.

Having irrigation available for pumpkins will pay big yield and quality dividends in some years. A good irrigation system that can apply 1 to 2 inches of water a week and keep ground temperatures a little cooler will increase yields dramatically and pay for itself in a drought year. Using drip irrigation on pumpkins has made the difference between high profits and total crop failure for some Kentucky pumpkin growers in dry years; the easiest and most effective system employs 8- to 10-mil drip lines without the use of plastic mulch. Supplemental irrigation is critical in dry summers during flowering and fruit setting.

Summer squash (yellow straightnecks, yellow crooknecks, or zucchini types) are usually grown for an early summer market in mid- to late June or for an early fall market when prices begin to rise in September (see Appendix J). Growers producing squash for the late summer/early fall market usually encounter serious virus or fungal disease problems and should plant either a variety with the precocious

yellow trait that masks virus symptoms or one of the varieties with conventional or genetically engineered virus resistance. Varieties are also available with resistance to powdery mildew (see "Varieties" table).

Squash and pumpkins are warm-season crops and do not do well until soil and air temperatures are above 60°F. Seed may decay before germinating if planted in cold, wet soil. Black plastic on raised beds with trickle irrigation will speed soil warming in spring squash plantings and can dramatically increase early and total yields. Use white plastic mulch for late squash plantings in July or August. Seed or transplants can be planted through the plastic by hand, with a waterwheel setter or with machinery designed for direct-seeding through plastic.

Squash or pumpkin transplants should be started in the greenhouse in 72-128 cell trays two to three weeks before the anticipated transplanting date. The plants are ready when the first true leaves are fully developed; delays in transplanting can result in stunting of plants in the field.

## Watermelon

Lighter-textured soils are considered best for watermelons, although medium-textured soils can be just as productive with good management practices. Watermelons should not be grown on the same ground year after year because of disease problems; they are best grown on land that has not been in tomatoes, peppers, or another vine crop (cantaloupes, squash, pumpkins, etc.) for at least three years.

Watermelon seedlings are often transplanted to the field. This method must be used for seedless watermelons due to their high seed costs and poor germination percentages. If this procedure is followed, the seed should be planted 14 to 21 days before planting to the field (see Appendix J). Transplants should be planted to the field around the time the first true leaf forms. Transplanted melons will mature 10 to 14 days earlier than direct-seeded melons.

Black plastic on raised beds with drip irrigation is commonly used in commercial watermelon production for earlier maturity and higher yields; soils warm up

### VARIETIES: Squash, Pumpkins, Gourds

Variety	Days to Maturity	Comments
<b>SQUASH</b>		
<b>Straightneck</b>		
Fortune	39	Precocious yellow trait (py) masks virus symptoms on fruit, downy mildew tolerant; teardrop shape.
Multipik	40	Precocious yellow trait (py) masks virus symptoms on fruit; downy mildew tolerant; teardrop shape.
XPT 1832	42	Precocious yellow trait (py) masks virus symptoms on fruit, Genetically engineered resistant for 3 viruses (CMV, WMV, ZYMV)
Conqueror III	41	Genetically engineered resistance to CMV, WMV, ZYMV and intermediate resistance to PRSV.
Lioness	50	Tolerance to ZYMV, CMV, WMV, PRSV, and powdery mildew; green stem, mature fruit have a very light greenish cast.
Sunray	50	Precocious yellow trait (py) masks virus symptoms on fruit.
<b>Crookneck</b>		
Prelude II	40	Genetically engineered resistance to 2 viruses (WMV, ZYMV) plus conventional powdery mildew resistance. Full crook.
Destiny III	40	Genetically engineered resistance to 3 viruses (WMV, CMV, ZYMV); similar to Dixie. Semi- to full crook.
Gentry	43	Semi-crook; reduced spines, green stems; open bush plant.
<b>Zucchini</b>		
Dividend	47	Medium green, cylindrical, some with slight curve; tolerant to some strains of WMV, CMV, ZYMV.
Tigress	45	Cylindrical, slightly tapered; attractive medium to dark green; tolerant to WMV, ZYMV.
Wildcat	45	Intermediate resistance to powdery mildew, PRSV, ZYMV
Zucchini Elite	45	Long, slightly curved and tapered fruits.
Cashflow	45	Medium green fruit with a slight taper, tolerant to some races of ZYMV, large plant.
Payroll	45	Attractive medium green fruit; virus tolerant.
Spineless Beauty	50	Fruits similar to Zucchini Elite.
<b>Other Summer Squashes</b>		
Papaya Pear	45	Yellow pear shaped squash, 3.5 inches, AAS winner
Sunburst	50	Bright yellow scalloped, AAS winner.
Patty Pan	54	White scalloped; plants compact bush type.
<b>Acorn</b>		
Tay Belle PM	70	1 to 1.5 lb, powdery mildew tolerant, attractive, dark green exterior, bush type plant, medium orange sweet, tender flesh; excellent taste.
Mesa Queen	70	1 to 1.5 lb, dark green exterior, medium orange flesh, semi-bush, excellent taste.
Honey Bear	85	1 to 1.25 lb fruit, excellent taste, AAS winner.
Cream of the Crop	85	1.5 lb, attractive creamy white exterior, cream colored flesh, bush type plant.
Table Ace	85	1.5 lb, dark green exterior, yellow orange flesh, semi-bush plants hold up well, high yielding.
Table Gold	95	1 to 1.5 lb, bright golden exterior, dark orange flesh, semi-bush plant, very attractive and excellent taste.
<b>Ornamental Acorn</b>		
Carnival	85	1 to 1.5 lb, skin flecked with shades of green, gold, and yellow, semi-bush plant.
Heart of Gold	90	1.5 lb, white with dark green mottling and golden flesh, large vine, excellent taste.

(continued on next page)

**VARIETIES: Squash, Pumpkins, Gourds (continued)**

Variety	Days to Maturity	Comments
<b>Butternut</b>		
Butterboy	80	Very uniform, and early, slightly smaller than others.
Chieftan	90	2 to 2.5 lb
Butternut Supreme	95	Productive, thick neck, very uniform shape; excellent taste.
Waltham Butternut	95	3 to 5 lb; blocky and uniform.
<b>Buttercup/Kabocha</b>		
Sun Spot	75	2 lb; very attractive, orange fruit with dark orange, fine grained, slightly moist, sweet flesh (buttercup).
Sweet Mama	85	5 lb; sweet, fine-grained, deep yellow flesh, dark green fruit; excellent taste and high yielding (kabocha).
Delica	90	4 lb; medium-dry, slightly sweet flesh; dark green with gray-green stripes; excellent taste (kabocha)
Special Export	90-95	3 lb; excellent flavor, attractive exterior and interior, excellent eating quality (kabocha).
Burgess Buttercup	90	2 lb; smooth texture; excellent eating quality.
Sunshine	95	4 lb; bright orange skin, nutty, smooth, stringless; very sweet, excellent eating quality (buttercup).
Ambercup	100	Bright orange fruit with dry, sweet flesh, excellent eating quality (buttercup).
<b>Spaghetti</b>		
Small Wonder	70	2 to 2.5 lb; yellow exterior; large vine
Vegetable Spaghetti	100-105	Large 4 lb fruit, vigorous vine.
<b>Miscellaneous Squash</b>		
La Estrella	70-90	10 lb, Calabash squash, attractive green to tan blotchy exterior, fluorescent orange, moist fine grained flesh.
Hubba Hubba	95	3 lb, attractive small bright orange hubbard, orangish green flesh, bush type.
Bush Delicata	100	1 lb, exterior creamy white with green stripes, powdery mildew tolerance, excellent quality.
Grey Ghost	100	7 lb, attractive grey exterior, yellow orange, moist fine grained flesh, storage squash with ornamental value.
Cushaw Green Stripe	110	15 lb, very productive.
<b>PUMPKINS</b>		
<b>Extra Large</b>		
Atlantic Giant	120	Pink-orange color, world record over 1,000 lb.
Prize Winner	120	50 to 200 lb, orange, attractive; very large with good shape and color for extra large pumpkins, limit to 1 fruit per vine to get maximum size.
Full Moon	120	White color, 60 to 90 lb fruit, 36 x 24 inches.
<b>Large (15-35 lb)</b>		
Big Autumn	90	Variable sized fruit about 13 lb, high yielding; 10-inch diameter, strong handles, dark green with an orange base, deep orange, very smooth, deeply ribbed.
New Moon	90	30 to 35 lb, white fruit, full vine, heavy fruit, good med-large white pumpkin.
Gold Bullion	100	18 lb, dark orange, excellent yields, handles and color, semi bush.
Mustang	100	15 to 18 lb, 10 x 12 inches, excellent powdery mildew resistance, strong handle, light orange color.
Camaro	110	20 to 25 lb, round, excellent powdery mildew resistance, strong handles, light yellow/orange color.
Conestoga Giant	110	30 lb, dark orange, full vines, uniform, good stems.
Gold Medallion	110	Large fruited, 25 to 35 lb, large vine.
Aladdin	115	25 lb, deep orange, good yield potential, nice stems.
Magic Wand	115	15 to 25 lb, dark orange, similar to Magic Lantern with improved handles and a higher powdery mildew tolerance.
Warlock	115	20 lb, dark orange, strong handle, semi-hardshell, can be warty, excellent powdery mildew resistance, not a heavy pumpkin if selling by weight.
Gladiator	115	18 to 28 lb, deep orange, good handles and excellent powdery mildew tolerance, one of the best, good for roadside sales.
Super Herc	115	20 to 35 lb, powdery mildew tolerant, great handle.
Magic Lantern	115	15 to 22 lb, dark orange, large vines, strong, dark green handle, powdery mildew tolerant.
Merlin	115	15 to 25 lb, dark orange, large vines, powdery mildew tolerant.
Buckskin	115	12 to 18 lb, 7x10 inches, attractive, looks like a large buff colored acorn, large vine, pretty not a jack-o-lantern.
Wolf	120	15 to 20 pound, full aggressive vines, unusually large stems, for roadside sales.
<b>Medium (5-10 lb)</b>		
Schooltime	82	8 to 10 lb, slightly flat to round, compact vines, semi-bush.
Magician	90	10 to 15 lb, dark orange, round to tall, powdery mildew tolerant.
Pick A Pie	85	5 to 6 lb, dark orange pie pumpkin with large dark green handles, uniform fruit, semi-bush.
Hybrid Pam	90	5 to 7 lb, deep orange.
Cotton Candy	105	6 to 10 lb, white pumpkin, full vine
Lumina	110	7 to 8 lb white pumpkin for carving and painting with bright orange flesh; 9 inch diameter. Shape varies from globe to flat globe; not a particularly high yielder and fruit scars easily. Harvest slightly immature to obtain a better white color, otherwise these can turn gray.
<b>Miniature (5 oz-4 lb)</b>		
Cannonball	90	3 to 5 lb, orange to dark orange, round, smooth, long shelf life, solid pumpkin, powdery mildew tolerant.
Spooktacular	95	5 to 6 inch diameter; dark orange skin, smooth shallow ribbing, uniform.
Baby Boo	95	5 oz. white deeply ribbed fruit; 3.5 inch diameter, vines large; very productive.
Touch of Autumn	95	3.5 to 4 lb, 6 x 5 inches, very attractive, semi-bush vine type, excellent handles that remain dark green, stores well, powdery mildew tolerant.
Rockafellow	95	2.5 to 3.5 lb, bottom heavy and tall with long handle, powdery mildew tolerant.
Baby Bear	105	1.5 lb, 5 inch diameter, good disease tolerance.
Oz	105	2 to 4 lb semi-bush; 5 to 6 inch diameter, precocious yellow gene—colors early, excellent for painting.
Ironman	110	3 to 4 lb, 7 to 8 inch diameter, dark orange; long shelf life; tolerant to powdery mildew, long shelf life.
Lil' Ironsides	115	2 lb, 6 inch diameter, tough, hard, dark orange shell that is not carveable, strong stem, large vine, long shelf life.
<b>ORNAMENTAL GOURDS</b>		
Autumn Wings Large Swan	100	Unique gourd, multiple colors with wings, warts, shaped like a swan gourd.
Autumn Wings Medium	100	Unique gourd, many colors with wings, shape of a spoon gourd.
Autumn Wings Small	100	Unique gourd, many colors with wings, shaped like a swan pear gourd. Potential for shipping.

faster in the spring, and weeds will not grow under the mulch. Soil moisture is also retained and nutrient leaching minimized.

Direct-seeding in hills was once the most common method of planting watermelons. The seedbed for planting should be thoroughly prepared to ensure good plant stands. Soil moisture should be adequate throughout the early growing season to produce good plant growth and vigorous blossoms. After fruits reach full size, it is usually best to withhold or reduce irrigation during the ripening season. Sugar content will usually be higher and the melons will have better flavor if moisture levels are not high during ripening. Keep in mind that watermelon plants have deep root systems.

Good weed control is essential for high-quality melons. Melon yields and sugar

content can be reduced if weeds are allowed to shade and otherwise compete with the plants. Black plastic helps to control weeds during early growth; however, it is critical to control weeds in the bare ground middles between rows of plastic. Herbicides and/or mechanical cultivation can be effectively used for early-season weed control in these middles.

### Special Considerations for Seedless (Triploid) Watermelon Production:

#### Germination

- The most common reasons for poor germination are overwatering, incorrect watering, poor temperature control, and shallow seed placement.
- For growing transplants, the growing media should be moist but not wet. Check moisture level by squeezing a

handful of media. Generally, if water drips from the media, it is too wet.

- Water the media and allow it to dry for 12 to 24 hours. During this time, bring the temperature of the media to 85° to 90°F. Before filling trays and seeding, stir the media to ensure that it is evenly moistened.
- Seeds should be planted between ½ to ¾ inches deep in trays. This planting depth helps prevent germinating seeds from pushing out of the media and maintains better uniformity of moisture around seed.
- Plant seeds with the pointed end (root end) up; this helps prevent the seed coats from sticking to the germinating seedling.
- Place the seeded trays in a germination room or chamber for 48 to 72 hours or un-

### VARIETIES: Watermelon

Variety	Days to Maturity	Size (lb)	Comments <sup>1</sup>
<b>SEEDED</b>			
Tiger Baby	80	10-12	Excellent quality, firm flesh, small seeds; resistant to Fusarium race 1.
Sangria	83	20-25	Crimson Sweet rind; elongated; outstanding flavor; fruit blossom end may taper with drought; tolerant to Fusarium race 1 and anthracnose
Royal Star	84	21-26	Royal Sweet rind; blocky oblong fruit; good for shipping; excellent flavor; tolerant to Fusarium
Crimson Sweet	85	15-25	Dark and light green striped, blocky fruit; bright red tender sweet flesh; tolerant to Fusarium wilt and anthracnose.
Starbrite	85	21-29	Royal Sweet rind; elongated; very sweet and high yielding; resistant to Fusarium race 1 and anthracnose
Royalty	85	22-26	Royal Sweet rind; thin rind; excellent eating quality; high yields
Stars N' Stripes	85	22-31	Crimson Sweet rind; elongated; very sweet; high yielding; resistant to Fusarium race 1 and anthracnose
Star Gazer	85	24-28	Allsweet rind, elongated; excellent quality; uniform; resistance to Fusarium and anthracnose
Royal Sweet	85	20-24	Oblong; bright red flesh, small dark seeds; vigorous, resistant to Fusarium—shipper
All Sweet	90	25-30	Medium green thin stripes; elongated oval; high sugar content
<b>SEEDLESS</b>			
Fascination	83	16-20	Crimson Sweet rind; firm red flesh with good taste; good yield; resistance to Fusarium
Sweet Gem	79	13-16	Black rind; deep red firm flesh
Harvest Moon	90	8-13	Dark green rind with yellow spots. Seedless version of Moon and Stars. Excellent quality and because of the unique appearance it is well suited to farm markets and local production
Captivation	89	14-17	Crimson Sweet rind with blocky shape. Deep red flesh color of good quality with high yields.
Maxima	90	19-22	Allsweet rind pattern. Oval fruit with crisp red flesh.
Unbridled	85	18-22	Allsweet rind pattern. Round fruit with crisp red flesh.
Troubadour	87	14-17	Allsweet rind; deep red flesh color of good quality; good yield
Treasure Chest	77	9-15	Jubilee rind; bright yellow flesh color; excellent quality
Sugar Red	85	16-18	Crimson Sweet rind; vibrant red firm flesh of good quality; good yield
Indiana	76	13-15	Jubilee rind, dark background; round to oval; attractive interior; resistance to Fusarium races 0 and 1 and anthracnose races 1 and 3
Revolution	82	16	Royal Sweet rind; elongated; bright red flesh; outstanding flavor; hollow heart tolerant
Harmony	84	15-18	Crimson Sweet rind, oval; very sweet, crisp, bright red flesh
Orange Sweet	84	15-25	Jubilee rind; round; attractive orange flesh
Ruby	85	14	Medium green dark double striped rind, oval; excellent dark red firm flesh; hollow heart tolerant
Cooperstown	85	16-22	Crimson Sweet rind; round; excellent bright red interior
Crunchy Red	90	15	Crimson Sweet rind; dark pink flesh, blocky-round shape
<b>MINI-SEEDLESS</b>			
Solitaire	85	6-9	Royal Sweet rind; round, attractive; very tough rind; very firm pink flesh
Petite Perfection	77	5-7	medium green striped. Good quality and high yield.
Poquito	90	3-5	Crimson Sweet rind; round; red flesh; excellent flavor
<b>POLLENIZER<sup>2</sup></b>			
Ace			Long vine, low growing, brittle fruit; susceptible to Fusarium and anthracnose
Pollen Pro			vigorous non-competing lacy vines with non-harvestable fruit
Sidekick			Blooms very early; long vine; slightly more erect; small fruit.
SP-5			Small fruit; distinct delicate vines with deeply lobed leaves; moderate resistance to Fusarium
SP-6			Similar appearance to SP-5; hardier transplants under cool conditions; moderate resistance to Fusarium
Accomplice			Bushy upright habit; consistent male flower production; hardy under early season cool conditions; moderate resistance to Fusarium

<sup>1</sup> Watermelon varieties are often grouped by rind color or pattern; these groups or types are often named for a popular variety with similar characteristics: Allsweet = medium green rind w/dark green, broad mottled stripes; Jubilee = light green rind with distinct narrow, dark green stripes; Black = solid dark green rind; Crimson Sweet = light green rind w/mottled dark green stripes; Royal Sweet = light green rind w/wide, mottled, dark green stripes.

<sup>2</sup> Pollenizers are used with seedless melons and planted in-row allowing for seedless melons to be grown in the entire field.

til germination begins. The temperature of the room should be held at 85° to 90°F and the relative humidity maintained between 90 and 100 percent.

- Once seedlings have begun to emerge, move trays to the greenhouse. Maintain a temperature of approximately 80° to 85°F until germination is complete.
- During the first week in the greenhouse, water only as needed to keep the planting media moist. Do not overwater, as this may destroy ungerminated seeds.
- Once the seedlings are established, temperature and watering can be adjusted to achieve sturdy plants.

#### *Transplanting and Pollination of Seedless Watermelons*

- A pollenizer, which can be a traditional seeded variety or a special pollenizer melon must be present for pollination and fruit set. Good pollination is extremely important for seedless watermelon production. Inadequate pollination results in triangular-shaped fruit, lower quality, and increased incidence of hollow heart.
- A ratio of 2 to 3 seedless plants to one seeded (used as pollenizer) is recommended. Pollenizer varieties can be planted on the edge of beds between the third and fourth seedless plant. When using a seeded melon as a pollenizer which will be harvested, outside rows and every third row in the field should be planted with the seeded variety. Never plant seedless and seeded (pollenizer) varieties in separate adjacent blocks in the field.
- Specific pollenizer varieties generally flower earlier and longer than typical seeded melons. When using a seeded melon as the pollenizer use a main-season variety. Early or late varieties may not provide pollen during the entire season, thus reducing fruit set.
- Specific pollenizer melons will be easily distinguished from your crop. Pollenizer varieties will produce small softball-size melons that are not harvested and easily crushed in the field. When using a diploid (seeded) variety as a pollenizer be sure that it is distinguished by shape or color from the seedless melons at harvest and one that is marketable, as it will make up about one third of your total production.
- Specific pollenizer varieties generally flower earlier than the seedless melons they are planted with. However, when using a traditional seeded melon as a pollenizer it should be seeded in the greenhouse one to two weeks earlier than the seedless variety. This schedule ensures good pollination when the seed-

less variety begins to produce female flowers.

### **Black Plastic and Irrigation**

Black plastic mulch on raised beds with drip irrigation is often used to obtain higher yields and to encourage faster growth and earlier maturity. Drip irrigation increases fruit quality and quantity and allows fertilizer to be injected through the system (fertigation). Plastic mulch can be purchased in roll widths of 3 and 4 feet; the 4-foot-wide film is most suitable for melons.

Bed shapers/plastic mulch layers and waterwheel setters are commercially available to make raised beds, lay plastic and drip lines, and aid in transplanting. A fine seedbed is required for plastic laying by machine; this operation is nearly impossible on cloddy ground. Clods will puncture plastic mulch, making it more vulnerable to wind damage. Machines are also available that enable direct-seeding through plastic mulch.

### **Plant Spacing**

Growers should also plan for spraying, harvesting, and other field operations by leaving an 8- to 9-foot-wide middle, or "skip row," after every fourth to sixth bed. The number and placement of these skip rows will depend on the type of sprayer being used.

### **Cucumbers**

Pickling cucumbers are usually machine harvested. If a crop is to be grown for mechanical harvest (once-over harvest), seeding with precision seeders in rows 15 inches apart with seed 2 to 3 inches apart in the row is recommended. Four pounds of seed per acre is required at this close spacing. For hand-harvested pickling or slicing cucumbers grown on bare ground, space rows 4 to 4½ feet apart and plant three to four seeds per foot of row. Thin plants to 8 inches between plants in the row. The seed should be planted ¾ to 1 inch deep. Uniform depth of planting is important to get uniform plant growth and maturity. Two pounds of seed will be required per acre. Plasticulture cucumbers are usually grown in double rows with 12 to 18 inches between the two rows and 9 to 12 inches between plants within each row. Beds are usually spaced 5 feet between centers. Only a single plant should be grown in each planting hole.

### **Muskmelons or Specialty Melons**

On plastic, single plants are usually spaced 18 inches apart in the rows on plastic; some growers use two plants per hill spaced 3 feet apart in the row. For direct-seeding in bare ground or into plas-

tic mulch, rows should be 5 to 6 feet apart, with plants thinned to hills 2 to 3 feet apart in the row and two or three plants per hill. Plant specialty melons 3 feet apart in the row with rows 5 to 6 feet apart on black plastic with drip irrigation and fertigation.

### **Summer Squash**

On plastic, single plants are usually transplanted 18 inches apart on beds 5 to 6 feet apart. For direct-seeding in bare ground or into plastic mulch, plant two to three seeds every 18 to 24 inches apart in rows 4 to 6 feet apart. Seed should be planted 1 inch deep.

### **Pumpkins and Winter Squash**

Final plant stands for extra large varieties should be 3 to 4 feet apart in the row with rows 8 to 12 feet apart (24 to 48 square feet per plant). Smaller bush types are spaced 2 to 3 feet apart in the row, with rows 5 to 6 feet apart. Miniature pumpkins can be planted as densely as 1 to 2 feet apart in the row with rows 4 to 6 feet apart. Pumpkins can be transplanted or direct-seeded at the above spacings. Seeds are planted at a depth of 1 to 2 inches. Many seed companies publish charts for appropriate plant spacing for the varieties that they sell.

### **Watermelon**

Spacing on plastic with drip irrigation depends on the variety and the desired melon size. In general, 6 to 8 feet between-row spacings and 3 to 4 feet in-row spacings are used. Use wider spacings to produce larger, heavier melons. Smaller "icebox" watermelons can be spaced more closely with in-row spacings of 2 feet and between-row spacings of 5 to 6 feet. Mini-seedless (also called "palm" or "personal") watermelons are spaced 1½ feet apart within rows and 5 to 6 feet between rows to produce the greatest number of melons weighing less than 8 pounds. On bare ground without irrigation, each plant requires about 48 square feet of space for maximum yield of larger-sized melons. In this case, thin plants to about 4 feet apart in the rows with rows spaced 12 feet apart.

### **Fertilizing Cucumber**

Make fertilizer and lime applications based on soil test results. A soil pH of 6.5 to 6.7 is most desirable for cucumbers. All fertilizer should be broadcast and disked in well before planting. All phosphorus and potassium and a portion of the total nitrogen requirement should be applied before laying plastic when plastic mulch and drip irrigation are used. The remaining N requirement can be fertigated (see "Fer-

tigation" table). When lime is needed before growing cucumbers, apply a dolomitic liming material if available in your area.

### Muskmelons

Phosphorus, potassium, and lime applications should be based on soil test results. Maintain the soil pH between 6.5 and 7.0; liming will be necessary if pH falls below 6.5. Because of shallower rooting depth and preplant N applications, muskmelons grown with drip irrigation on plastic mulch may be more susceptible to magnesium deficiency if soil pH is less than 6.5. Preplant and fertigated magnesium applications may be required on low CEC soils; added magnesium may also increase melon sugar contents. See below and Appendix B for further discussion of magnesium and molybdenum deficiencies and recommended application rates.

With plastic mulch and drip irrigation, apply all the lime, P and K and 1/2 of the total N recommendation before laying plastic. The remaining nitrogen can be divided into equal weekly doses and fertigated as indicated in the "Fertigation" table.

**Magnesium deficiencies.** Muskmelons have high magnesium requirements. Deficiencies sometimes appear a few weeks before harvest when fruits are rapidly growing in size and weight and when fruit loads are heavy. Typical symptoms are yellowing between the veins (veins remain green) on the oldest leaves (those nearest the crown of the plant). This interveinal discoloration turns brown or tan over time and eventually results in much of the leaf tissue dropping out, leaving a green and white leaf "skeleton." Entire fields are defoliated in severe cases. Magnesium deficiency problems are more likely to occur on light, sandstone-derived soils and in very dry years. Frequent fertigations with calcium or potassium nitrate can make the problem worse by competing with and displacing magnesium in soils. Preventive and/or corrective measures are required, especially on low CEC soils.

In general, we would like to have about 200 pounds per acre of magnesium on soil tests prior to planting. Magnesium sources include dolomitic lime (12% Mg), epsom salts (= magnesium sulfate, 10 to 16% Mg), magnesium nitrate (6.3% Mg), and magnesium oxide (45 to 55% Mg). Epsom salts and magnesium oxide can be fertigated through the drip system; make weekly applications of 1 to 2 pounds actual magnesium per acre (10 to 20 pounds per acre epsom salts or 2 to 4 pounds per acre magnesium oxide). Application rates may vary with solubility of the materials (check with the manufacturer). Foliar ap-

### FERTILIZER: *Vining Crops*

Soil Test Results (lb/A)		Fertilizer Needed (lb/A)			
Phosphorus		Phosphate (P <sub>2</sub> O <sub>5</sub> )			
		Cucumber	Melons	Squash/Pumpkin	Watermelon
Low	<31	241-300	121-180	121-180	180
Medium	31-60	121-240	61-120	61-120	120
High	61-80	1-120	1-60	1-60	60
Very High	>80	0	0	0	0
Potassium		Potash (K <sub>2</sub> O)			
		Cucumber	Melons	Squash/Pumpkin	Watermelon
Low	<201	201-300	101-150	201-300	150
Medium	201-300	101-200	51-100	101-200	100
High	301-450	51-100	1-50	51-100	50
Very High	>450	50	0	0-50	0

### Nitrogen

**Cucumbers:** Apply 40 to 50 lb of nitrogen (N) just before planting and disk into the soil. Sidedressing or topdressing an additional 30 to 50 lb of nitrogen (N) at first bloom is suggested. Rainfall, soil organic matter levels, and previous cropping history of land dictate nitrogen needs. Avoid applying N over tops of plants when foliage is wet. Applying granular fertilizer over the tops of plants when wet may burn the fruit as well as the foliage. A second sidedressing of 40 to 50 lb may be necessary with some crops. See the "Fertigation" table (page 113) for slicing cucumbers grown on plastic mulch with drip irrigation.

**Melons:** Broadcast and disk into the soil 50 lb of nitrogen (N)/A before planting. High rates of nitrogen early in the season increase vine growth, delay fruiting, and make pollination more difficult. As plants begin to vine, apply an additional 70 to 100 lb N/A in two sidedressings prior to fruit formation. See the "Fertigation" table (page 113) for fertigating nitrogen.

**Squash and Pumpkins:** Bare ground plantings: apply 75 to 80 lb actual nitrogen (N)/A broadcast before planting. Apply 100 lb N/A if sod has been plowed under. Sidedress with an additional 50 lb N/A when vines begin to run. Reduce N application when manure is used; excess N may reduce fruit quality.

**Summer squash on plastic with drip irrigation:** apply 30 to 50 lb N/A preplant together with P and K recommendation. Fertigate an additional 50 to 75 lb N/A (see the "Fertigation" table, page 113).

**Watermelon:** Apply 50 to 70 lb of nitrogen (N)/A before planting. This should be broadcast and disked into the soil. As plants begin to vine, apply an additional 50 lb of nitrogen (N)/A as a sidedress (see the "Fertigation" table, page 113).

plications of epsom salts are usually not as effective. A better long-term solution is to raise soil test magnesium levels with dolomitic lime prior to planting, although some soils may also require magnesium fertigations throughout the season.

**Molybdenum deficiency** is usually associated with acid soils. Molybdenum becomes less available to the plant as the pH is lowered. Under lowered pH, manganese and aluminum toxicities may also occur and reduce yields. First symptoms are light yellow spots on the leaves followed by death of the tissue at the margins. Symptoms have also been observed in cantaloupe where black plastic has been used and the preplant nitrogen has not been disked in deep enough. This can result in lowered pH in the top 2 to 3 inches of soil where most of the plant roots are concentrated. Soils should be tested and limed to maintain pH around 6.5 to 7.0. A foliar spray of sodium molybdate usually corrects molybdenum deficiency within two weeks. Apply 1 quart of setter water molybdenum per acre as a foliar spray. This product contains 3.5 ounces actual molybdenum per gallon. Apply no more than 12 ounces actual molybdenum during a five-year period on the same field.

### Pumpkins and Squash

Pumpkins and squash can tolerate a fairly broad range in soil pH from 5.5 to 6.8.

Apply lime if needed to raise the pH to 6.5. Apply phosphate and potash as required based on soil test results. Potassium and especially phosphorus are likely to accumulate in most Kentucky soils following several years of heavy applications for vegetable crops or tobacco.

Consider the previous crop when deciding how much nitrogen to apply; there will probably be some residual nitrogen following a crop that received heavy doses of nitrogen fertilizer during the previous season. Apply 30 to 50 pounds of nitrogen per acre prior to planting crops to be grown on plastic with drip irrigation. See the "Fertilizer" table for rates for bare ground plantings.

The recommendations in the "Fertigation" table have worked well for growers in Kentucky for summer squash grown on black plastic mulch with drip irrigation. Fertigation should begin about two weeks after transplanting and continue throughout the season. A grower may need to modify the recommendations slightly, depending on duration of harvest, soil type, previous crop, etc.

Calcium nitrate and potassium nitrate are commonly used water-soluble sources of nitrogen for fertigation. The simplest system that has worked well on medium-textured soils in Kentucky uses calcium nitrate or potassium nitrate injected into the drip irrigation water. We recommend

that all potassium and phosphorus be applied prior to laying plastic. In areas with very sandy soils, there may be some yield advantage in fertigating some of the potassium. In these cases potassium can be fertigated with a water-soluble muriate of potash (0-0-60) or potassium nitrate (14-0-45).

### Watermelons

The soil pH should be maintained between 6.0 and 6.5. Liming will be necessary when the pH is below 6.0. Fertilizer and lime applications should be based on soil test results. With plastic mulch and drip irrigation, apply all the P and K and ½ of the total N recommendation before laying plastic. The remaining nitrogen can be applied in equal weekly doses according to the "Fertigation" table.

### Pollination

#### Cucumber

Provide one hive of bees for each acre of cucumbers to ensure good pollination. This is especially important for high plant populations of gynoecious hybrid varieties grown for once-over mechanical harvesting. Low bee populations result in low fruit set and poor fruit shape.

#### Muskmelons

Muskmelon have both male and perfect flowers on the same plant. However, the perfect flowers are not capable of self-pollination and must receive pollen from male flowers. Growers with large acreages should provide one to two strong hives of bees for each acre of plants to ensure good pollination. Spraying for insect control should be done late in the day to avoid unnecessary bee kill.

#### Pumpkins and Squash

The plants have separate male and female flowers on the same plant. Pollen must be transferred from the male flowers to the female flowers by bees in order to get high yields of good quality fruit. If bees are not abundant in the field at flowering time, hives should be placed next to the field, with at least one strong hive per acre. Special precautions should be taken with insecticide treatments during flower blooming; applications should be delayed until late in the afternoon to prevent killing the bee population.

Some varieties of pumpkins grown under high temperatures (90°F days and 70°F nights) produce female flowers that wither and die before they open. The same thing may happen if pumpkin plants are heavily shaded. In both situations, male flowers develop normally and open on schedule,

### FERTIGATION: *Vining Crops*<sup>1</sup>

<b>CUCUMBERS</b>		Total amount/season: 120 lb/A
Actual N/week: 7 lb 12 oz/A		Preplant amount: 50 lb/A
Calcium 50 lb/A		Fertigated amount: 70 lb/A
Nitrate 2 lb 6 oz/1,000 plants		Growing season: 9 weeks
		Fertigation should begin about 2 weeks after seedling emergence or two weeks after transplanting.
		The doses for 1,000 plants are based on a plant population of 20,908 plants/A (i.e., beds on 5 foot centers with two rows per bed and single plants spaced 10 inches apart in the row; 12 to 18 inches between the double rows).
		For seasons extending beyond 9 weeks, a maintenance dose of 1 to 1.5 lb N/week is adequate.
<b>MUSKMELONS, SPECIALTY MELONS</b>		Total amount/season: 120 lb/A
Actual N/week: 8 lb 12 oz/A		Preplant amount: 50 lb/A
Calcium 56 lb 7 oz/A		Fertigated amount: 70 lb/A
Nitrate 15 lb 9 oz/1,000 plants		Growing season: 8 weeks
		Fertigation begins about two weeks after transplanting or when vines begin to "run."
		The doses for 1,000 plants are based on a plant population of 3,630 plants/A (i.e., beds on 6 foot centers with single plants 2 feet apart in the rows).
		For seasons extending beyond 8 weeks from "running," a maintenance dose of 1 to 1.5 lb N/week is adequate.
<b>SQUASH</b>		Total amount/season: 100 lb/A (moderate rate)
<b>Moderate Rate</b>		125 lb/A (high rate)
Actual N/week: 5 lb/A		Preplant amount: 50 lb/A
Calcium 32 lb/A		Fertigated amount: 50 lb/A (moderate rate)
Nitrate 7 lb/1,000 plants		75 lb/A (high rate)
		Growing season: 10 weeks
		Fertigation can begin 14 days after transplanting.
		The doses for 1,000 plants are based on a plant population of 4,840 plants/A (i.e., rows on 6 foot centers and plants 18 inches apart in the rows).
		For seasons extending beyond 10 weeks a maintenance dose of 1 to 1.5 lb N/week is adequate.
<b>High Rate</b>		
Actual N/week: 7 lb 8 oz/A		
Calcium 48 lb/A		
Nitrate 10 lb/1,000 plants		
<b>WATERMELONS</b>		Total amount/season: 120 lb/A
Actual N/week: 5 lb/A		Preplant amount: 60 lb/A
Calcium 32 lb 4 oz/A		Fertigated amount: 60 lb/A
Nitrate 17 lb 12 oz/1,000 plants		Growing season: 12 weeks
		Fertigation begins about 2 weeks after transplanting or when vines begin to "run."
<b>Icebox Types</b>		
Actual N/week: 5 lb/A		Standard melons: The doses for 1,000 plants are based on plant populations of 1,815 plants/A (i.e., beds on 8 foot centers with single plants 3 feet apart in the rows).
Calcium 32 lb 4 oz/A		
Nitrate 8 lb 14 oz/1,000 plants		Icebox melons: The doses for 1,000 plants are based on plant populations of 3,630 plants/A (beds on 6 foot centers and plants 2 feet apart in rows).
		For seasons extending beyond 12 weeks, a maintenance dose of 1 to 1.5 lb N/week is adequate.

<sup>1</sup> All recommendations assume starter fertilizer was used.

but few if any female flowers are seen in the field. In some cases female flowers appear but fail to bear fruit because of pollen sterility at high temperatures. The variety 'Howden's Field' is particularly susceptible to these problems.

#### Watermelons

The plants have male and female flowers that grow separately on the same plant. Bees must carry pollen from male flower to female flower to ensure good fruit set and development. Wild bees will help provide pollination; however, commercial growers should consider putting bee hives near their fields. One strong hive of bees is generally considered adequate for two acres of watermelons.

### Harvesting and Handling

#### Cucumbers

Picking the first cucumbers that develop when they reach the proper size is very important. If the early crown set is not harvested, production will be greatly reduced. Cucumbers picked by hand should be harvested every other day for best yields and quality. Cucumbers should be handled carefully to prevent bruising and spoilage, especially slicing types sold for fresh market. Cucumbers should never be put in plastic bags or containers where air will be excluded for any period of time. Cucumbers for the fresh, wholesale market are waxed and marketed in 1 ½ bushel waxed cartons. Fancy cucumbers should be 2 ¾ inches in diameter and 6 inches in length. Cucumbers can be held in storage

for about two weeks at 45° to 50°F and a relative humidity of 95 percent. Do not store at temperatures below 45°F or chilling injury will result.

### Muskmelons

Cantaloupes to be sold locally should be harvested at the full slip stage. The term “full slip” indicates that the vine easily detaches, or slips, from the fruit with a gentle pull. The ground color under the netting starts to turn yellowish at this time. For melons to

be shipped and held for some time before marketing, it may be necessary to harvest at “¼ slip” to “half slip” (only ¼ to ½ of the end of the vine detaches from the fruit when gently pulled). In some cases it may be desirable to harvest melons based on subtle color changes in the fruit; check with buyers or co-op managers to determine exactly when to harvest. It may also be necessary to harvest every day or every other day during periods of high temperatures. Honeydew

melons do not slip from the stem when ripe, but they do change colors. They usually take on a yellowish-white color and give off a slight aroma when ripe.

Harvest melons in the early morning while the fruit is cool. Care should be taken when walking through the plants to avoid injury to the plants. The plants can be trained during the early stages of development to grow in rows, enabling easier harvest. Temperature of the melon fruit at

#### PESTICIDE SAFETY: *Vining Crops*

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)	NOT Approved for Use on:			
				Cucumber	Melons	Squash/ Pumpkin	Watermelon
<b>INSECTICIDES</b>							
Acramite 50 WS	C	12	3				
Actara 25 W	C	12	0				
Admire Pro	C	12	21				
Assail 30 SG	C	12	0				
Avaunt 30 DG	C	12	3				
Belay 2.13 Sc	C	12	21				
Beleaf 50 SG	C	12	0				
Belt SC	C	12	1				
Closer 2 SC	C	12	1				
Coragen 1.67 SC	-	4	1				
Courier 40 SC	W	12	7				
Dicofol 4 E	C	12	2		X		X
Dimethoate 4 E	W	48	3	X		X	X
Entrust 2 SC	C	4	3				
Exirel 0.83 SE	C	12	1				
Fulfill 50 DF	C	12	0				
Intrepid 2 F	C	4	3				
Kanemite 15 SC	C	12	1			X	
Knack 0.86 EC	C	12	7				
Malathion 8	C	24	1		X		X
Oberon 2 SC	C	12	7				
Platinum 2 SC	C	12	30				
Portal 0.4 EC	W	12	3			X	
Radiant SC	C	4	1/3 <sup>4</sup>				
Requiem 25 EC	C	4	0				
Rimon 0.83 EC	W	12	1				
Scorpion 35 SL	C	12	1/21 <sup>4</sup>				
Sevin XLR	C	12	3				
Sivanto 1.67 SL	DC	12	1/21 <sup>4</sup>				
Trigard 75 WP	C	12	0				
Venom 70 SG	C	12	1/21 <sup>4</sup>				
Zeal 72 WP	C	12	7				
<b>Restricted Use</b>							
AgriMek 0.15 EC	W	12	7				
Asana XL	W	12	3				
Baythroid XL	W	12	0				
Brigade 2 EC	W	12	3				
Danitol 2.4 EC	W	24	7				
Decis 1.5 EC	DP	12	3				
Diazinon AG500	C	24	3	X		X	
Diazinon 50 W	C	24	3	X		X	
Hero 1.24 EC	C	12	3				
Lannate 90 SP	DP	48	1/3 <sup>4</sup>				
Mustang Max	W	12	1				
Permethrin 3.2 EC	C	12	0				
Renounce 20 WP	C	12	0				
Vydate 2 L	DP	48	1				
Warrior II	W	24	1				

#### PESTICIDE SAFETY: *Vining Crops*

	Signal <sup>1</sup>	Re-entry (hrs)	Harvest (days)	NOT Approved for Use on:				
				Cucumber	Melons	Winter Squash/ Pumpkins	Summer Squash	Watermelon
<b>FUNGICIDES</b>								
Actigard 50 WG	C	12	0					
Aftershock	C	12	1					
Aliette WDG <sup>2</sup>	C	12	0.5					
Ariston	C	12	3					
Cabrio EG	C	12	0					
Chlorothalonil <sup>3</sup>	D	12	0					
Fixed coppers <sup>3</sup>	D	24/48	0					
Curzate 60 DF	W	12	3					
Endura	W	12	0					
Flint	C	12	0					
Fontelis	C	12	1					
Forum SC	C	12	0					
Gavel 75 DF	C	48	5					
Inspire Super	C	12	7					
Luna Experience	C	12	7					
Mancozeb <sup>3</sup>	C	24	5					
ManKocide	D	24	5					
MetaStar 2EC AG	W	48	0					
Presidio	C	12	2					
Pristine	C	12	0					
Previcur Flex	C	12	2					
Procure 50 WS	C	12	0					
Proline 480 SC	C	12	7					
Quadris	C	4	1					
Quadris Opti	W	12	1					
Quadris Top	C	12	1					
Quintec	C	12	3	X			X	
Ranman	C	12	0					
Rally 40 WSP	W	24	0					
Reason 500 SC	C	12	14					
Revus	C	4	0					
Ridomil Gold SL	C	48	0					
Ridomil Gold Bravo SC	W	48	0					
Ridomil Gold Copper	D	48	5					
Ridomil Gold MZ	C	48	5			X		
Sulfur <sup>3</sup>	C	24	0					
Switch 62.5 WG	C	12	1					
Tanos	C	12	3					
Tebuconazole <sup>3</sup>	C	12	7					
Thiophanate-methyl <sup>3</sup>	C	12	0					
Torino	C	4	0					
Ultra Flourish	W	48	0					
Vivando	C	12	0					
Zampro	C	12	0					
Zing!	C	12	0					

<sup>1</sup> W: Warning, C: Caution, D: Danger; P: Poison

<sup>2</sup> The use of Aliette in the following Kentucky counties has certain restrictions to protect endangered freshwater mollusks and their habitat, so read labels carefully: Campbell, Green, Hart, Kenton, Logan, Marshall, Rockcastle, Todd, Warren, and Wayne.

<sup>3</sup> Several formulations are marketed. See the general introduction for more details on fungicides.

<sup>4</sup> Dependent on application or cucurbit type, see label.

harvest may be 85° to 95°F or even higher. Cantaloupes benefit greatly from pre-cooling as soon after harvest as possible. Some chain store buyers may purchase only pre-cooled melons. Hydrocooling cantaloupes to a temperature of 55°F is possible. They should be kept at a relative humidity of 95 percent. Grower-shippers have been using forced air cooling at 40° to 42°F in recent years in order to participate in the larger chain store markets.

### Summer Squash

Harvest at the proper size for your market and before the skin becomes tough and hard. The skin should still have a glossy appearance and will be ready for harvest from two to five days after flowers have fully opened. It is a good idea for squash pickers to use plastic buckets and wear soft gloves to avoid bruises, scratches, and fingernail punctures. Squash should be cut from the plant, leaving ½ to 1 inch of the stem attached to the fruit. Harvests may be required every other day or even daily during the peak. Always remove over-mature or oversized fruit from the plants to maintain plant vigor and production.

Summer squash is normally sold on the fresh, wholesale market in half-bushel (21 pounds) waxed cardboard cartons or 1 ½ (42 to 44 pounds) bushel cartons or wire-bound crates. Produce buyers expect a uniform count of clean fruit in each carton or crate. Squash should be uniform in size to meet the buyer's count and weight requirements; talk to your buyers to become familiar with their requirements before packing the product. The USDA's Agricultural Marketing Service has established grading standards for squash and other vegetables. They are available on the Internet at [ams.usda.gov/AMSV1.0/freshmarketvegetablestandards](http://ams.usda.gov/AMSV1.0/freshmarketvegetablestandards). Squash should be marketed quickly and not stored if possible; if storage is necessary, however, they can be kept for a week at 45° to 50°F and 90 to 95 percent relative humidity. Chilling injury can occur after several days of storage below 50°F.

### Pumpkins

They are normally harvested when they reach a deep solid color and the rind is hard. Wholesale buyers may require a large percentage of 15-pound pumpkins and may also specify the number of pumpkins, or "count," per bin. Pumpkins that are picked when they are green and immature will not color up. In emergencies—late maturity, fruit rots occurring, or large insect populations present—it is possible to harvest pumpkins at the mature-green stage, and most of them will color up within a few weeks. At the mature-green stage, the skin

### SAMPLE FUNGICIDE PROGRAMS: *Vining Crops*

Refer to the "Fungicide" table in this chapter for product rates; read product labels carefully before application.

Weeks <sup>1</sup>	Cucumber	Melon	Squash	Pumpkin/ Winter Squash	Watermelon
1, 2	chlorothalonil or mancozeb	chlorothalonil or mancozeb	chlorothalonil or mancozeb	chlorothalonil or mancozeb	chlorothalonil or mancozeb
3	chlorothalonil or mancozeb	(flowering) mancozeb + copper	chlorothalonil or mancozeb	chlorothalonil or mancozeb	chlorothalonil or mancozeb
4	Pristine or Fontelis	Quadris, Cabrio, Pristine, or Fontelis	Pristine or Fontelis	Quadris, Cabrio, Quadris Top, or Inspire Super	(flowering) mancozeb + copper
5	chlorothalonil or mancozeb	chlorothalonil or mancozeb + copper	chlorothalonil or mancozeb	chlorothalonil	tebuconazole
6	Pristine or Fontelis	Quadris, Cabrio, Pristine, or Fontelis	Pristine or Fontelis	Quadris, Cabrio, Quadris Top, or Inspire Super	chlorothalonil or mancozeb + copper
7	chlorothalonil or mancozeb	chlorothalonil or mancozeb + copper	chlorothalonil or mancozeb	chlorothalonil	Fontelis, Luna Experience, Inspire Super, or tebuconazole
8	chlorothalonil or mancozeb	chlorothalonil or mancozeb + copper	chlorothalonil or mancozeb	Quadris, Cabrio, Quadris Top, or Inspire Super	mancozeb + copper
9, 10	-	-	-	chlorothalonil	-

<sup>1</sup> Weeks after transplanting.

**All:** Begin applications of Quadris/Cabrio/Pristine earlier if disease becomes severe. Tank-mix Quintec, Torino, or Rally 40 WSP if powdery mildew appears. **Cucumber:** Finish season with chlorothalonil or mancozeb. Include appropriate fungicides if downy mildew or *Phytophthora* blight becomes severe. **Melon/Watermelon:** Finish season with mancozeb. **Squash:** Include appropriate fungicides if downy mildew or *Phytophthora* blight becomes severe. **Pumpkin:** Finish season with chlorothalonil or mancozeb. Include appropriate fungicides if downy mildew or *Phytophthora* blight becomes severe.

has toughened up and cannot be punctured with your fingernail. It is recommended, however, that pumpkins undergo at least some change in color before harvesting.

Cut pumpkins from vines carefully, leaving a 3- to 4-inch stem attached. Pumpkins do not all mature at the same time on the plant but will continue to color up over a period of three to four weeks if diseases and insects are held in check. Sunny weather is especially important in the development of mature fruit with good color.

When harvesting, use a pair of loppers, pruning shears, or a sharp knife to snip the large stem from the plant; this makes for a more attractive stem and also prevents the stem from separating from the fruit. Pumpkins are best harvested when the rind is hard and has good color characteristics typical of the variety. Do not carry a pumpkin by its stem or "handle" since these often break off, reducing the pumpkin's marketability and its storage life by encouraging decay.

It may be necessary to harvest and hold pumpkins in storage for two to four weeks before they are sold. Do not store on bare ground after harvest. Tobacco barns are usually a good place for storage. Spread out a layer of dry straw or hay and set the pumpkins on it. Keep them dry. Good air circulation will help reduce rotting. Pumpkins should be harvested and stored before temperatures drop to the 30s and 40s.

Although harvests for Halloween usually begin in late September to early October, high temperatures may cause

pumpkins to mature in late August and early September. These pumpkins often rot or decay long before they can be marketed. Some rot, caused by injury or seasonal stresses such as drought and/or heat, is unavoidable. Diseases such as powdery or downy mildew, viruses, or gummy stem blight may also cause premature ripening. There are a few precautions that should be taken to minimize the decay of prematurely ripened fruit. Harvest should begin earlier. Get the pumpkins out of the field when they mature early. Pumpkins should be handled carefully to avoid cuts and bruises, which are the major entry points for rotting fungi and bacteria.

A curing period of seven to 10 days at temperatures of 80° to 85°F with relative humidity of 80 to 85 percent has been recommended in the past to heal over surface injuries and allow for further ripening; however, this practice is seldom used, and research has shown that it may not be necessary. It has not been beneficial for several types of squash, including Butternut, and may be detrimental to Acorn squash.

Store pumpkins cool and dry; storage temperatures should be 50° to 55°F with a relative humidity of 50 to 70 percent. The surface of the fruit should be dry. Keep the area as well ventilated as possible and away from any ethylene sources (tomatoes, apples). Ventilation can be provided by placing fruits on pallets or slatted benches, which allow air movement around the fruits. Avoid stacking pumpkins on top of one another. Stacking

is a sure way to create bruises, and the pile will only create unwanted heat. It is possible to hold pumpkins for six to eight weeks when held at 50° to 55°F but only for a few weeks at 70°F.

Ornamental pumpkins have virtually no value after Halloween. Plant early enough for the variety you have selected and be careful not to over-fertilize with nitrogen, which can delay maturity. A dry period without irrigation can also result in pumpkins at the wrong stage of maturity at harvest. Green-mature pumpkins can be harvested but are not as likely to color up uniformly.

Avoid temperatures below 50°F, which can cause chilling injury to green-mature pumpkins and will result in poor color and more fruit decay. One possibility is to put green or partially colored pumpkins in a warm greenhouse, which will accelerate the maturing process.

Irrigation and proper post-harvest care are always good investments, especially because supplies may be short after growing seasons that result in orange pumpkins in August or green pumpkins in September.

Pumpkin prices and, therefore, returns per acre, can vary greatly depending on supplies available and the marketing channel used. Higher and more stable prices can be expected from direct sales or even “pumpkin festival” sales, but this market can become saturated with too many growers near a population center. In some cases, smaller growers can help supply the larger festival market grower to obtain prices that may be higher than wholesale. Larger producers and those who do not have time for direct sales will need to find wholesale buyers or, in some cases, sell directly to supermarkets. Wholesale prices are often considerably lower than direct market (retail) prices. Smaller growers should consider joint marketing efforts to attract wholesale buyers. Although consumer demand for pumpkins has expanded considerably in recent years, more growers are getting into production, and some markets may disappear at harvest time. Good production, management, and marketing can result in high profits, especially when supplies are short.

### Watermelon

A grower must become familiar with the variety to determine the best stage for harvesting. A dead tendril or curl at the point where the fruit attaches to the vine is not a conclusive indication that the fruit is ready for harvest. “Thumping” the fruit is sometimes used, but only over-ripeness

can be determined in this manner.

The best indicator for harvest is the color of the underside of the melon. When ‘Crimson Sweet’ melons turn yellowish-brown on the bottom surface, for example, they are fully ripe and ready for harvest. The fruits will take on a dull appearance compared to their slick appearance prior to maturity. Determining the proper time to harvest seedless watermelons is generally more difficult than for seeded melons. The death of a tendril usually does not correlate with seedless watermelon ripeness. Melon undercolor is usually the only index of maturity on seedless watermelons, and this color will vary among varieties. Melons should not be left long in the sun, or they may develop sunscald.

Melons should be handled gently to avoid bruising. When loading, melons should not be stacked so high that their weight bruises the bottom fruit. Watermelons should be stored at 50° to 60°F and 90 percent relative humidity.

## Common Diseases/Management

### General Practices

Field selection, crop rotation, sanitation, resistant varieties, seed treatment, insect management, residue destruction, irrigation/water management, and fungicide use are important disease control practices for all of these crops. Select fields with good soil and air drainage and those that have not been in cucurbits, tobacco, peppers, or tomatoes during the past two to three years. Longer rotation will be required if certain diseases occurred in previous crops.

Fungicides are an important tool for management of cucurbit diseases; follow a preventive program and apply materials in a timely fashion. Chlorothalonil, mancozeb (Dithane DF, Manzate, and Penncozeb), and fixed coppers tend to be inexpensive relative to other materials and should form the “backbone” of a fungicide program. Maneb (Maneb, Manex) fungicides were pulled from the marketplace in 2010, and existing stocks cannot be used legally on cucurbits. Keep in mind that the more expensive materials (strobilurins, for example) may be more effective under severe disease pressure and should be applied when these conditions prevail.

Not all cucurbits are subject to all of the common diseases listed below. In brackets after the name of the disease, abbreviations are used to indicate the susceptible cucurbit crops (C: cucumber, M: muskmelon, SP: squash and pumpkin, W: watermelon).

**Anthracnose** [C/M/SP/W], **Alternaria leaf blight** [C/M/SP/W], and **Cercospora**

**leaf spot** [C/M/W]. Use disease-free seed, promptly destroy crop residues, and practice rotation to crops other than cucurbits for two to four years. Varieties vary in susceptibility, so consider using resistant varieties. Plant anthracnose-resistant varieties whenever possible. The sample spray program on page 115 will suppress most fungal diseases, starting no later than the first appearance of disease or when vines touch within the rows (or earlier if conditions favor disease).

**Angular leaf spot, bacterial leaf spots** [C/M/SP]. Use disease-free seed (hot water, acid, or bleach treatments; see Appendix H) and crop rotations of two to three years with non-cucurbits. Severity is enhanced with high nitrogen and low potassium levels. Work crops only when they are dry to reduce plant-to-plant spread. Using drip irrigation rather than overhead applications can aid control. Fixed coppers are helpful. Repeated use of copper may cause leaf yellowing. Several angular leaf spot-tolerant cucumber varieties are available, and that level of control may be adequate for most seasons. Resistant cultivars are not available for muskmelons, but they have considerable tolerance to these diseases.

**Bacterial fruit blotch** [W]. This disease was found in Kentucky for the first time in 2011. Suspect plant samples should be sent to the UK Plant Disease Diagnostic Lab for proper diagnosis. Since the disease is seed-borne, a key to control is to plant uncontaminated seed in clean sites. If transplants are being used, be sure they have been started from seed lots that were negative in laboratory tests for this pathogen and were produced in greenhouses operated under very sanitary conditions. Avoid plants from any greenhouse that has the disease. Plants produced from different seed lots should be segregated during transplant production and in the field to reduce cross-contamination and spread. Use sites rotated to crops other than cucurbits for at least two years. Beginning at bloom (or earlier if the disease is found), apply a fixed copper product and keep copper in the spray program or alternate with fungicides (to control fungal diseases).

**Bacterial wilt** [C/M/SP]. The pathogen causing this wilt overwinters in and is transmitted by cucumber beetles. Controlling these insects is essential before they feed on the plant, starting from the day of plant emergence or transplanting through fruit set. Use appropriate insecticides (see “Insect Control” table), particularly after mild winters that may promote large overwintering populations of beetles.

**Belly rot (Rhizoctonia fruit rot)** [C]. Belly rot affects cucumbers, particularly those grown for pickling, but other types of cucurbits may be affected. Plant on raised beds to control soil moisture; plastic mulch will also improve disease control. Incorporate cover crops early to ensure thorough rotting before planting. Fungicides may also provide some control.

**Cold injury** [C/M/SP]. Chilling injury causes pitting of the tender skin and can occur either in storage or in the field after several days of exposure to temperatures below 40°F, especially if humidity is high. This can occur following several days of cold, rainy weather in the fall; however, symptoms may not show in the fruit until it is well beyond the farm. Winter squash and pumpkins are sensitive to frost and temperatures of 32°F or below; some varieties may also be sensitive to cold injury at slightly higher temperatures.

**Cottony leak (Pythium fruit rot)** [C/M/SP/W]. Use well-drained sites, raised beds, and plastic mulch to reduce soil contact and wet conditions. On known problem sites, use mefenoxam or metalaxyl pre-plant or after seeding/transplanting. Incorporate cover crops and crop residues early enough to ensure that they completely decompose.

**Choanephora fruit rots (wet rot)** [C/SP]. Fungicides are not available. The disease is promoted by high moisture conditions, so the cultural practices to reduce cottony leak and belly rot may help reduce disease severity (raised beds, wider row spacings, weed control, proper N fertilization, etc.).

**Downy mildew** [C/M/SP/W]. Downy mildew is most problematic in the late summer and fall and thus tends to be more severe on winter squash and pumpkins than on other cucurbit crops. Fungicide programs aimed at other diseases of vining crops should suppress early introduction of downy mildew, although spray intervals may need to be shortened to achieve good control. Do not wait to see symptoms of downy mildew before applying fungicides, as it can be nearly impossible to control the disease once it starts if fungicides are not in place. Check the Cucurbit Downy Mildew Forecasting System ([cdm.ipmpipe.org/](http://cdm.ipmpipe.org/)) for updates on the status of downy mildew in the Commonwealth and neighboring states. If downy mildew appears prior to the start of the regular fungicide spray program, include newer fungicides such as Ranman, Zampro, or Tanos tank mixed with a protectant fungicide such as mancozeb or chlorothalonil. Materials such as Ridomil, Forum, Revus, Presidio, and strobilurins (Quadris and Cabrio) are not recommended for control of downy

mildew, as resistance to these chemistries has been reported in the U.S. Resistant or tolerant varieties are becoming available in summer squash and other cucurbits (see “Varieties” table).

**Fusarium fruit rot** [C/M/SP/W]. Rotation has not proven very effective in controlling this disease. No fungicides are labeled for controlling Fusarium fruit rot; fumigation may reduce populations of Fusarium in soil. (See “Soil Fumigants for Control of Nematodes and Soilborne Diseases” on page 16.) Control insects and diseases (especially powdery mildew) from planting through harvest, and avoid wounding to aid in suppression of Fusarium fruit rot.

**Fusarium wilt** [M/W]. Resistant varieties offer the best control. For muskmelons, use those with resistance to Race 2 of *F. oxysporum* sp. *melonis* on sites with a history of the disease; if these varieties also contract Fusarium wilt, consider varieties with resistance to other races. Athena has resistance to Races 0, 1, and 2.

Watermelon varieties with resistance to Race 1 of *F. oxysporum* f.sp. *niveum* have performed well in infested fields, although other races could be present.

Rotation to crops other than cucurbits for three to five years will reduce pathogen populations in soil; however, rotation alone is not an adequate control. Failure to control root-knot nematode is often tied in to Fusarium wilt outbreaks. Fumigation of soil may also provide some benefit (see “Soil Fumigants for Control of Nematodes and Soilborne Diseases” on page 16 for more information).

**Gummy stem blight** [C/M/SP/W]. Use disease-free seed or transplants. Rotations of two to three years away from cucurbits will reduce the incidence of gummy stem blight. Start fungicide applications when vines begin to touch in rows or when symptoms appear. In wet years, don’t wait to see the disease before spraying! Spray programs that include chlorothalonil or mancozeb are effective in managing gummy stem blight; strobilurins and Pristine should be included in the program for maximum disease control. Resistance to strobilurins (Quadris, Cabrio) and benzimidazoles (Topsin M, T-Methyl) is common in the southeastern United States, including Kentucky and therefore these fungicides are not recommended. Resistance to carboximide fungicides (Presidio, Endura, Fontelis) is commonplace in the southern U.S., but has not been found in Kentucky to date; use caution when applying these products. Be sure to follow resistance management guidelines listed on product labels.

**Microdochium blight (Plectosporium blight)** [SP]. Microdochium blight can be suppressed by fungicide programs used to control other diseases of squash and pumpkins. Quadris, Quadris Top, Inspire Super, Cabrio EG, and Flint are specifically labeled for this disease.

**Ozone injury** [C/M/SP/W]. Symptoms are associated mainly with older leaves and appear as a flecking of the upper leaf surface (almost never the bottom side). Mancozeb-containing materials can reduce damage but are probably not needed in Kentucky on most muskmelon crops.

**Phytophthora blight** [C/M/SP/W]. Cultural practices are the most important disease control tools for Phytophthora blight. Avoid fields that were planted (within the last three years) to hosts of *P. capsici*, primarily pepper, eggplant, and all cucurbits. Improving soil drainage around plants and managing irrigation very carefully to reduce the duration of wet periods and contamination of water will also reduce disease. Soil pH should be maintained at the low end of the acceptable range. Use disease-free transplants. Keep cull piles away from fields or irrigation sources; destroy infected fruit in fields by deep plowing. Avoid, if possible, irrigation with surface water (ponds and creeks). Fungicide options are available. Good coverage and timely application are important considerations for fungicides used to control Phytophthora blight.

**Powdery mildew** [C/M/SP/W]. Unfortunately, powdery mildew fungi have developed resistance to benzimidazoles (Topsin M, Thiophanate 85WDG), DMI fungicides (Procure, Rally) and strobilurins (Quadris, Cabrio, Flint) in many parts of the United States. Chlorothalonil applied in a weekly spray program for other diseases will slow powdery mildew development, and rotation or tank-mixes with Quintec, Vivando, or Rally is an excellent strategy for managing this disease.

Systemic products such as Rally and Procure give the added benefit of suppressing powdery mildew on lower leaf surfaces, areas where good spray coverage can be hard to achieve. Quintec can redistribute to untreated foliage by vapor action. If one fungicide is not effective, switch immediately to a new class of chemicals, and always follow resistance management guidelines where applicable.

Sulfur is also labeled for powdery mildew and works well; however, sulfur can cause serious leaf burn during hot (90°F or higher), humid weather. The amounts needed for full-season control can lower soil pH. Powdery mildew-resistant or tol-

erant muskmelon, summer squash, and pumpkin varieties are available. Excellent resistance is available in some cantaloupes, cucumber, squash, and pumpkin varieties (see "Varieties" tables).

**Rind necrosis** [W]. Bacterial rind necrosis appears sporadically but can cause serious losses in certain years. External symptoms are rare; however, cut melons exhibit a dry, brown, corky necrosis in the rind that typically doesn't extend into the fruit. Entire fields have been rejected by brokers where even a few diseased melons were found. Little is known about the epidemiology of the disease, believed to be caused by *Erwinia* spp., and no controls are available. Watermelon varieties vary in their susceptibility, and environment plays a role in the appearance of the disease.

**Scab** [C/M/SP/W]. Use scab-resistant varieties, depending upon the cucurbit being grown, and rotate to unrelated crops for three years or more in problem fields. If resistance is not used, then fungicide sprays may be necessary in cool, wet weather. Spray programs used for anthracnose and gummy stem blight will suppress scab but must begin early (with first leaves). Under severe disease pressure, such as on non-rotated sites, chlorothalonil is the best option (use highest labeled rate).

**Root-knot nematode** [C/M/SP/W]. Rotation to small grains for two or more years is a highly effective control measure. See "Nematode Control" on page 15 for more information on nematodes. Preplant soil fumigation is also highly effective but may not be economical for cucumbers. A few contact nematicides are available.

**Seed and seedling blights** [C/M/SP/W]. Buy fungicide-treated seed whenever possible. If seed has not been treated, use Captan WP at 1 teaspoon per pound of seed. Planting into warm (when soil temperatures are 65°F or greater), well-drained soils greatly reduces the risk of seedling death. Fungicides applied to control cottony leak will also help with *Pythium* seedling diseases. Greenhouse-produced transplants should be seeded into pathogen-free media with the trays on well-drained benches rather than on the soil. Carefully manage watering to minimize prolonged periods of wetness.

**Viruses** [C/M/SP/W]. Viruses (Cucumber Mosaic, Watermelon Mosaic, Papaya Ringspot Virus, Squash Mosaic, and Zucchini Yellow Mosaic) are common in some years in Kentucky. Plant certified, disease-free seed. Elimination of perennial weeds within 150 feet of the planting by using grasses or non-susceptible annual crops around the cucurbit planting is helpful.

Control aphids to reduce secondary spread within the planting. Do not plant cucurbits adjacent to peppers, tomatoes, tobacco, or earlier cucurbit crops. The use of stilet oils and planting into reflective mulches has been shown to delay or reduce virus transmission; however, success with these methods in Kentucky has been marginal. Control aphids in nearby tobacco to reduce virus movement into cucurbits. Plant CMV-resistant cucumber cultivars. Consider using resistant squash varieties (see "Varieties" table), but check current requirements or restrictions regarding labeling and marketing of transgenic-resistant varieties. Controlling insect vectors in fall plantings is not a practical control solution for this disease complex. In pumpkins, earlier planting can reduce losses by allowing fruit to set and color before high virus loads are present.

**Yellow vine decline** [M/SP/W]. Cucurbit yellow vine decline (CYVD) is a relatively new and serious disease in Kentucky. The symptoms of yellowing and stunting are commonly observed. It is now known that the causal agent is a bacterium, *Serratia marcescens*, and it appears to survive in and be vectored into the cucurbit plants by the squash bug, *Anasa tristis*. Control measures must be focused on the squash bug. See the "Insect Control" table for specifics.

**INSECT CONTROL: Vining Crops<sup>1,2</sup>—Cucumber, Melon, Pumpkin, Squash, and Watermelon**

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
<b>PREPLANT INCORPORATED</b>			
<b>Wireworms, Cutworms:</b> Wireworms are a potential problem for crops following grass or legume-grass sod.			
Diazinon 50 W	6 to 8 lb	-	Incorporate immediately. For melons and watermelons only.
Diazinon 14 G	14 to 28 lb	-	Incorporate immediately. For melons and watermelons only.
<b>SOIL TREATMENTS</b>			
<b>Aphids, Cucumber Beetles, Whiteflies</b>			
Admire Pro	7 to 10.5 fl oz	10.5 fl oz	See label for application methods.
Belay 2.13 SC	9 to 12 fl oz	12 fl oz	At planting only. See label for application methods.
Platinum 2 SC	5 to 11 fl oz	11 fl oz	See label for application methods.
Scorpion 35 SL	9 to 10.5 fl oz	21 fl oz	See label for application methods.
Sivanto 1.67 SL	21 to 28 fl oz		For aphids, leafhoppers and whiteflies.
Venom 70 SG	5 to 6 oz	12 oz	Allow 7 days between applications. Not for cucumber beetles or aphids.
<b>FOLIAR TREATMENTS</b>			
<b>Aphids</b>			
Actara 25 WDG	1.5 to 3 oz	11 oz	Allow 5 days between applications. Not during bloom.
Assail 30 SG	2.5 to 4 oz	26.5 oz	Limit 5 applications. Allow 5 days between applications.
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.
Beleaf 50 SG	2 to 2.8 oz	8.4 oz	Limit 3 applications at the 2.8 oz/A rate. Allow 7 days between applications.
Brigade 2 EC	2.6 to 6.4 fl oz	19.2 fl oz	Limit 2 applications after bloom. Allow 7 days between applications.
Closer 2 SC	1.5 to 2 fl oz	17 fl oz	Allow 7 days between applications.
Exirel 0.83 SE	13.5 to 20.5 fl oz	61.5 fl oz	Allow 5 days between applications.
Fulfill 50 DF	2.75 oz	5.5 oz	Allow 7 days between applications.
Malathion 8	1.75 pt	2 applications	Allow 7 days between applications.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications. Do not combine with soil applications.
Sivanto 1.67 SL	7 to 12 fl oz	28 fl oz	Allow 7 days between applications.
Requiem 25 EC	2 to 3 qt	-	-
Rimon 0.83 EC	9 to 12 fl oz	36 fl oz	Allow 14 days between applications.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications. Not during bloom.
<b>Cucumber Beetles:</b> Key insect pest attacking cucumbers, vector of bacterial wilt. Must begin control when seedlings first emerge. Repeat applications as necessary to maintain control, particularly when plants are small. See Bacterial Wilt. Management can be relaxed when harvest begins.			
Asana XL	5.8 to 9.6 fl oz	48 fl oz	-
Assail 30 SG	2.5 to 5.3 oz	26.5 oz	Limit 5 applications. Allow 5 days between applications.
Battalion 1.5 EC	1.5 to 2.4 fl oz	14.4 fl oz	-
Belay 2.13 SC	3 to 4 fl oz	12 fl oz	Allow 7 days between applications. Not during bloom.

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**INSECT CONTROL:** *Vining Crops*<sup>1,2</sup> (continued)

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
Brigade 2 EC	2.6 to 6.4 fl oz	19.2 fl oz	Limit 2 applications after bloom. Allow 7 days between applications.
Danitol 2.4 EC	10.67 to 16 fl oz	42.67 fl oz	Allow 7 days between applications.
Mustang Max	1.28 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	64 fl oz	-
Sevin XLR	1 qt	6 applications	Allow 7 days between applications.
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications. Do not combine with soil applications.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications. Not during bloom.
Warrior II	1.28 to 1.92 fl oz	11.5 fl oz	Allow 5 days between applications.
<b>Cutworms:</b> Eliminate weeds from field margins and plow fields at least 2 weeks before planting to destroy cutworm food sources and egg laying sites.			
Asana XL	5.8 to 9.6 fl oz	48 fl oz	-
Battalion 1.5 EC	1 to 2.4 fl oz	14.4 fl oz	-
Belt 2 SC	1.5 fl oz	4.5 fl oz	Allow 7 days between applications.
Brigade 2 EC	2.6 to 6.4 fl oz	19.2 fl oz	Limit 2 applications after bloom. Allow 7 days between applications.
Mustang Max	1.28 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	64 fl oz	-
Warrior II	1.28 to 1.92 fl oz	11.5 fl oz	Allow 5 days between applications.
<b>Spider Mites:</b> Regular weed control around the outside perimeter of the field is very important.			
Acramite 50 WS	0.75 to 1 lb	1 application	-
AgriMek 0.15 EC	8 to 16 fl oz	48 fl oz	Allow 7 days between applications.
Brigade 2 EC	5.12 to 6.4 fl oz	19.2 fl oz	Limit 2 applications after bloom. Allow 7 days between applications. For end of season control.
Danitol 2.4 EC	10.67 fl oz	42.67 fl oz	Allow 7 days between applications. For end of season control.
Miteus 0.42 EC	2 pt	4 pt	Limit 2 applications. Allow 14 days between applications.
Oberon 2 SC	7 to 8.5 fl oz	25.5 fl oz	Allow 7 days between sprays.
Portal 0.4 EC	2 pt	4 pt	Limit 2 applications. Allow 14 days between applications.
Zeal	2 to 3 oz	1 application	-
<b>Squash Bug:</b> Squash bug is a common pest of squash and pumpkins through feeding and transmission of the bacteria that causes Yellow Vine Decline. It also can transmit the disease to melons and watermelons. Destroy crop residues to reduce overwintering sites for squash bugs.			
Assail 30 SG	5.3 oz	26.5 oz	Limit 5 applications. Allow 5 days between applications.
Belay 2.13 SC	3 to 4 oz	12 oz	Allow 7 days between applications. Not during bloom.
Brigade 2 EC	2.6 to 6.4 fl oz	19.2 fl oz	Limit 2 applications after bloom. Allow 7 days between applications.
Mustang Max	1.28 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	64 fl oz	-
Rimon 0.83 EC	12 fl oz	36 fl oz	Allow 14 days between applications.
Sivanto 1.67 SL	10.5 to 14 fl oz	28 fl oz	Allow 7 days between applications.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications. Not during bloom.
Warrior II	1.28 to 1.92 fl oz	11.5 fl oz	Allow 5 days between applications.
<b>Squash Vine Borer:</b> Squash vine borer is primarily a pest of squashes and pumpkins. Treat for squash vine borer beginning 3rd week in June and repeat 3 to 5 times at weekly intervals.			
Asana XL	5.8 to 9.6 fl oz	48 fl oz	-
Assail 30 SG	5.3 oz	26.5 oz	Limit 5 applications. Allow 5 days between applications.
Belt 2 SC	1.5 fl oz	4.5 fl oz	Allow 7 days between applications.
Brigade 2 EC	2.6 to 6.4 fl oz	19.2 fl oz	Limit 2 applications after bloom. Allow 7 days between applications.
Mustang Max	1.28 to 4 fl oz	24 fl oz	Allow 7 days between applications.
Permethrin 3.2 EC	4 to 8 fl oz	64 fl oz	-
Warrior II	1.28 to 1.92 fl oz	11.5 fl oz	Allow 5 days between applications.
<b>Whiteflies</b>			
Actara 25 W	3 to 5.5 oz	11 oz	Allow 5 days between applications. Not during bloom.
Assail 30 SG	2.5 to 5.3 oz	26.5 oz	Limit 5 applications. Allow 5 days between applications.
Courier 40 SC	9 to 13.6 fl oz	2 applications	Allow 7 days between applications.
Exirel 0.83 SE	13.5 to 20.5 fl oz	61.5 fl oz	Allow 5 days between applications.
Knack 0.86 EC	8 to 10 fl oz	20 fl oz	Limit 2 applications. Allow 14 days between applications.
Miteus 0.42 EC	2 pt	4 pt	Limit 2 applications. Allow 14 days between applications.
Oberon 2 SC	7.0 to 8.5 fl oz	25.5 fl oz	Allow 7 days between sprays.
Portal 0.4 EC	2 pt	4 pt	Limit 2 applications.
Requiem 25 EC	2 to 3 qt	-	-
Scorpion 35 SL	2 to 7 fl oz	10.5 fl oz	Allow 7 days between applications. Do not combine with soil applications.
Sivanto 1.67 SL	10.5 to 14 fl oz	28 fl oz	Allow 7 days between applications.
Venom 70 SG	1 to 4 oz	6 oz	Allow 7 days between applications. Do not use following a soil application of Venom, Platinum, or Admire.

<sup>1</sup> See an IPM Scouting Guide for Common Problems of Cucurbit Crops in Kentucky (ID-91) for photos of pests.

<sup>2</sup> Generic products available (Appendix E).

**WEED CONTROL:** *Vining Crops—Cucumber, Melon, Pumpkin, Squash, and Watermelon*

Product Amt/A	Lb A.I./A	Comments
<i>The stale seedbed technique for direct seeded vine crops can be very effective in eliminating initial flushes of weeds occurring when soil is disturbed. This technique involves preparing the soil, allowing a flush of weeds to emerge, and then cultivating or applying paraquat before seeding or transplanting the crop. Paraquat will have no residual activity.</i>		
0.5-1.6 fl oz	0.008-0.025	For contact post-emergence control of annual broadleaf weeds and suppression of annual grasses. Do not confuse and use the non-labeled Aim EC formulation. Can be applied as a preplant, pre-transplant burndown, or before crop emerges to actively growing weeds up to 4 inches tall. Can also be applied post-emergence as a directed hooded application between crop rows. Use min. 10 gal water/A and crop oil 1% v/v. Max. rate 6.1 fl oz/A. PHI = 0 days.
Aim 1.9 EW	carfentrazone	

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**WEED CONTROL: Vining Crops (continued)**

Product Amt/A	Lb A.I./A	Comments
0.4-1 pt Command 3ME	0.15-0.37 clomazone	Not labeled for gourd. For control of annual grasses and small-seeded broadleaves; poor control of pigweed. Apply immediately after seeding. Max. rate for muskmelon and watermelon is 0.67 pt/A. See label for additional instructions and restrictions. Label specifically states not to use on Jack-o-Lantern pumpkins due to unacceptable whitening. PHI = 45 days.
3-4.5 pt Curbit 3 E	1.13-1.5 ethalfuralin	Not labeled for gourd. For pre-emergence control of annual grasses and broadleaves. Do not use on wet or cloddy soils or before a heavy rain to avoid crop injury. Do not apply over or under hot caps, row covers, or plastic mulch. Do not apply broadcast to transplants. Do not incorporate. Clean cultivate and apply as a banded spray to soil between rows of plastic mulch.
6-14 lb Dacthal W-75	4.5-10.5 DCPA	Not labeled for pumpkin and some gourds. For pre-emergence control of annual grasses and small-seeded broadleaves. Apply only to crop with 4 to 5 true leaves that is well-established and when growing conditions are favorable. Do not incorporate. Not labeled for transplanted crop.
1.0-1.33 pt Dual Magnum	0.95-1.27 s-metolachlor	Pumpkin only. For pre-emergence control of select weed species. Leave at least 6 inches of untreated area on either side of hill or row and/or any pumpkin foliage. Direct contact with foliage will result in injury. PHI = 30 days.
2-4 pt Gramoxone Inteon	0.69-1.38 paraquat salt	For non-selective contact kill of annual grasses and broadleaf weeds and top-kill of perennial weeds. Apply preplant, pre-emergence, or before transplanting in min. 10 gal water/A. Apply banded or broadcast. Use higher rate for heavy weed infestations. Use non-ionic surfactant 0.25% v/v.
0.5-1.5 pt Poast 1.5 E	0.09-0.27 sethoxydim	Not labeled for gourd. For control of actively growing grasses only. Use high rate on Johnson grass. PHI = 14 days. Max. rate of 1.5 pt/application and 4.5 pt/season.
5-6 qt Prefar 4 E	5-6 bensulide	For control of grasses and broadleaf weeds. Apply preplant and incorporate to 1 to 2 inch depth. Apply pre-emergence only if it can be watered in within 36 hours. Max. rate of 6 qt/season.
16-22 fl oz Roundup Weather- Max 5.5L	0.69-0.94 glyphosate-salt	For non-selective post-emergence control of annual and perennial grasses and broadleaf weeds. Use only AMS 1 to 2% v/v. Adding a non-ionic surfactant can reduce weed control effectiveness. Min. 3 days between application and planting and min. 30 days before planting any non-labeled crop.
0.5-1 oz Sandea 75 DF	0.023-0.047 halosulfuron	For control of broadleaf weeds and yellow nutsedge. Cucumber (30 days PHI), cantaloupe, and honeydew melon (57 days PHI): Can be applied preplant under plastic mulch. Apply after final bed preparation and before laying plastic and transplant 7 days after application. Can also be applied post-transplanting on bare ground. Check label for instructions for direct-seeded and row middle applications. Watermelon and muskmelon (57 days PHI): Apply only in row middles in direct-seeded and transplanted watermelon. If plastic mulch is used, do not spray Sandea on plastic. Check label for crop specific applications.
9-16 fl oz Select Max	0.07-0.12 clethodim	For selective post-emergence of actively growing annual grasses and suppression of perennial grasses. Add crop oil 1% v/v. Max. 16 fl oz/application. Min. 14 days between applications. PHI = 14 days.
2-4 oz Sinbar 80 WP	0.1-0.2 terbacil	Watermelon only. For pre-emergence control of broadleaves and grasses. Apply after seeding but before watermelon emerges. For transplanted watermelons, apply pre-transplant. Sinbar may be used pre-emergence under plastic mulch or to row middles. Sinbar may also be applied broadcast over the plastic mulch prior to transplanting, or prior to punching holes in the plastic mulch for transplanting. Sinbar must be washed off the plastic mulch with a minimum of 0.5 inch rain prior to transplanting. PHI = 70 days.
3-6 pt Strategy 2.1E	0.6-1.18 ethalfuralin + 0.18-0.39 clomazone	Not labeled for gourd. For pre-emergence control of annual grasses and broadleaf weeds. Apply to seeded crop before its emergence or as a banded spray between rows after crop emergence or transplanting. Rainfall (0.5 inch) within 2 days is needed for activation. Do not incorporate. Crop injury may occur under cool temperatures that delay seedling emergence. PHI = 45 days for cucumber. Max. 1 application/year. Use lowest labeled rate for summer squash.
1.25-2 pt Treflan HFP 4 E	0.6-1 trifluralin	For control of annual grasses and broadleaf weeds. Apply after emergence to plants with 3 to 4 true leaves. Can be applied directed to soil between the rows to older plants but avoid foliage contact. PHI = 30 days for most cucurbits but 60 days for watermelon.

All products in this table are labeled for use on muskmelons, watermelons, pumpkins, and cucumbers unless otherwise indicated.

**DISEASE CONTROL: Vining Crops—Cucumber, Melon, Squash and Pumpkin, Watermelon**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Angular Leaf Spot, Bacterial Leaf Spots [C/M/SP]</b>					
Actigard	21	0	0.5 to 1 oz	16 oz	Begin applications before onset of disease; apply every 7 to 14 days. Apply in a minimum of 20 gal/A of water. May cause phytotoxicity and yield reduction. Do not apply to stressed or injured plants.
Fixed coppers					
Badge SC	M	0	1 to 2.5 pt	-	-
Badge X2	M	0	0.5 to 2.5 lb	-	OMRI-listed.
Basic Copper 53	M	0	2 lb	-	OMRI-listed.
C-O-C-S WDG	M	0	2 to 4 lb	-	-
Champ DP	M	0	1.33 lb	-	-
Champ Formula 2 FL	M	0	1.33 pt	-	-
Champ WG	M	0	1.5 to 3 lb	-	OMRI-listed.
COC DF	M	0	3 to 4 lb	-	-
COC WP	M	0	3 to 4 lb	-	OMRI-listed.
Copper-Count-N	M	0	3 to 4 pt	-	-
Cueva	M	0	0.5 to 2 gal	-	OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 2 lb	-	-
Kentan DF	M	0	1 to 2.62 lb	-	-
Kocide 2000	M	0	1 to 2.25 lb	-	-
Kocide 3000	M	0	0.5 to 1.25 lb	-	-
Kocide DF	M	0	1.5 to 3 lb	-	-
Mastercop	M	0	0.5 to 1 pt	-	-
Nordox 75 WG	M	0	1 to 1.25 lb	-	OMRI-listed.
Nu-Cop 50 WP	M	0	1.5 to 3 lb	-	OMRI-listed.
Nu-Cop 3 L	M	0	0.66 to 4 pt	-	-
Nu-Cop 50 DF	M	0	1.5 to 2 lb	-	OMRI-listed.
ManKocide2	M	5	2 to 2.5 lb	see footnote	Apply when disease appears and continue every 3 to 7 days as needed.
Tanos	11/27	3	8 to 10 oz	4 apps	Suppression of bacterial fruit blotch only. Tanos must be tank-mixed with a fungicide from FRAC Group M appropriate for the target disease. Apply prior to disease onset, continue every 5 to 7 days.

(continued on next page)

**DISEASE CONTROL: Vining Crops—Cucumber, Melon, Squash and Pumpkin, Watermelon (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Anthraco­nose and Alternaria Leaf Blight [C/M/SP/W], Cercospora Leaf Spot [C/M/W]</b>					
Aftershock	11	1	3.0 to 5.7 oz	4 apps	Apply before disease onset, continue every 7 to 14 days. Alternate with a fungicide outside FRAC group 11.
Ariston	M/27	3	1.9 - 3.0 pt	17.5 pt	Apply before disease onset, continue every 7 days. May sunburn mature watermelon.
Azoxystrobin <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days.
Azoxy 25C	11	1	11 to 15.5 fl oz <sup>3</sup>	4 apps	
AzoxyStar	11	1	11 to 15.5 fl oz <sup>3</sup>	4 apps	
Quadris	11	1	11 to 15.5 fl oz <sup>3</sup>	4 apps	
Satori	11	1	11 to 15.5 fl oz <sup>3</sup>	4 apps	
Cabrio	11	0	12 to 16 oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
Chlorothalonil <sup>4</sup>					Apply before disease onset; continue every 7 days as needed.
Bravo Ultrex	M	0	1.4 to 2.7 lb	19.1 lb	
Bravo WeatherStik	M	0	1.5 to 3 pt	21 pt	
Endura	7	0	6.5 oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
Fixed coppers					Apply every 5 to 10 days beginning before disease onset, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1 to 2.5 pt	-	
Badge X2	M	0	0.5 to 2.5 lb	-	OMRI-listed.
Basic Copper 53	M	0	2 lb	-	OMRI-listed.
C-O-C-S WDG	M	0	2 to 4 lb	-	
Champ DP	M	0	1.33 lb	-	
Champ Formula 2 FL	M	0	1.33 pt	-	
Champ WG	M	0	1.5 to 3 lb	-	OMRI-listed.
COC DF	M	0	3 to 4 lb	-	
COC WP	M	0	3 to 4 lb	-	OMRI-listed.
Copper-Count-N	M	0	3 to 4 pt	-	
Cueva	M	0	0.5 to 2 gal	-	OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 2 lb	-	
Kentan DF	M	0	1 to 2.62 lb	-	
Kocide 2000	M	0	1 to 2.25 lb	-	
Kocide 3000	M	0	0.5 to 1.25 lb	-	
Kocide DF	M	0	1.5 to 3 lb	-	
Mastercop	M	0	0.5 to 1 pt	-	
Nordox 75 WG	M	0	1 to 1.25 lb	-	OMRI-listed.
Nu-Cop 50 WP	M	0	1.5 to 3 lb	-	OMRI-listed.
Nu-Cop 3 L	M	0	0.66 to 4 pt	-	
Nu-Cop 50 DF	M	0	1.5 to 2 lb	-	OMRI-listed.
Nu-Cop 50 HB	M	0	0.75 to 1 lb	-	
Gavel 75 DF2	22/M	5	1.5 to 2 lb	8 apps	Apply when conditions favor disease and continue every 7 to 10 days.
Fontelis	7	1	12 to 16 fl oz	67 fl oz	Alternaria. Apply before disease onset, continue every 7 to 14 days.
Inspire Super	3/9	7	16 to 20 fl oz	80 fl oz	Begin prior to disease onset, continue every 7 to 10 days.
Mancozeb <sup>3</sup>					Products include Dithane, Koverall, Manzate, Penncozeb.
Dry formulations	M	5	1.5 to 3 lb	24-25.6 lb	Apply before disease appears and continue every 4 to 7 days as needed.
Liquid formulations	M		1.2 to 2.4 qt	19.2 qt	
ManKocide <sup>3</sup>	M	5	2 to 2.5 lb	see footnote	Apply before disease onset, continue every 7 to 14 days. Limit 4 apps/season. Use highest rates for anthracnose.
Pristine	7/11	0	12.5 to 18.5 oz	4 apps	Apply before disease onset, continue every 10 to 14 days. Rotate to another mode of action between applications of RG Bravo. Observe seasonal limits for chlorothalonil.
Quadris Opti	11/M	1	3.2 pt	4 apps	Apply before disease onset, continue every 7 to 14 days.
Quadris Top	11/3	1	12 to 14 fl oz	56 fl oz	Apply before disease onset, continue every 7 to 14 days.
Reason 500 SC	11	14	5.5 fl oz	4 apps	Alternaria leaf blight. Apply before disease onset, continue every 5 to 10 days. Limit 22 fl oz of Reason/A per season.
Ridomil Gold Bravo SC	4/M	0	2.5 to 3.25 pt	4 apps	-
Switch 62.5 WG	9/12	1	11 to 14 oz	56 oz	Alternaria leaf blight. Apply every 7 to 10 days.
Tanos	11/27	3	8 oz	4 apps	Tanos must be tank-mixed with a fungicide from FRAC Code M appropriate for the target disease. Apply before disease onset, continue every 5 to 7 days.
Thiophanate-methyl <sup>4</sup>					Anthracnose. Apply before disease onset, continue every 7 to 14 days.
Topsin 4.5 FL	1	0	10 fl oz	60 fl oz	
Topsin M 70 WP	1	0	0.5 lb	3 lb	
Topsin M WSB	1	0			
Zing!	M/22	0	36 fl oz	8 apps	Apply before disease onset and repeat every 7 to 10 days. Alternate with another FRAC code. May cause sunburn on watermelon.
<b>Bacterial Wilt [C/M/SP]:</b> No bactericides available. Control of insect vectors is the only recommended practice—refer to the “Insect Control” table.					
<b>Belly Rot, Fruit Rot (Rhizoctonia) [C]</b>					
Aftershock	11	1	3.0 to 5.7 oz	4 apps	Apply before disease onset, continue every 7 to 14 days. Alternate with a fungicide outside FRAC group 11.
Azoxystrobin <sup>4</sup>					Make first application at 1-3 leaf stage and second at vine tip-over or 14 days after the first application, whichever comes first.
Azoxy 25C	11	1	11 to 15.5 fl oz <sup>3</sup>	4 apps	
AzoxyStar	11	1	11 to 15.5 fl oz <sup>3</sup>	4 apps	
Quadris	11	1	11 to 15.5 fl oz <sup>3</sup>	4 apps	Make first application at 1-3 leaf stage and second at vine tip-over or 14 days after the first application, whichever comes first. Observe seasonal limits for chlorothalonil.
Quadris Opti	11/M	1	3.2 pt	4 apps	
Quadris Top	11/3	1	12 to 14 fl oz	56 fl oz	
Satori	11	1	11 to 15.5 fl oz <sup>3</sup>	4 apps	-

**DISEASE CONTROL: *Vining Crops—Cucumber, Melon, Squash and Pumpkin, Watermelon (continued)***

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
<b>Thiophanate-methyl<sup>4</sup></b>					
Topsin 4.5 FL	1	0	10 fl oz	60 fl oz	Apply in sufficient volume to permit runoff to soil. Begin at vine-run and make a second application at fruit-set.
Topsin M 70 WP	1	0	0.5 lb	3 lb	
Topsin M WSB	1	0			
<b>Downy Mildew [C/M/SP/W]</b>					
Actigard	21	0	0.5 to 1 oz	16 oz	Begin applications before onset of disease; apply every 7 to 14 days. Apply in a minimum of 20 gal/A of water. May cause phytotoxicity and yield reduction. Do not apply to stressed or injured plants.
Aftershock	11	1	3.0 to 5.7 oz	4 apps	Apply before disease onset, continue every 7 to 14 days. Alternate with a fungicide outside FRAC group 11.
Aliette WDG <sup>6</sup>	33	0.5	2 to 5 lb	7 apps	Apply when conditions favor disease and continue every 7 to 14 days. Do not tank-mix with copper compounds.
Ariston	M/27	3	1.9 - 3.0 pt	17.5 pt	Apply before disease onset, continue every 7 days. May sunburn mature watermelon.
Cabrio	11	0	8 to 12 oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
<b>Chlorothalonil<sup>4</sup></b>					
Bravo Ultrex	M	0	1.4 to 1.8 lb	19.1 lb	Begin before disease onset; continue every 7 days as needed.
Bravo WeatherStik	M	0	1.5 to 2 pt	21 pt	
Curzate 60 DF	27	3	3.2 oz	9 apps	Must be tank-mixed with a fungicide from FRAC Code M. Apply before disease onset, continue every 5 to 7 days.
<b>Fixed coppers</b>					
Apply every 5 to 10 days beginning before disease onset, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.					
Badge SC	M	0	1 to 2.5 pt	-	-
Badge X2	M	0	0.5 to 2.5 lb	-	OMRI-listed.
Basic Copper 53	M	0	2 lb	-	OMRI-listed.
C-O-C-S WDG	M	0	2 to 4 lb	-	-
Champ DP	M	0	1.33 lb	-	-
Champ Formula 2 FL	M	0	1.33 pt	-	-
Champ WG	M	0	1.5 to 3 lb	-	OMRI-listed.
COC DF	M	0	3 to 4 lb	-	-
COC WP	M	0	3 to 4 lb	-	OMRI-listed.
Copper-Count-N	M	0	3 to 4 pt	-	-
Cueva	M	0	0.5 to 2 gal	-	OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 2 lb	-	-
Kentan DF	M	0	1 to 2.62 lb	-	-
Kocide 2000	M	0	1 to 2.25 lb	-	-
Kocide 3000	M	0	0.5 to 1.25 lb	-	-
Kocide DF	M	0	1.5 to 3 lb	-	-
Mastercop	M	0	0.5 to 1 pt	-	-
Nordox 75 WG	M	0	1 to 1.25 lb	-	OMRI-listed.
Nu-Cop 50 WP	M	0	1.5 to 3 lb	-	OMRI-listed.
Nu-Cop 3 L	M	0	0.66 to 4 pt	-	-
Nu-Cop 50 DF	M	0	1.5 to 2 lb	-	OMRI-listed.
Nu-Cop 50 HB	M	0	0.75 to 1 lb	-	-
Flint	11	0	4 oz	4 apps	Apply before disease onset, continue every 7 to 14 days.
Gavel 75 DF2	22/M	5	1.5 to 2	8 apps	Apply when conditions favor disease and continue every 7 to 10 days.
<b>Mancozeb<sup>4</sup></b>					
Products include Dithane, Koverall, Manzate, Penncozeb.					
Dry formulations	M	5	1.5 to 3 lb	24-25.6 lb	Apply before disease appears and continue every 4 to 7 days as needed.
Liquid formulations	M		1.2 to 2.4 qt	19.2 qt	
ManKocide <sup>3</sup>	M	5	2 to 2.5	see footnote	Apply before disease appears and continue every 3 to 7 days as needed.
Presidio	43	2	3 to 4 fl oz	12 fl oz	Apply every 7 to 14 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Previcur Flex	28	2	0.6 to 1.2 pt	6 pt	Apply prior to disease onset, continue every 7 to 14 days. Use low rate when tank-mixing with other downy mildew fungicides.
Quadris Opti	11/M	1	3.2 pt	4 apps	Apply before disease onset, continue every 7 to 14 days. Observe seasonal limits for chlorothalonil.
Ranman	21	0	2.1 to 2.75 fl oz	6 apps	Apply before disease onset, continue every 7 to 10 days. Tank-mix with an organosilicone surfactant when disease pressure is severe; use an organosilicone or non-ionic surfactant when disease pressure is light-to-moderate.
Tanos	11/27	3	8 oz	4 apps	Tanos must be tank-mixed with a fungicide from FRAC Code M appropriate for the target disease. Apply before disease onset, continue every 5 to 7 days.
Zampro	40/45	0	14 fl oz	3 apps	Apply before disease onset and repeat every 5 to 7 days.
Zing!	M/22	0	36 fl oz	8 apps	Apply before disease onset and repeat every 7 to 10 days. Alternate with another FRAC code. May cause sunburn on watermelon.
<b>Gummy Stem Blight (Black Rot) [C/M/SP/W]</b>					
Aftershock	11	1	3.0 to 5.7 oz	4 apps	Apply before disease onset, continue every 7 to 14 days. Alternate with a fungicide outside FRAC group 11.
Ariston	M/27	3	3.0 pt	17.5 pt	Apply before disease onset, continue every 7 days. May sunburn mature watermelon.
<b>Chlorothalonil<sup>4</sup></b>					
Begin before disease onset; continue every 7 days as needed.					
Bravo Ultrex	M	0	1.8 to 2.7 lb	19.1 lb	
Bravo WeatherStik	M	0	2 to 3 pt	21 pt	
Endura	7	0	6.5 oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.

(continued on next page)

**DISEASE CONTROL: Vining Crops—Cucumber, Melon, Squash and Pumpkin, Watermelon (continued)**

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Fixed coppers					Apply every 5 to 10 days beginning before disease onset, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1 to 2.5 pt		-
Badge X2	M	0	0.5 to 2.5 lb		OMRI-listed.
Basic Copper 53	M	0	2 lb		OMRI-listed.
C-O-C-S WDG	M	0	2 to 4 lb		-
Champ DP	M	0	1.33 lb		-
Champ Formula 2 FL	M	0	1.33 pt		-
Champ WG	M	0	1.5 to 3 lb		OMRI-listed.
COC DF	M	0	3 to 4 lb		-
COC WP	M	0	3 to 4 lb		OMRI-listed.
Copper-Count-N	M	0	3 to 4 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 2 lb		-
Kentan DF	M	0	1 to 2.62 lb		-
Kocide 2000	M	0	1 to 2.25 lb		-
Kocide 3000	M	0	0.5 to 1.25 lb		-
Kocide DF	M	0	1.5 to 3 lb		-
Mastercop	M	0	0.5 to 1 pt		-
Nordox 75 WG	M	0	1 to 1.25 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	1.5 to 3 lb		OMRI-listed.
Nu-Cop 3 L	M	0	0.66 to 4 pt		-
Nu-Cop 50 DF	M	0	1.5 to 2 lb		OMRI-listed.
Fontelis	7	1	12 to 16 fl oz	67 fl oz	Alternaria. Apply before disease onset, continue every 7 to 14 days.
Inspire Super	3/9	7	16 to 20 fl oz	80 fl oz	Begin prior to disease onset, continue every 7 to 10 days.
Luna Experience	3/7	7	17 fl oz	34 fl oz	Watermelon only. Begin prior to disease onset, continue every 10 to 14 days.
Mancozeb <sup>4</sup>					Products include Dithane, Koverall, Manzate, Penncozeb.
Dry formulations	M	5	1.5 to 3 lb	24-25.6 lb	Apply before disease appears and continue every 7 to 10 days as needed.
Liquid formulations	M		1.2 to 2.4 qt	19.2 qt	
ManKocide2	M	5	2 to 2.5 lb	see footnote	Apply before disease appears and continue every 3 to 7 days as needed.
Pristine	7/11	0	12.5 to 18.5 oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
Proline 480SC	3	7	5.7 fl oz	17.1 fl oz	Maximum two foliar applications.
Quadris Top	11/3	1	12 to 14 fl oz	56 fl oz	Apply before disease onset, continue every 7 to 14 days.
Ridomil Gold Bravo	4/M	0	2 to 3 lb	4 apps	Apply before disease onset, continue every 10 to 14 days. Rotate to another mode of action between applications of RG Bravo. Avoid late-season applications. Observe seasonal limits for chlorothalonil.
Tebuconazole <sup>4</sup>	3	7			--
Thiophanate-methyl <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days.
Topsin 4.5 FL	1	0	10 fl oz	60 fl oz	
Topsin M 70 WP	1	0	0.5 lb	3 lb	
Topsin M WSB	1	0			
<b>Microdochium (Plectosporium) Blight [SP]</b>					
Aftershock	11	1	3.0 to 5.7 oz	4 apps	Apply before disease onset, continue every 7 to 14 days. Alternate with a fungicide outside FRAC group 11.
Cabrio	11	0	12 to 16 oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
Dithane F-45 Rainshield	M	5	1.6 to 2.4 qt	19.2 qt	-
Dithane M-45	M	5	2 to 3 lb	24 lb	-
Flint	11	0	4 oz	8 oz	Apply before disease onset, continue every 7 to 14 days.
Inspire Super	3/9	7	16 to 20 fl oz	80 fl oz	Begin prior to disease onset, continue every 7 to 10 days.
Quadris	11	1	11 to 15.5 fl oz	4 apps	Apply before disease onset, continue every 7 to 14 days.
Quadris Top	11/3	1	12 to 14 fl oz	56 fl oz	--
<b>Phytophthora Blight [C/M/SP/W]</b>					
Forum SC	40	0	6 fl oz	5 apps	Must be tank-mixed with a protectant fungicide. Apply before disease onset, continue every 5 to 10 days.
Presidio	43	2	3 to 4 fl oz	12 fl oz	Apply every 7 to 14 days. Must be tank-mixed with a fungicide NOT in FRAC Group 43.
Ranman	21	0	2.75 fl oz	6 apps	Apply before disease onset, continue every 7 to 10 days. Tank-mix with an organosilicone surfactant when disease pressure is severe; use an organosilicone or non-ionic surfactant when disease pressure is light-to-moderate.
Revus	40	0	8 fl oz	32 fl oz	Apply every 7 to 14 days. Use a spreader/penetrant surfactant. Must be tank-mixed with a fungicide NOT in FRAC Group 40.
Tanos	11/27	3	8 to 10 oz	4 apps	Tanos must be tank-mixed with a fixed copper plus mancozeb fungicide. Apply before disease onset; continue every 5 to 7 days.
Zampro	40/45	0	14 fl oz	3 apps	Apply before disease onset and repeat every 5 to 7 days.
<b>Powdery Mildew [C/M/SP/W]</b>					
Actigard	21	0	0.5 to 1 oz	16 oz	Begin applications before onset of disease; apply every 7 to 14 days. Apply in a minimum of 20 gal/A of water. May cause phytotoxicity and yield reduction. Do not apply to stressed or injured plants.
Aftershock	11	1	3.0 to 5.7 oz	4 apps	Apply before disease onset, continue every 7 to 14 days. Alternate with a fungicide outside FRAC group 11.
Ariston	M/27	3	3.0 pt	17.5 pt	Apply before disease onset, continue every 7 days. May sunburn mature watermelon.

(continued on next page)

**DISEASE CONTROL: *Vining Crops—Cucumber, Melon, Squash and Pumpkin, Watermelon (continued)***

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Chlorothalonil <sup>4</sup>					Begin before disease onset; continue every 7 days as needed.
Bravo Ultrex	M	0	1.8 to 2.7 lb	19.1 lb	
Bravo WeatherStik	M	0	2 to 3 pt	21 pt	
Fixed coppers					Apply every 5 to 10 days beginning before disease onset, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Badge SC	M	0	1 to 2.5 pt		
Badge X2	M	0	0.5 to 2.5 lb		OMRI-listed.
Basic Copper 53	M	0	2 lb		OMRI-listed.
C-O-C-S WDG	M	0	2 to 4 lb		-
Champ DP	M	0	1.33 lb		-
Champ Formula 2 FL	M	0	1.33 pt		-
Champ WG	M	0	1.5 to 3 lb		OMRI-listed.
COC DF	M	0	3 to 4 lb		-
COC WP	M	0	3 to 4 lb		OMRI-listed.
Copper-Count-N	M	0	3 to 4 pt		-
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Cuprofix Ultra 40 Disperss	M	0	1.25 to 2 lb		-
Kentan DF	M	0	1 to 2.62 lb		-
Kocide 2000	M	0	1 to 2.25 lb		-
Kocide 3000	M	0	0.5 to 1.25 lb		-
Kocide DF	M	0	1.5 to 3 lb		-
Mastercop	M	0	0.5 to 1 pt		-
Nordox 75 WG	M	0	1 to 1.25 lb		OMRI-listed.
Nu-Cop 50 WP	M	0	1.5 to 3 lb		OMRI-listed.
Nu-Cop 3 L	M	0	0.66 to 4 pt		-
Nu-Cop 50 DF	M	0	1.5 to 2 lb		OMRI-listed.
Fontelis	7	1	12 to 16 fl oz	67 fl oz	Alternaria. Apply before disease onset, continue every 7 to 14 days.
Pristine	7/11	0	12.5 to 18.5 oz <sup>5</sup>	4 apps	Apply before disease onset, continue every 7 to 14 days.
Procure 50 WS	3	0	4 to 8 oz	40 oz	Apply prior to vining or when symptoms are first observed and continue every 7 to 14 days.
Proline 480SC	3	7	5.7 fl oz	17.1 fl oz	Maximum two foliar applications.
Quadris Opti	11/M	1	3.2 pt	4 apps	Apply before disease onset, continue every 7 to 14 days. Observe seasonal limits for chlorothalonil.
Quadris Top	11/3	1	12 to 14 fl oz	56 fl oz	Apply before disease onset, continue every 7 to 14 days.
Quintec	13	3	4 to 6 fl oz		Muskmelon, gourd, pumpkin, watermelon, and winter squash only. Apply before disease onset, continue every 7 to 14 days.
Rally 40 WSP	3	0	2.5 to 5 oz	1.5 lb	Apply every 7 to 10 days, beginning when symptoms are first observed or when conditions favor disease.
Sulfur <sup>4</sup>	M				Apply every 7 to 10 days, beginning when symptoms are first observed or when conditions favor disease. Phytotoxicity may occur when sulfur is applied when temperatures exceed 90°F.
Tebuconazole <sup>4</sup>	3	7			Apply preventively and repeat at 10 to 14 days. Use lowest listed rate of surfactant to improve coverage.
Thiophanate-methyl <sup>4</sup>					Apply before disease onset, continue every 7 to 14 days. Limit 2.1 lb ai/A per season.
Topsin 4.5 FL	1	0	10 fl oz		
Topsin M 70 WP	1	0	0.5 lb		
Topsin M WSB	1	0			
Torino	U6	0	3.4 fl oz	2 apps	Apply at disease onset, make a second application 7 days later.
Vivando	U8	0	15.4 fl oz	3 apps	Apply prior to disease onset, continue every 7 to 14 days. Do not mix with horticultural oils and alternate with a different FRAC code.
<b>Pythium Damping-off and Cottony Leak [C/M/SP/W]</b>					
Previcur Flex	28	2	1.2 pt	6 pt	Pythium root rot, seedling diseases only. Field application. Can be directed at lower stems and soil, applied in transplant water, or delivered through drip irrigation. Greenhouse use. Can be applied as a drench or by chemigation—refer to label for rates.
Ridomil Gold SL	4	0	1 to 2 pt	1 app	Preplant. Apply to soil as a broadcast spray or in a 7-inch band; incorporate into the upper 2 inches of soil. At planting. Apply broadcast or banded, move into seed zone with 0.5 to 1 inch of irrigation if rainfall is not expected within 24 hours. Can be applied through drip and sprinkler irrigation systems.
MetaStar 2EC AG	4	0	4 to 8 pt		
Ultra Flourish	4	0	2 to 4 pt		
<b>Scab [C/M/SP/W]</b>					
Actigard	21	0	0.5 to 1 oz	16 oz	Begin applications before onset of disease; apply every 7 to 14 days. Apply in a minimum of 20 gal/A of water. May be applied through drip irrigation. May cause phytotoxicity and yield reduction. Do not apply to stressed or injured plants.
Chlorothalonil <sup>4</sup>					Begin before disease onset; continue every 7 days as needed.
Bravo Ultrex	M	0	1.8 to 2.7 lb	19.1 lb	
Bravo WeatherStik	M	0	2 to 3 pt	21 pt	
Fixed coppers					Apply every 5 to 10 days beginning before disease onset, depending upon product and conditions. See label for mixing instructions and tank-mix precautions.
Cueva	M	0	0.5 to 2 gal		OMRI-listed. Mix in 100 gallons of water, use 50 to 100 gal/A of solution.
Mancozeb <sup>4</sup>					Products include Dithane, Koverall, Manzate, Penncozeb.
Dry formulations	M	5	1.5 to 3 lb	24 lb	Apply before disease appears and continue every 7 to 10 days as needed.
Liquid formulations	M	5	1.2 to 2.4 qt	19.2 qt	

(continued on next page)

Product	FRAC Code <sup>1</sup>	PHI <sup>2</sup> (days)	Amt/A	Seasonal Limits/A	Comments
Ridomil Gold Bravo SC	4/M	0	2.5 to 3.25 pt	4 apps	Apply before disease onset, continue every 10 to 14 days. Rotate to another mode of action between applications of RG Bravo. Avoid late-season applications. Observe seasonal limits for chlorothalonil.

<sup>1</sup> Products with numerical FRAC codes must be alternated or tank-mixed with products that have a different FRAC code to discourage resistance development. See product label for maximum number of consecutive applications allowed. Refer to the table on page 13 for more information on FRAC codes.

<sup>2</sup> Pre-harvest interval.

<sup>3</sup> Observe seasonal limits for mancozeb.

<sup>4</sup> Generic products available (Appendix F). Amounts and seasonal limits per acre are product dependent.

<sup>5</sup> Use higher rate when pressure is severe.

<sup>6</sup> Restricted in some Kentucky counties. See fungicide safety table on page 20.

Appendix A

# Production and Marketing Information Online

Internet Web sites contain an incredible wealth of useful information of interest to commercial vegetable growers in Kentucky and surrounding states. Below is a list of topics from over 50 Web sites considered to be of particular value to commercial growers. Links to these sites can be found at:

<http://www.uky.edu/hort/documents-list-commercial-vegetable>

## Warning!

Use this information with caution and at your own risk. You should be very careful about using any variety, fertilizer, or pesticide recommendation from another region or distant state. Some pesticides may be legal only for use in that particular state or production region. Varieties that perform well in another state may or may not perform well in Kentucky.

Remember that Internet addresses sometimes change. Those listed here worked as of October, 2013.

## University of Kentucky College of Agriculture

**College of Agriculture:** Provides links to most UK agriculture departments and their publications.

- <http://www.ca.uky.edu/>

**Horticulture Department:** Has most of UK's vegetable crop publications linked under "Commercial Horticulture" and "Vegetables".

- <http://www.uky.edu/hort/>

**Department of Entomology:** Fact sheets on Kentucky's vegetable insect and mite pests.

- [www2.ca.uky.edu/entomology/dept/ent-facts.asp](http://www2.ca.uky.edu/entomology/dept/ent-facts.asp)

**Center for Crop Diversification:** Provides research updates, profiles of promising new crops, and marketing information for Kentucky.

- <http://www.uky.edu/Ag/CCD/>

**Ag. Weather Center:** An excellent source of current and historical weather information.

- [www.wagwx.ca.uky.edu/](http://www.wagwx.ca.uky.edu/)

**Vegetable Production Guidelines for Commercial Growers:** This publication (ID-36) and most other UK extension publications available online.

- [uky.edu/hort/commercial/horticulture](http://www.uky.edu/hort/commercial/horticulture)

**Integrated Pest Management (IPM) guidelines:** Detailed production information and pest management strategies for Kentucky sweet corn, cabbage, peppers, and pumpkins.

- <http://www.uky.edu/Ag/IPM/manuals.htm>

**Vegetable and Melon Enterprise Budgets for Kentucky:** These interactive crop budgets provide average costs and returns for most vegetable crops and allows users to enter their own cost and price figures to instantly estimate returns per acre.

- [www.uky.edu/Ag/NewCrops/budgets.html](http://www.uky.edu/Ag/NewCrops/budgets.html)

## General Vegetable Production Information from Other States

**Southeastern U.S. Vegetable Crop Handbook. A collaboration of several Southeastern U.S. states contains useful production information.**

- <http://www.thepacker.com/grower/2015-southeastern-us-vegetable-crop-handbook>

**NCSU and UK Downy Mildew Forecasts:** Provides forecasts for downy mildew on melons, pumpkins, cucumbers, and squash. Some chemicals listed on this site may not be legal in Kentucky.

- [ces.ncsu.edu/depts/pp/cucurbit](http://ces.ncsu.edu/depts/pp/cucurbit)

**University of Florida:** Extensive vegetable production information, petiole sap testing for nitrogen nutrition, alternative crops, newsletter, and Florida transplant producers.

- [edis.ifas.ufl.edu/TOPI\\_C Commercial\\_Vegetable\\_Production](http://edis.ifas.ufl.edu/TOPI_C Commercial_Vegetable_Production)

**Mississippi State University Greenhouse Information:** Links to Greenhouse Tomato Handbook, Starting Vegetable Transplants, and to other sources of information on greenhouse vegetable production and pest management.

- [www2.msstate.edu/~ricks/index.html?#35](http://www2.msstate.edu/~ricks/index.html?#35)

## Weekly Vegetable IPM and Other Newsletters

**Kentucky Pest News:** Access to the current and back issues of KPN.

- [www.uky.edu/Agriculture/kpn/kpnhome.htm](http://www.uky.edu/Agriculture/kpn/kpnhome.htm)

**Illinois Fruit & Vegetable News:** Produced at the University of Illinois.

- [ipm.uiuc.edu/ivfn/index.html](http://ipm.uiuc.edu/ivfn/index.html)

## Organic Vegetable Production

**Appropriate Technology Transfer for Rural Areas (ATTRA):** A number of extensive online organic vegetable production guides.

- [attra.org](http://attra.org)

**USDA Publications:** Information on organic food production, sustainable agriculture and community supported agriculture (CSA).

- [na.usda.gov/afsic/pubs/csa/csafarmer.shtml](http://na.usda.gov/afsic/pubs/csa/csafarmer.shtml)

**USDA National Organic Program (NOP):**

Links to new NOP standards.

- [ams.usda.gov/AMSV1.0/nop](http://ams.usda.gov/AMSV1.0/nop)

**Kentucky Organic Certification:** Kentucky Department of Agriculture's organic certification program (forms and information).

- [kyagr.com/marketing/organic-marketing.html](http://kyagr.com/marketing/organic-marketing.html)

**University of Kentucky:** Information of organic crop certification.

- [www.uky.edu/Ag/CCD/introsheets/organic-cert.pdf](http://www.uky.edu/Ag/CCD/introsheets/organic-cert.pdf)

**Sustainable Agriculture Research and Education (SARE):** A grower focused organization that is affiliated with land grant universities around the country. Excellent resource for growers.

- [sare.org](http://sare.org)

## Marketing and Market Prices

**UK's Marketing Options for Commercial Vegetable Growers:** Publication # ID-134; this is written with tobacco growers in mind. It compares and contrasts most of the available produce marketing options.

- [www.ca.uky.edu/agc/pubs/id/id134/id134.pdf](http://www.ca.uky.edu/agc/pubs/id/id134/id134.pdf)

**Kentucky Horticulture and New Crops Marketing:** A number of other marketing fact sheets for vegetable and fruit crops.

- [www.uky.edu/Ag/NewCrops/marketing.html](http://www.uky.edu/Ag/NewCrops/marketing.html)

**USDA Wholesale Price Information:** The same wholesale prices plus specialty, auction, and farmers' market reports.

- [www.marketnews.usda.gov/portal/fv](http://www.marketnews.usda.gov/portal/fv)

**Kentucky Farmers' Markets:** Kentucky Department of Agriculture provides information on farmers' markets throughout the state.

- [www.kyagr.com/marketing/farmmarket/index.htm](http://www.kyagr.com/marketing/farmmarket/index.htm)

**USDA Grading Standards:** Fruit and vegetable grading standards.

- <http://www.ams.usda.gov/grades-standards/vegetables>

**ProduceLinks.com:** Claims to be the largest free list of produce and agricultural industry Web sites in the world. This site helps find new suppliers, customers, and services.  
 • [procelinks.com/main.html](http://procelinks.com/main.html)

**USDA Direct Marketing Home Page:** The USDA hosts this site.  
 • <https://afsic.nal.usda.gov/alternative-marketing-and-business-practices/direct-marketing>

**Kentucky Department of Agriculture:** Includes links to Horticultural Division, Organic Certification, and KY Produce Shipper's Directory. Information about Kentucky's vegetable

marketing cooperatives, a Farmers' Market Directory, and guidelines for "Kentucky Proud" logo program.  
 • [kyagr.com](http://kyagr.com)

**KDA Country Store:** The Department of Agriculture helps Kentucky producers build their own Web site and hosts those sites at no charge.  
 • [kyagr.com/buyky/webbuild/index.htm](http://kyagr.com/buyky/webbuild/index.htm)  
 • [kyagr.com/buyky/cstore/cstore.htm](http://kyagr.com/buyky/cstore/cstore.htm)

**Kentucky Farm Bureau:** Provides a link to its map and directory of Kentucky Certified Roadside Farm Markets.  
 • [kyfb.com](http://kyfb.com)

**Post-harvest and Food Safety (handling, cooling, grading, packaging, etc.)**

**Kentucky Department of Agriculture Good Agricultural Practices (GAP) Program.** Good food safety information specific to Kentucky growers.  
 • [kyagr.com/marketing/gap.htm](http://kyagr.com/marketing/gap.htm)

**Cornell University Food Safety:** Some of the best information on food safety and good agricultural practices for growers is available in the publication: Food Safety Begins on the Farm—A Grower's Guide. Excellent resource.  
 • [gaps.cornell.edu/educationalmaterials.html](http://gaps.cornell.edu/educationalmaterials.html)

Appendix B

## Secondary Nutrients and Micronutrients

**Calcium**—Calcium levels in soils vary with soil pH and cation exchange capacity (CEC). To avoid developing soil conditions that may lead to low levels of available calcium and low calcium uptake by some crops, have soil tested frequently. Apply lime to obtain the recommended soil pH at least six months before growing the crop. See the publication "Lime and Fertilizer Recommendations" (AGR-1) for lime rates to achieve desired pH changes.

**Magnesium**—Magnesium levels in Kentucky soils range from very high (loess-derived soils) to somewhat low (some sandstone-derived and recently cleared soils). Magnesium is included as part of the routine soil test. For vegetable crops, a test level of 80 pounds per acre is considered the minimum, and 200 pounds per acre is recommended for staked tomatoes and muskmelons. If both lime and magnesium are needed, dolomitic lime should be applied. If dolomitic lime is not available or when lime is not needed and magnesium is recommended, other sources of magnesium such as magnesium oxide or Epsom salts (magnesium sulfate) are available for

broadcast or row application. Refer to the "Vining Crops" chapter for magnesium application rates. Magnesium deficiencies are readily identifiable in many plants. Typically deficiencies show up as interveinal chlorosis on older leaves.

**Iron, Copper, Manganese**—For horticultural crops, we have not measured consistent responses to soil-applied iron, copper, or manganese. To verify a suspected deficiency of iron, copper or manganese, have an analysis of plant tissue appropriate for the crop carried out with a commercial lab through your county Extension agent. Responses to foliar applications of iron, copper, or manganese, after diagnosis of a deficiency, have been superior to soil applications. Many deficiencies of iron, copper and manganese show similar signs as magnesium deficiencies (ie. interveinal chlorosis); however, typically micronutrient deficiencies appear first in new growth, whereas magnesium deficiencies will tend to first appear in older growth.

**Sulfur**—We have not measured a response to sulfur application on horticultural crops in Kentucky. However, cole crops established early in the spring on soils that tend to be cool and moist may be susceptible to low amounts of available sulfur. A meaningful and suitable soil test for sulfur is not available in Kentucky

because of several factors affecting available sulfur levels in soils. It is suggested that sulfur-containing fertilizer be used where cole crops are to be grown as they are high sulfur users.

**Boron**—Yield responses to boron have been observed only for certain crops under some conditions. A boron soil test is available in Kentucky upon request through your county Extension agent. Boron should only be applied when soil test boron is less than 1 pound per acre. Boron is normally applied at the rate of 1 to 2 pounds of actual boron per acre.

**Zinc**—Zinc deficiency in snap beans and sweet corn may be significant in Central and South-central Kentucky. The test for zinc is now included in the routine soil test. The results of this test, in conjunction with soil test results for pH and phosphorus, can help farmers make needed applications of zinc fertilizer. When zinc is recommended and equipment is available, banding can reduce costs by two-thirds over a broadcast application. Zinc sulfate (36% Zn) is usually applied at 30 to 90 pounds per acre when broadcast. Chelated zinc (14%) can be applied at 15 to 40 pounds per acre. For a foliar spray, use chelated zinc at ¾ to 1 pound in 100 gallons of water. See also the "Fertilizing" section of the "Sweet Corn" chapter.

Appendix C

## Conversion Tables for Use of Pesticides on Small Areas

LIQUID MATERIALS								
Approximate Rate Per:	Recommended Rate/A							
	1 pt	1 qt	2 qt	1 gal	25 gal	50 gal	75 gal	100 gal
1,000 sq ft	¾ tbs	1½ tbs	3 tbs	6 tbs	4½ pt	4½ pt	7 qt	9 qt
100 sq ft	¼ tsp	½ tsp	1 tsp	2 tsp	1 cup	1 pt	1½ pt	1 qt

DRY MATERIALS											
Approximate Rate Per:	Recommended Rate/A										
	1 lb	2 lb	3 lb	4 lb	5 lb	6 lb	8 lb	10 lb	100 lb	200 lb	400 lb
1,000 sq ft	2¼ tsp	4½ tsp	2¼ tbs	3 tbs	4 tbs	4½ tbs	2½ cup	½ cup	2¼ lb	4½ lb	9 lb
100 sq ft	¼ tsp	½ tsp	¾ tsp	1 tsp	1¼ tsp	1½ tsp	¾ tsp	2 tsp	¼ lb	½ lb	1 lb

# English Measurement Units

3 teaspoons (tsp)	=	1 tablespoon
2 tablespoons (tbs)	=	1 fluid ounce
16 tablespoons (tbs)	=	1 cup
8 fluid ounces (fl oz)	=	1 cup
2 cups (c)	=	1 pint
2 pints (pt)	=	1 quart
4 quarts (qt)	=	1 gallon (gal)

# Generic Insecticides

Active Ingredient	Generics	Manufacturer
<b>Abamectin</b> Original Product: Agri-Mek 0.15 EC (Syngenta)	Abba 0.15 EC	Adama
	Abba Ultra 0.3 EC	
	AgriMek 0.7 SC	Syngenta
	Borrada 0.15 EC	Adama
	Epi-Mek 0.15 EC	
	Nufarm Abamectin 0.15 EC	Nufarm
	Reaper 0.15 EC	Loveland
	Reaper Advance 0.15 EC	
	Temprano 0.15 EC	Chemtura
	Tide Timectin 0.15 EC	Tide Intl.
	Zoro 0.15 EC	Cheminova
<b>Acephate</b> Original Product: Orthene 90 SP (Valent)	Acephate 90 Prill	Adama
	Acephate 90 WDG	Loveland
	Acephate 90 WSP	
	Acephate 97 UP	United Phosphorous
	Bracket 90 WDG	Winfield
	Orthene 97	Amvac
<b>Bifenthrin</b> Original Product: Brigade 2 EC, Capture 2 EC (FMC)	Bifen 2 AG Gold	Direct AG Source
	Bifenture 2 EC	United Phosphorous
	Discipline 2 EC	Amvac
	Fanfare 2 EC, ES	Adama
	Revere 2 EC	Adama
	Sniper 2 EC	Loveland
	Tailgunner 2 EC	Adama
	Tundra 2 EC	Winfield
	Xpedient 2 EC	Amvac
<b>Carbaryl</b> Original Product: Sevin 4L, 80 S, SL, XLR (Bayer)	Carbaryl 4 L	Drexel, Loveland
	Prokoz Sevin SL	Prokoz
<b>Chlorpyrifos</b> Original Product: Lorsban 4 E, 15 G, 75 WDG, Advanced 3.76 E (Dow AgroSciences)	Chlorpyrifos 4 E	Adama, Drexel
	Govern 4 E	Tenkos
	Hatchet 4 E	Dow AgroSciences
	Nufos 4 E	Cheminova
	Saurus 15 G	Helena
	Vulcan 3.76 E	Adama
	Warhawk 4 E	Loveland
	Yuma 4 E	Winfield
	Whirlwind 4 E	Helena
<b>Cyfluthrin</b> Original Product: Baythroid XL 1 EC, Renounce 20 WP (Bayer)	Tombstone 2 E	Loveland
	Tombstone Helios 2 E	
<b>cypermethrin</b> Original Product: Ammo (discontinued)	Holster 2.5 EC	Loveland

Active Ingredient	Generics	Manufacturer
<b>Esfenvalerate</b> Original Product: Asana XL 0.66 EC (Dupont)	S-FenvaloStar 0.66 EC	LG Life Sciences
	Zyrate 0.66 EC	Rotam NA
<b>Gamma-cyhalothrin</b> Original Product: Proaxis 0.5 EC (Loveland)	Declare Insecticide 0.5 EC	Cheminova
	Proaxis Insecticide 0.5 EC	
<b>Imidacloprid</b> Original Product: Admire Pro 4.6 F (Bayer)	Advise 2 FL	Winfield
	Mana Alias 2 F, 4 F	Adama
	Amtide Imidacloprid 2 F	AmTide
	Couraze 2 F, 4 F	Cheminova
	Imida E-AG, 1.6 F, 2 F	Cheminova
	Imidacloprid 4 SC	Willowood
	Macho 2 FL, 4 F	Albaugh
	Malice 75 WSP	Loveland
	Midash 2 SC	Sharda USA
	Montana 2 F, 4 F	Rotam NA
	NuPrid 2 F, 2 SC, 4 F Max, 4.6 F	Nufarm
	Pasada 1.6 F	Adama
	Prey 1.6 F	Loveland
	Sherpa 1.6 F	Loveland
	Widow 2 F	Loveland
	Wrangler 4 F	Loveland
<b>Lambda-cyhalo- thrin</b> Original Product: Karate 1 EC, Warrior with Zeon 1 ME, II 2 ME (Syngenta)	Grizzly Z 1 CS	Winfield
	Kendo 1 EC	Helm
	Kiaso 24 WG	Nufarm
	Lambda-CY AG	Direct AG Source
	Lambda T 1 CS	Helena
	Lambda CY 1 EC	United Phosphorous, Willowood
	Lambda-Cyhalothrin 1 EC	Nufarm
	LambdaStar 1 EC, 1 CS, PLUS 2 CS	LG Life Sciences
	Lamcap 1 CS	Syngenta
	Paradigm 1 EC	Adama
<b>Permethrin</b> Original Product: Pounce 3.2 EC (not available) (FMC)	Province 1 SC	TENKoz
	Silencer 1 EC	Adama
	Arctic 3.2 EC	Winfield
	Perm-Up 3.2 EC	United Phosphorous
	PermaStar 3.2 EC	LG Life Sciences
	Permethrin 3.2 EC	Loveland, TENKoz, Helena
	<b>Zeta-cypermethrin</b> Original Product: Mustang Max 1.5 EW (FMC)	Respect 0.8 EC

## Generic Fungicides

Active Ingredient	Generics	Manufacturer
<b>Azoxystrobin</b> Original Product: Quadris (Syngenta)	Azoxy 2SC	Willowood
	AzoxyStar	Albaugh/Agri-Star
	Azoxystrobin 100 ST	Albaugh/Agri-Star
	Satori	Loveland
<b>Chlorothalonil</b> Original Product: Bravo WeatherStik 720 SC (Syngenta)	Chloronil 720	Syngenta
	Chlorothalonil 720 SC	Arysta
	Echo 720	SipcamAdvan
	Equus 720 SST	MANA
	Initiate 720	Loveland
Original Product: Bravo Ultrex 82.5 WDG (Syngenta)	Echo 90 DF	SipcamAdvan
	Equus DF	MANA
<b>Iprodione</b> Original Product: Rovral 4F (Bayer)	Iprodione 4L AG	Arysta
	Meteor	United Phosphorus
	Nevado 4F	MANA
	Rovral 4F Fungicide	FMC
<b>Propiconazole</b> Original Product: Tilt (Syngenta)	Amtide Propiconazole 41.8% EC	AmTide
	Bumper 41.8 EC	MANA
	Bumper ES	
	Fitness	Loveland
	Propi-Star EC	Albaugh/Agri-Star
	Propimax EC	Dow
	Shar-Shield PPZ	Sharda USA
	Topaz	Winfield Solutions

Active Ingredient	Generics	Manufacturer
<b>Sulfur</b> Original Product: Various products and manufacturers	Kumulus DF	Arysta
	Microfine Sulfur	Loveland
	Microthiol Disperss	United Phosphorus
	Suffa	Drexel
	Sulfur 6L	Arysta
	Yellow Jacket Dusting Sulfur Yellow Jacket Wettable Sulfur	Georgia Gulf Sulfur
<b>Tebuconazole</b> Original Product: Folicur 3.6F (Bayer)	Monsoon	Loveland
	Onset 3.6L	Winfield Solutions
	Orius 3.6F	MANA
	Tebu-Crop 3.6F	Sharda USA
	Tebustar 3.6L	Albaugh/Agri-Star
	Tebuzol 3.6F	United Phosphorus
	Toledo	Rotam North America
<b>Thiophanate-methyl</b> Original Product: Topsin M 70WDG, 70WP, WSB (United Phosphorus)	Nufarm T-Methyl 70WSB	Nufarm
	Thiophanate-Methyl 85WDG	MANA
Original Product: Topsin 4.5FL (United Phosphorus)	Incognito 4.5F	MANA
	Nufarm T-Methyl 4.5F	Nufarm

## Organic Manures and Fertilizers

Animal manure contributes more to the soil than just nitrogen, phosphorus, and potassium. Continued use of manure builds organic matter in soils and improves soil structure. This modification of soil structure helps improve water holding capacity, aeration, friability, and drainage. In addition, many trace nutrients needed for optimal plant growth are available from manure. Plant nutrients are also released more slowly and over a longer period of time than from most commercial fertilizers.

Disadvantages of using manure are the handling and transportation problems associated with large amounts of manure required to obtain sufficient quantities of nutrients for vegetables. The use of fresh manure may also introduce new weeds into fields since certain weed seeds remain alive even after passage through animals. Another concern is that the careless use of manure can expose fresh produce to human pathogens such as *E. coli*, which can cause serious illness. Food safety must be a primary consideration in any vegetable operation but especially where manure are being used.

### General Considerations

#### Fresh Vegetables, Not Fresh Manure

Manure cannot be used fresh (raw) if you intend to plant directly into it; composting results in a more readily usable form of manure. Composting will also destroy many weed seeds that could otherwise be introduced into new fields or gardens. Composting requires that the temperature reach 131 to 170°F for at least 15 days, and the compost must be turned 5 times. For more information on the composting process, see UK Extension publication HO-75, *Home Composting: A Guide to Managing Home Organic Waste*. This guide along with other home and commercial vegetable publications are available from the Horticulture Department's Web site at [uky.edu/Horticulture/Horticulture/homeveggies.html](http://uky.edu/Horticulture/Horticulture/homeveggies.html). If fresh manure is used on soil, it should be worked in as soon as possible or covered with other organic materials such as straw, hay, or grass clippings to prevent the loss of nitrogen through leaching. No fresh manure may be used during the year of harvest for certified organic production so you may want to plant a green manure or cover crop on this ground for the first year (see Web site above for information on Kentucky cover crops). See also [kyagr.com/marketing/plantmktg/organic/index.htm](http://kyagr.com/marketing/plantmktg/organic/index.htm) for detailed information on organic

certification in Kentucky. This allows soil microbes to start the decomposition process that regulates nutrient availability and prevents burning of young plant roots. It also substantially reduces the chance of produce *E. coli* and *Salmonella* contamination.

**Caution:** Fresh manure is best applied and plowed down the fall before planting. There should be at least 120 days between manure application and planting for vegetable crops in which the edible portion touches the ground.

Remember that some types of animal manure have higher nitrogen contents than others (see Tables 1 and 2). These include horse, sheep, chicken, and rabbit manure. These are sometimes referred to as "hot" and are best used after composting. Cow and hog manures are considered "cold" because of their lower nitrogen levels.

#### Application

Composted manure can be broadcast and worked into fields or worked into rows and beds for various vegetable crops. A general recommendation for vegetable gardens is to broadcast poultry, sheep, cow, or horse manure at 25 to 100 pounds per 100 square feet (approximately 5 to 20 tons per acre). This amount may need to be supplemented with 1 to 2 pounds of a

complete inorganic fertilizer such as 10-10-10. Organic growers can supplement with ground rock phosphate or raw bone meal to obtain phosphorus required (see below). For crops such as melons, squash, and cucumbers, composted manure can be worked directly into planting hills and mixed thoroughly with the soil.

### Nutrient Contents

It is important to remember that nutrient contents in manure vary widely according to age of the animals, feed used, moisture content, degree of decomposition, and the amount of litter or bedding material mixed in with the manure. The only really accurate way of determining the nutrient content of the manure you are using is through laboratory analysis. You may need to adjust your application rates up or down according to what you know about the age, quality, and moisture content of the manure.

When buying or getting ready to spread manure, remember that moisture content greatly affects the total pounds of nutrients in a ton of material. For example, broiler manure at 25% to 30% moisture when removed from the house will contain about 34 pounds of nitrogen, 37 pounds of phosphate, and 31 pounds of potash per ton. But a ton of fresh manure at 75% moisture will contain only 27, 28, and 14 pounds of these nutrients, respectively. At 75% moisture you will be hauling around 1,500 pounds of water and only 500 pounds of solid material. Not all nutrients in manure are available to crops during the season of application. In poultry manure, for example, 90% of the N, most of the potassium, but only half of the phosphorus becomes available in the first year.

Because phosphorus in manure must decompose before it becomes available and because it is not very mobile in soil, broadcasting manure is not considered a very efficient way of applying this element for establishment of vegetable crops. For poultry manure, phosphorus and potassium portions are considered to be about 50% to 75% as effective as they are in commercial fertilizers during the year of application; the remainder is released as the litter decomposes. Supplement manures with a complete inorganic fertilizer or with an organically approved material such as bone meal or ground rock phosphate.

### How to Use and Convert Fertilizer Recommendations in this Publication

Plant nutrient requirements are provided in the "Fertilizer" tables under each crop in this publication. These nutrients are expressed in terms of the amounts of nitrogen (N), phosphorus or phosphate (P<sub>2</sub>O<sub>5</sub>), and potassium (K<sub>2</sub>O) required by the crop. Amounts of phosphorus and potassium recommended vary according to what may already be present in the soil. For this reason, both conventional and organic growers should always have their soil tested, preferably in the fall or early spring. Soil test sample boxes and instructions are available from your county Extension office.

To calculate the amount of manure required for application on a sweet corn crop, for example, first find the suggested nutrient application rates in the "Fertilizer" table in the "Sweet Corn" chapter. **Warning:** Manure applications should never exceed the total nitrogen requirements of a crop in an attempt to satisfy phosphorus and potassium requirements—burning of the roots and leaves could occur.

#### Nitrogen First

We will choose nitrogen as our "priority" nutrient, which will be used to limit the total amount of manure to be used; i.e., we will calculate the manure requirements based only on the nitrogen recommendation. Although most manure high in nitrogen is also high in potassium (Tables 1 and 2), additional phosphorus may

**Table 1. Nutrients in FRESH animal manure.**

Source	Water Content	Average Nutrient Composition (percent of fresh weight)		
		N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Beef cattle	80	0.70	0.45	0.55
Dairy cattle	84	0.60	0.25	0.60
Horses	60	0.60	0.25	0.45
Hogs	75	0.50	0.35	0.65
Sheep	65	1.05	0.35	0.95
Laying hens	75	1.00	1.25	0.50
Broilers (litter) <sup>1</sup>	30	2.95	2.75	1.85

<sup>1</sup> Some broiler producers use Roxarson and Nitarsone in their feed mixes as medications. Growers using litter containing these products cannot sell produce grown with this manure as certified organic in Kentucky.

**Table 2. Nutrient contents of DRY manures and organically approved fertilizer materials.**

Source	Average Nutrient Composition (percent dry weight)		
	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O
Dairy cows	1.3	0.9	3.0
Feedlot cattle	1.7	1.2	3.0
Horse	2.3	0.9	1.7
Poultry	3.2	5.2	1.8
Sheep	3.5	1.4	3.5
Hogs	3.5	0.5	0.7
Goat	1.5	1.5	3.0
Rabbit	2.4	1.4	0.6
Tobacco stems <sup>1</sup>	1.5	0.5	7.0
Bat guano	10.0	2.0-4.0	0-2.0
Blood meal	13.0-14.0	2.0	1.0
Bone meal, raw	3.0	22.0	-
Bone meal, steamed	1.0-2.0	11.0-15.0	-
Cottonseed meal	6.0	0.4-3.0	1.5
Fish meal	10.0	6.0	-
Fish emulsion	5.0	2.0	2.0
Feather meal	12.0	0	0
Soybean meal	7.0	1.2	1.5
Tankage <sup>1</sup>	7.0	10.0	1.5
"Soft" rock phosphate	0	14.0-16.0	0
Greensand	0	0	3.0
Phytamin 800	7.0	0	0

<sup>1</sup> Not cleared for certified organic production. Sewage sludge should not be used for vegetable crops because of possible heavy metal and *E. coli* contamination.

need to be obtained from other sources. Because soil and plant nitrogen tests are not widely used in Kentucky and because much of the nitrogen in soils is used or lost from one season to the next, we make a blanket recommendation of 80 to 100 pounds of N per acre for sweet corn preplant. When commercial fertilizers are used, this amount is applied before planting and is supplemented by a sidedressing of 40 to 50 pounds of N per acre when plants are about knee-high.

#### Consider the Source

Now consider the source, moisture content, and quality of the manure or organic material to be used. If we are using a dry or composted material containing little or no moisture, we should use Table 2 to make the necessary calculations.

#### Making Conversions

We have decided to use the lower N level of 80 pounds per acre because we feel our soil may still have some residual N from last year's bean crop that was grown on this plot. We have found a source of composted poultry manure and plan to use it as our nutrient source. To calculate the manure required to provide the required 80 pounds of nitrogen, look at Table 2 under poultry; the N content is 3.2%. Divide the 80 pounds by 3.2 = 25 and multiply the result by 100 = 2,500 pounds. This is the amount of poultry

manure required to obtain the 80 pounds per acre of nitrogen recommended. To convert to tons, simply divide again by 2,000 ( $2,500 \div 2,000 = 1.25$  tons).

In this example we will have obtained 80 pounds of nitrogen together with 130 pounds of phosphorus ( $P_2O_5$ ) and 45 pounds of potassium ( $K_2O$ ). The amount of  $P_2O_5$ , and  $K_2O$  are calculated for the 2,500 pounds of manure by multiplying 2,500 by the appropriate percentages in Table 2 and then dividing by 100. The amount of  $P_2O_5$ , for example, is  $2,500 \text{ pounds} \times 5.2 = 13,000$  divided by 100 = 130 pounds. For the amount of  $K_2O$ , multiply 2,500 pounds  $\times 1.8$  and then divide by 100 = 45 pounds.

### Additional Phosphorus

Now suppose that the soil is very low in phosphorus and the soil test suggests applying 180 pounds of phosphorus. We have

obtained 130 pounds of phosphorus from the poultry manure and need an additional 50 pounds, but we do not want to apply much more nitrogen.

Looking at Table 2 we decide to supply our phosphorus using raw bone meal, which is 22%  $P_2O_5$  and 3% N. Dividing 50 pounds of  $P_2O_5$  by 22 = 2.27 and multiplying by 100 = 227 pounds. Thus, 227 pounds of raw bone meal/acre will supply 50 pounds of  $P_2O_5$ . Performing a similar calculation for the N tells us that we will only obtain about 7 (6.8) pounds of N/acre using raw bone meal. Use this same means of calculation if additional potassium is needed.

**Note:** Information in Tables 1 and 2 should be used only as guidelines. Nutrient contents for manures vary greatly. The figures represented are averages from a range of possible values.

## Appendix H

# Disinfection and Treatment of Vegetable Seeds

### Hot Water Treatment (most vegetable seeds)

Seeds many vegetables can be soaked in hot water to reduce populations of seedborne bacteria and fungi. Germination may be reduced to some degree, so some experimentation with small seed lots should be carried out before treating large amounts of seed. Cucurbits other than cucumber may be severely harmed by hot water treatment and should be disinfected by other methods. In general, use fresh seed for this process, as research indicates that viability of older seed (more than 1 year old) is drastically reduced by treatment with hot water. Bacterial and fungal pathogens associated with the embryo will not be affected by hot water soaking (bacterial canker of tomato, for example, can infect the embryo of the tomato seed along with being associated with the seed coat), nor will TMV be eradicated.

Water temperature and soaking time differ by species (Table 1), and relatively tight control of temperature is critical to the success of this method. A water bath capable of holding temperature within a reasonable range is a required piece of equipment, along with a quality canning thermometer to monitor temperature. A 5-degree drop in ideal temperature may allow some pathogens to survive on seed, while a 5-degree increase in water temperature may kill some or all of the seed being treated. The same rigor should be observed for soaking time.

Guidelines published by the University of Illinois suggest that seed should be pre-warmed before beginning the actual hot water treatment. This can be done by placing seed in a weighted cheesecloth bag and soaking in 100°F water for 10 minutes. The bag may need to be squeezed to remove air bubbles—maximum contact of water and seed is critical.

For the next step, place the bag containing the pre-warmed seed into a water bath set to the temperature recommended for the vegetable seed being treated (Table 1). Water volume should be 5 to 10 times greater than the volume of seed being treated. For example, if you were treating approximately one cup of tomato seed, the capacity of the water bath should be 5 to 10 cups. Agitation of the water during the treatment cycle will help maintain a uniform temperature in the water bath. After the prescribed amount of time, remove seed and spread on paper towels to dry. A recommended seed treatment can then be applied to protect against soilborne pathogens.

Treatment of crops other than those listed may cause serious injury to seed.

### Chlorine Bleach Treatment

Soaking seed in a solution of chlorine bleach has been shown to be effective in eradicating pathogens primarily borne on the surface of the seed, such as the bacteria that cause bacterial spot, speck, and canker of tomato. It is also reported that this method can also provide some control of seed-transmitted TMV. The soaking solution should be prepared by adding 1 quart of commercial bleach (sodium hypochlorite) to 3 to 4 quarts of water. Add a drop or two of dish detergent to decrease surface tension of the solution. Soak seed in solution for 1 minute, remove and rinse thoroughly with clean water. Spread

**Table 1. Recommended temperatures and soaking times for hot-water disinfection of selected vegetable seeds.**

Vegetable Crop	Water Temp. (°F)	Soaking Time (min.)
Broccoli	122	20-25
Brussels sprout	122	25
Cabbage	122	25
Carrot	122	15-20
Cauliflower	122	20
Celery	122	25
Chinese cabbage	122	20
Collard	122	20
Cucumber	122	20
Eggplant	122	25
Garlic	120	20
Kale, Kohlrabi	122	20
Lettuce	118	30
Mint	112	10
Mustard, Cress, Radish	122	15
Onion (sets)	115	60
Pepper	125	30
Rape, Rutabaga	122	20
Shallot	115	60
Spinach	122	25
Sweetpotato (roots)	115	65
Sweetpotato (cuttings, sprouts)	120	10
Tomato	122	25
Turnip	122	20

seed on paper towels to dry. Seed can be treated with a recommended fungicide to protect against soilborne pathogens.

### Trisodium Phosphate (TSP)

Tomato seed can be soaked in a 10% solution of TSP for 15 minutes to eradicate seed-transmitted TMV. Remove seeds, rinse, and spread evenly on paper towels to dry. Treat with approved fungicides if needed. Most home supply and paint stores carry TSP, which is used to clean walls and surfaces prior to painting and staining. As with the other methods, it is advisable to test this process on small batches of seed at first to make sure that there are no negative effects on germination.

# Sprayer Calibration

To apply the right amount of material per acre, it is necessary to know how much liquid the sprayer is delivering per acre at a given speed and pressure. The following is a fast, simple method of calibrating a sprayer for broadcast application.

## Ounce Calibration Method:

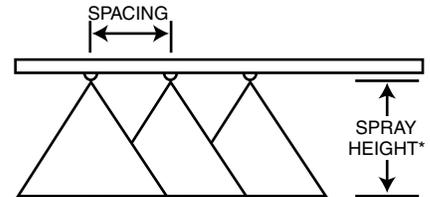
- Using the table to the right, select the distance to catch discharge based on the row or nozzle spacing of your sprayer.
- Measure that distance in the field to be sprayed.

- Note the time in seconds spent to drive the measured distance at the desired throttle setting (constant speed).
- Catch the nozzle discharge for the noted time (#3 above) in a measuring cup or other container graduated in fluid ounces.
- The total discharge per row or nozzle spacing in fluid ounces is equal to the gallons per acre applied (at the constant speed used in #3).
- Repeat for each nozzle or nozzle group to ensure equal distribution.

## SPRAYER CALIBRATION (Distance)

Nozzle Spacing (inches)	Distance to Catch Discharge (feet)
40	102
38	107
36	113
34	120
32	127
30	136
28	146
26	157
24	170
22	185
20	204
18	227
16	255
14	291

TIP NO. (Strainer Screen Size)		Liquid Pressure in PSI	Capacity 1 Nozzle in GPM	Capacity 1 Nozzle in oz./min.	GALLONS PER ACRE 20" SPACING				GALLONS PER ACRE 30" SPACING			
80° SERIES	110° SERIES				5 MPH	6 MPH	7 MPH	8 MPH	5 MPH	6 MPH	7 MPH	8 MPH
8001VS (100 Mesh)	11001VS (100 Mesh)	30	.09	11	5.1	4.3	3.7	3.2	3.4	2.9	2.5	2.1
		35	.09	12	5.6	4.6	4.0	3.5	3.7	3.1	2.6	2.3
		40	.10	13	5.9	5.0	4.2	3.7	4.0	3.3	2.8	2.5
		45	.11	14	6.3	5.3	4.5	3.9	4.2	3.5	3.0	2.6
		60	.12	15	7.3	6.1	5.2	4.6	4.9	4.0	3.5	3.0
80015VS (100 Mesh)	110015VS (100 Mesh)	30	.13	17	7.7	6.4	5.5	4.8	5.1	4.3	3.7	3.2
		35	.14	18	8.3	6.9	6.0	5.2	5.6	4.6	4.0	3.5
		40	.15	19	8.9	7.4	6.4	5.6	5.9	5.0	4.2	3.7
		45	.16	20	9.5	7.9	6.8	5.9	6.3	5.3	4.5	3.9
		60	.18	23	10.9	9.1	7.8	6.8	7.3	6.1	5.2	4.6
8002VS (50 Mesh)	11002VS (50 Mesh)	30	.17	22	10.3	8.6	7.4	6.4	6.9	5.7	4.9	4.3
		35	.19	24	11.1	9.3	7.9	6.9	7.4	6.2	5.3	4.6
		40	.20	26	11.9	9.9	8.5	7.4	7.9	6.6	5.7	5.0
		45	.21	27	12.6	10.5	9.0	7.9	8.4	7.0	6.0	5.3
		60	.25	32	14.6	12.1	10.4	9.1	9.7	8.1	6.9	6.1
8003VS (50 Mesh)	11003VS (50 Mesh)	30	.26	33	15.4	12.9	11.0	9.7	10.3	8.6	7.4	6.4
		35	.28	36	16.7	13.9	11.9	10.4	11.1	9.3	7.9	6.9
		40	.30	38	17.8	14.9	12.7	11.1	11.9	9.9	8.5	7.4
		45	.32	41	18.9	15.8	13.5	11.8	12.6	10.5	9.0	7.9
		60	.37	47	22	18.2	15.6	13.6	14.6	12.1	10.4	9.1
8004VS (50 Mesh)	11004VS (50 Mesh)	30	.35	45	21	17.2	14.7	12.9	13.7	11.4	9.8	8.6
		35	.37	47	22	18.5	15.9	13.9	14.8	12.3	10.6	9.3
		40	.40	51	24	19.8	17.0	14.9	15.8	13.2	11.3	9.9
		45	.42	54	25	21	18.0	15.8	16.8	14.0	12.0	10.5
		60	.49	63	29	24	21	18.2	19.4	16.2	13.9	12.1
8005VS (50 Mesh)	11005VS (50 Mesh)	30	.43	55	26	21	18.4	16.1	17.2	14.3	12.3	10.7
		35	.47	60	28	23	19.8	17.4	18.5	15.4	13.2	11.6
		40	.50	64	30	25	21	18.6	19.8	16.5	14.1	12.4
		45	.53	68	32	26	23	19.7	21	17.5	15.0	13.1
		60	.61	78	36	30	26	23	24	20	17.3	15.2
8006VS (50 Mesh)	11006VS (50 Mesh)	30	.52	67	31	26	22	19.3	21	17.2	14.7	12.9
		35	.56	72	33	28	24	21	22	18.5	15.9	13.9
		40	.60	77	36	30	25	22	24	19.8	17.0	14.9
		45	.64	82	38	32	27	24	25	21	18.0	15.8
		60	.74	95	44	36	31	27	29	24	21	18.2
8008VS (50 Mesh)	11008VS (50 Mesh)	30	.69	88	41	34	29	26	27	23	19.6	17.2
		35	.75	96	44	37	32	28	30	25	21	18.5
		40	.80	102	48	40	34	30	32	26	23	19.8
		45	.85	109	50	42	36	32	34	28	24	21
		60	.98	125	58	49	42	36	39	32	28	24



\*Adjust spray height in the field to overlap approximately 30% of each edge of pattern.

SUGGESTED MINIMUM SPRAY HEIGHT	
SPRAY ANGLE	SPRAY HEIGHT 20" SPACING
80°	17-19"
110°	10-12"

### Flat Fan Spray Tips

- 8002VS Stainless Steel with VisiFlo color coding
- 8002-HSS Hardened Stainless Steel
- 8002-SS Stainless Steel
- 8002 Brass

Tee Jet™ is a registered trademark of Spraying Systems Co. of Wheaton, Illinois.

# Earliest and Latest Vegetable Crop Planting Dates in Kentucky

As every vegetable grower knows, a week earlier (or later) on the market can sometimes make the difference between a highly profitable crop and a net loss. Information in the following tables is provided as an aid to planning. Table 1 lists earliest and latest safe planting dates for various vegetable crops based on experiences of growers in eastern, central, and western Kentucky; however, these are not absolute and it is always possible for killing frosts to occur later or earlier than the range of dates provided. Frosts are greatly influ-

enced by small variations in topography and microclimate, and growers can best judge for themselves how prone their fields are to early or late frosts.

Table 2 provides average dates for the latest frosts in spring and the earliest frosts in the fall. These dates are based on 30-year averages from the Kentucky weather stations listed. Find the nearest station location in the list and use the dates found in the same row. These dates represent a 90% probability (nine years out of 10) that the last frost (at or below 32°F) will occur on or before the date listed for "Latest Spring Frost" or a 90% probability that the first frost will occur on or after the date listed for "Earliest Fall Frost."

Use this information with caution; small differences in landscape and elevation can result in later frosts in spring and earlier frosts in the fall. Local experience will help determine the best planting dates for various crops at your location.

**Table 1. Earliest and latest safe planting dates for Eastern, Central and Western Kentucky.**

Crops	Earliest Date <sup>1</sup>			Latest Date <sup>1,2</sup>		
	Eastern	Central	Western	Eastern	Central	Western
Asparagus (crowns)	Mar 20	Mar 15	Mar 10			
Beans (snap)	May 1	Apr 25	Apr 10	Jul 15	Jul 25	Aug 1
Beans (lima)	May 10	May 1	Apr 15	Jun 15	Jun 20	Jul 1
Beets	Mar 20	Mar 15	Mar 10	Jul 15	Jul 20	Aug 15
Broccoli (plants)	Apr 10	Apr 5	Mar 30	Jul 15	Aug 1	Aug 15
B. Sprouts (plants)	Apr 10	Apr 5	Mar 30	Jul 1	Jul 15	Aug 1
Cabbage	Apr 1	Mar 25	Mar 15	Jul 1	Jul 15	Aug 1
Carrots	Apr 1	Mar 20	Mar 10	Jul 1	Jul 15	Aug 1
Cauliflower (plants)	Apr 10	Apr 5	Mar 30	Jul 15	Jul 20	Aug 5
Chard	Apr 1	Mar 20	Mar 15	Jun 15	Jul 15	Aug 1
Collards	Mar 15	Mar 10	Mar 1	Jul 15	Aug 1	Aug 15
Sweet Corn	May 1	Apr 20	Apr 10	Jun 15	Jul 10	Jul 20
Cucumbers	May 10	May 5	Apr 25	Jun 15	Jul 1	Jul 15
Eggplant (plants)	May 15	May 10	May 1	Jun 1	Jun 15	Jul 1
Kale	Apr 1	Mar 20	Mar 10	Jul 15	Aug 1	Aug 15
Kohlrabi	Mar 25	Mar 20	Mar 15	Jul 15	Aug 1	Aug 15
Lettuce (leaf)	Apr 1	Mar 25	Mar 15	Aug 1	Aug 15	Sep 1
Lettuce (bibb plants)	Apr 1	Mar 25	Mar 15	Jul 15	Aug 1	Aug 15
Muskmelons	May 15	May 10	Apr 25	Jun 15	Jul 1	Jul 15
Okra	May 15	May 10	Apr 20	Jul 1	Jul 15	Aug 1
Onions (sets)	Mar 15	Mar 10	Mar 1			
Onions (plants)	Apr 1	Mar 25	Mar 15	Jun 15	Jul 1	Jul 15
Onions (seed)	Apr 1	Mar 20	Mar 10	Jun 1	Jun 15	Jul 1
Parsley	Apr 1	Mar 20	Mar 10	Jul 15	Aug 1	Aug 15
Parsnips	Apr 1	Mar 20	Mar 10	Jun 1	Jun 15	Jul 1
Peas	Mar 15	Mar 1	Feb 20			
Peppers (plants)	May 20	May 10	May 1	Jun 15	Jul 1	Jul 15
Potatoes	Mar 20	Mar 15	Mar 15	Jun 15	Jul 1	Jul 15
Sweetpotatoes	May 20	May 10	May 1	Jun 1	Jun 10	Jun 15
Pumpkins	May 10	May 5	Apr 25	Jun 1	Jun 15	Jul 1
Radishes	Mar 15	Mar 10	Mar 1	Sep 1	Sep 15	Oct. 1
Rhubarb (crowns)	Mar 15	Mar 10	Mar 1			
Southernpeas	May 10	May 5	Apr 20	Jun 15	Jul 1	Jul 15
Snow Peas	Mar 15	Mar 1	Feb 20	Jul 20	Aug 1	Aug 8
Spinach	Mar 10	Mar 1	Feb 15	Aug 15	Sep 1	Sep 15
Summer Squash	May 15	May 10	Apr 20	Jul 15	Aug 1	Aug 15
Tomatoes (plants)	May 15	May 5	Apr 20	Jun 1	Jun 15	Jul 1
Turnips	Mar 15	Mar 10	Mar 1	Jul 15	Aug 1	Aug 15
Watermelons	May 15	May 5	Apr 20	Jun 15	Jul 1	Jul 15
Winter Squash	May 15	May 10	Apr 20	Jun 15	Jul 1	Jul 15

<sup>1</sup> Dates are for direct seeding unless otherwise indicated under "Crops" column.

<sup>2</sup> Based on the average time to harvest for early maturing varieties; mid-season and late-maturing varieties need to be planted 15 to 30 days earlier than latest date. Most fall-planted crops require irrigation.

**Table 2. Average frost dates in Kentucky.**

Weather Station	Latest Spring Frost	Earliest Fall Frost
<b>Eastern</b>		
Ashland	May 21	Sep 28
Barbourville	May 8	Oct 9
Baxter	May 6	Oct 9
Grayson	May 17	Sep 28
Heidelberg	May 12	Oct 4
Hyden	May 12	Oct 4
London Corbin Airport	May 7	Oct 1
Manchester	May 17	Sep 25
Middlesboro*	May 11	Oct 4
Monticello	May 6	Oct 3
Mount Vernon	May 10	Oct 3
Somerset	May 7	Oct 2
Stearns	May 12	Sep 29
West Liberty	May 22	Sep 25
Williamsburg	May 8	Oct 5
<b>Bluegrass</b>		
Bardstown	May 6	Oct 3
Berea College	Apr 29	Oct 6
Carrrollton Lock	May 4	Oct 8
Cincinnati/Covington	May 6	Oct 5
Covington	May 9	Oct 4
Cynthiana	May 8	Oct 6
Danville	Apr 26	Oct 13
Dix Dam	Apr 25	Oct 12
Falmouth*	May 10	Sep 24
Farmers 2 S	May 10	Sep 30
Frankfort (Lock 4)	May 3	Oct 6
Lexington (Blue Grass Airport)	Apr 28	Oct 10
Maysville Sewage Plant	May 7	Oct 7
Mount Sterling	May 5	Oct 9
Shelbyville	May 14	Sep 22
Warsaw Markland Dam	May 9	Oct 3
Williamstown	Apr 26	Oct 6
<b>Central</b>		
Barren River Lake	Apr 29	Oct 5
Berheim Forest	May 12	Oct 2
Bowling Green	Apr 26	Oct 8
Bradfordsville	May 10	Sep 30
Cambellsville*	Apr 30	Oct 5
Glasgow	Apr 28	Oct 6
Greensburg	May 2	Oct 6
Hodgenville-Lincoln	May 2	Oct 6
Jamestown	Apr 28	Oct 9
Leitchfield	May 6	Oct 3
Louisville Airport	Apr 21	Oct 15
Mammoth Cave	May 10	Oct 1
Nolin River Lake	May 13	Sep 29
Rough River Lake	May 11	Sep 26
Scottsville	Apr 19	Oct 11
Summer Shade	May 6	Oct 4
<b>Western</b>		
Bardwell	Apr 21	Oct 3
Beaver Dam	Apr 28	Oct 3
Gilbertsville	Apr 17	Oct 16
Golden Pond	Apr 18	Oct 11
Henderson	Apr 20	Oct 7
Hopkinsville*	Apr 22	Oct 4
Lovelsville	Apr 28	Oct 3
Madisonville	Apr 24	Oct 6
Mayfield	Apr 25	Oct 7
Murray	Apr 17	Oct 10
Owensboro*	Apr 23	Oct 5
Paducah (Barkley Regional Airport)	Apr 21	Oct 9
Princeton	Apr 25	Oct 6
Rochester Ferry	Apr 24	Oct 5
Russellville	Apr 26	Oct 6

\*Weather station had missing data. Dates were estimated using data from surrounding stations.

# Relative Efficacy of Insecticides Against Common Arthropod Pests of Vegetable Crops in the Southeastern United States

Not all insecticides listed below are registered on all vegetable crops—check the label before applying to a specific crop.

Chemical class (IRAC)	Common name	Example Product	Greenhouse use	Flea beetles	Colorado potato beetle*	Cucumber beetles	Corn earworm*	European corn borer	Fall armyworm	Cabbage looper	Imported cabbageworm	Diamondback moth*	Squash vine borer	Beet armyworm*	Stink/Harlequin bugs	Squash bug	Aphids*	Thrips	Western flower thrips	Maggots	Whiteflies*	Cutworms	Wireworms	White grubs	Spider mites*
1A	carbaryl	Sevin		3	1	2	1	2	1	1	2	1	1	x	x	x	x	1	x	x	x	1	x	x	x
	methomyl	Lannate		1	x	x	2	2	2	2	2	2	x	1	2	2	1	3	2	x	1	x	x	x	x
1B	malathion	Malathion		2	1	2	1	1	1	2	1	1	x	1	1	1	1	1	x	1	x	1	x	x	x
	chlorpyrifos	Lorsban		x	x	x	1	1	1	1	2	1	1	x	x	x	x	1	x	3	x	2	3	2	x
	acephate	Orthene	No	x	x	x	1	3	2	1	2	x	x	x	x	x	2	2	x	x	1	2	x	x	x
	diazinon	Diazinon	No	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2	x	1	2	1	x
	dimethoate	Dimethoate		2	x	1	x	x	x	x	x	x	x	x	2	1	3	3	1	x	x	-	-	-	-
3	permethrin	Pounce		2	1	2	2	1	2	3	1	3	x	1	2	1	1	x	x	x	2	x	x	x	x
	alphacypermethrin	Fastac		3	1	3	2	3	2	2	3	1	3	x	1	2	1	1	x	x	x	2	x	x	x
	zeta cypermethrin	Mustang Max		3	1	3	2	3	2	2	3	1	3	x	1	2	1	2	x	x	x	3	x	x	x
	cyfluthrin	Baythroid/Renounce		2	1	2	2	2	1	2	3	1	3	x	1	2	1	1	x	x	x	3	x	x	x
	lambda cyhalothrin	Warrior		3	1	3	2	3	2	2	3	1	3	x	1	2	1	2	x	x	x	3	x	x	x
	esfanvalerate	Asana XL		3	2	2	2	2	1	2	3	1	2	x	1	1	1	1	x	x	x	2	x	x	x
	gamma cyhalothrin	Proaxis		3	1	3	2	3	2	2	3	1	3	x	1	2	1	2	x	x	x	3	x	x	x
	fenpropathrin	Danitol		2	x	2	2	1	1	3	1	2	x	1	2	1	1	x	x	1	2	x	x	1	
	bifenthrin	Brigade/Capture		3	1	3	2	2	1	1	3	1	3	x	2	1	2	1	2	x	1	1	3	2	1
4A	imidacloprid	Admire		3	2	3	x	x	x	x	x	x	x	x	1	2	3	2	x	2	2	x	1	2	x
	acetamiprid	Assail		2	3	2	x	x	x	x	x	x	1	x	1	1	3	2	x	x	2	x	x	x	x
	clothianidin	Belay/Clutch		3	3	2	x	x	x	x	x	x	x	x	x	2	x	x	2	x	x	1	2	x	
	thiamethoxam	Platinum/Actara	No	3	2	2	x	x	x	x	x	x	x	2	2	3	1	x	2	2	x	1	1	x	
	dinotefuran	Venom/Scorpion		3	3	2	x	x	x	x	x	x	x	3	3	1	2	x	x	2	x	x	x	x	
4C	sulfoxaflor	Closer		x	x	x	x	x	x	x	x	x	x	x	1	x	3	x	x	x	2	x	x	x	x
		Transform	No	x	x	x	x	x	x	x	x	x	x	x	1	x	3	x	x	x	2	x	x	x	x
4D	flupradifurone	Sivanto		x	x	x	x	x	x	x	x	x	x	x	x	3	x	x	x	2	x	x	x	x	
5	spinetoram	Radiant	No	x	3	x	3	3	2	2	3	2	2	2	x	x	x	3	2	x	x	1	x	x	x
6	emamectin benzoate	Proclaim	No	x	x	x	2	2	2	3	3	3	2	3	x	x	x	x	x	x	1	x	x	1	
	abamectin	AgriMek		x	3	x	x	x	x	x	x	x	x	x	x	x	2	1	x	x	x	x	x	3	
7C	pyriproxyfen	Knack/Distance		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2	x	x	x	x	
9B	pymetrozine	Fulfill		x	x	x	x	x	x	x	x	x	x	x	x	3	x	x	x	1	x	x	x	x	
9C	flonicamid	Beleaf		x	x	x	x	x	x	x	x	x	x	x	3	x	x	x	x	x	x	x	x	x	
10	etoxazole	Zeal		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2	
11	Bt	Dipel, various		x	x	x	1	1	1	2	3	1	1	1	x	x	x	x	x	x	x	x	x	x	
		XenTari		x	x	x	1	1	1	2	2	2	1	2	x	x	x	x	x	x	x	x	x	x	
15	novaluron	Rimont		x	3	x	3	3	3	2	3	1	2	3	1	1	x	2	2	x	2	x	x	x	
16	buprofezin	Courier		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2	x	x	x	
18	methoxyfenozide	Intrepid		x	x	x	2	2	3	3	3	1	2	3	x	x	x	x	x	x	x	x	x	x	
20B	acequinocyl	Kanemite		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	3	
21A	fenpyroximate	Portal	No	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2	
	tolfenpyrad	Torac		2	x	x	1	x	1	1	2	x	x	1	x	x	2	2	1	x	1	x	x	x	
22	Indoxacarb	Avaunt		1	2	1	3	2	2	3	3	2	2	3	x	x	x	x	x	x	1	x	x	x	
23	spiromesifen	Oberon		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	1	x	x	1	
	spirotetramat	Movento	No	x	x	x	x	x	x	x	x	x	x	x	x	2	x	x	x	2	x	x	x	x	
25	cyflumetofen	Nealta		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	2	
28	rynaxypyr	Coragen		x	3	x	3	3	3	3	3	3	2	3	x	x	x	1	x	x	2	1	x	x	
	cyantraniliprole	Exirel/Verimark	No	2	3	x	3	3	3	3	3	3	2	3	x	x	2	1	1	x	2	x	x	x	
	flubendiamide	Synapse/Belt	No	x	2	x	3	3	2	3	3	3	2	3	x	x	x	1	x	x	x	1	x	x	
	bifenazate	Acramite/Floramite		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	3	

\* Resistance may exist in some areas

x Ineffective or insufficient data

1 Somewhat effective

2 Effective

3 Very Effective

# Pesticide Emergency Telephone Numbers

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## Pesticide Spills

If you have a pesticide spill and need information on how to handle this type of emergency, call:

**911**

and

### **Kentucky Environmental Response Team**

(800) 928-2380

or

(502) 564-2380

### **CHEMTREC Pesticide Emergency Hotline (24 hour)**

(800) 262-8200

## Pesticide Exposures

If someone has been exposed to a particular pesticide, provide the physician with the following emergency number, which is designed to provide pharmacological information on pesticides to health professionals.

### **Kentucky Regional Poison Center**

(800) 222-1222

### **In Metro Louisville, call:**

(502) 589-8222

### **National Pesticide Information Center**

(800) 858-7378

Provides general and scientific information on pesticides. This center operates seven days a week from 6:30 am to 4:30 pm Pacific Time excluding some holidays.