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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.

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

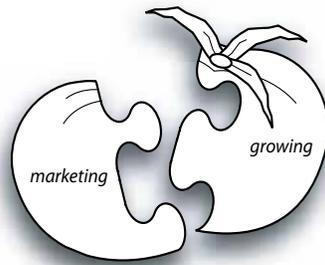
and seasonal items on their menus, so individual growers may be able to sell to them. Like most other forms of produce marketing, restaurant sales are based on good relationships developed over time.

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.

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
Total (5-7 yrs. reusable).....	\$2,185

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 valve¹ (for city water)
- Fertilizer injector
- Filter
- Pressure regulator and gauge
- Intake and delivery lines
- Drip tubes (drip tape)

¹Growers 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 SPACING¹

Row-spacing: center to center (inches)	In-row spacing (inches) ²									
	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

¹ Assuming an entire acre is planted, drive rows are not accounted for.

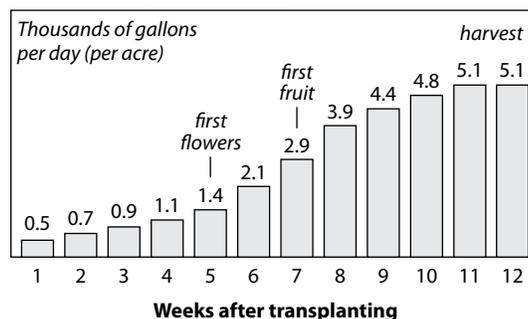
² Assumes a single row

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 BEES¹

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

¹ 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 ¹	Pepper	Snap Bean	Sweet Corn	Pumpkin	Melon ²	Cole Crops ³
Soybean or Tobacco Herbicides							
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 ⁴	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 ⁶
Blazer or Status	AH	AH	AH	AH	AH	AH	AH
Corn Herbicides							
Aatrex	SY	SY	SY	NR	SY	SY	SY
Accent	10 ⁵	10 ⁵	10 ⁵	10	10 ⁵	10	10 ⁵
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 ⁶

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

- ¹ Transplanted tomatoes only.
- ² Muskmelons and watermelons.
- ³ Broccoli, cabbage, and cauliflower.
- ⁴ Depends on rate applied; consult label.
- ⁵ 18 months with a soil pH of greater than or equal to 6.5.
- ⁶ 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
Preplant Incorporated																	
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
Pre-emergence																	
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
Post-emergence																	
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.

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 + anilinoypyrimidine
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

(continued on next page)

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) ¹	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

¹ 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). 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	Subtlex 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>Gladiolium cantenulatum</i>	PreStop Biofungicide	most vegetables (see label)	seed rots, root diseases, Botrytis stem canker	Yes	-
<i>Gladiolium 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	Armcarb, 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
Labeled for Greenhouse Use¹					
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 ²	beans, cole crops, cucurbits, pepper, tomato	foliar blights	Rates and preharvest intervals are crop-dependent; refer to label.
Copper fungicides ³	M	0	most vegetables (see label)	bacterial diseases, foliar blights, powdery mildew	-
Decree 50 WDG	17	0-60 ²	cucumber, lettuce, tomato	Botrytis gray mold	Do not make more than 2 consecutive applications.
Fontelis	7	0-1 ²	cucurbits, tomato	Alternaria diseases, Botrytis gray mold, powdery mildew, Sclerotinia diseases, Septoria diseases	-
Mancozeb (Dithane, Manzate, Penncozeb)	M	5-10 ²	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 ²	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 ²	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.
Not Prohibited for Greenhouse Use¹					
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 ²	most vegetables (see label)	foliar blights, bacterial diseases (+ fixed copper)	-
Quadris Top	11/3	0-1 ²	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	-

¹ 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.

² Crop dependent, see label.

³ 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)	
Phosphorus	Phosphate (P₂O₅)	
Low	<31	121-240
Medium	31-60	61-120
High	61-80	21-60
Very High	>80	0-20
Potassium	Potash (K₂O)	
Low	<201	201-300
Medium	201-300	101-200
High	301-450	51-100
Very High	>450	0-50
Nitrogen	N	
	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 ¹	Re-entry (hrs)	Harvest (days)
INSECTICIDES			
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
Restricted Use			
Lannate 90 SP	DP	48	1
Permethrin 3.2 EC	C	12	1
FUNGICIDES			
Aliette WDG ²	C	12	110
Fixed coppers ³	W	24/48	0
Chlorothalonil ³	C	12	190
Flint	C	12	180
Mancozeb ³	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 ³	C	24	0
Tebuconazole ³	C	12	180
UltraFlourish	W	48	1

¹ W: Warning, C: Caution, D: Danger, P: Poison

² 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.

³ 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*¹

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
SPEAR TREATMENTS			
Armyworms			
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.
Asparagus Beetles: 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.
Cutworms			
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.
FERN TREATMENTS			
Asparagus Beetles			
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.

¹ Generic products available (Appendix E).

WEED CONTROL: Asparagus

Product	Amt/A	Lb A.I./A	Comments
ESTABLISHED BEDS ONLY			
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.
ESTABLISHED BEDS AND NEW PLANTINGS			
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 ¹	PHI ² (days)	Amt/A	Seasonal Limits/A	Comments
Cercospora Blight, Rust					
Chlorothalonil ⁴					
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 ⁴					
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 ⁴					
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 ² (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 ⁴	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 ⁴	3	180			Rust. Apply after harvest of spears. Treat every 14 days when symptoms are first observed or when conditions favor disease.
Fusarium Crown Rot					
Mancozeb ⁴					Products include Dithane, Koverall, Manzate, Penncozeb.
Dry formulations	M	180	2 lb ³		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 ³		
Phytophthora Crown/Spear Rot					
Aliette ⁶	33	110	5.0 lb	1 app	Apply to fully expanded ferns.
MetaStar 2E AG	4	1	4 pt	2 apps	Cutting beds. 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. New plantings. 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	
Stemphylium Purple Spot					
Azoxystrobin ⁴					Apply before disease onset, continue every 7 to 14 days.
Azoxy 2SC	11	100	6.0 to 15.5 fl oz ⁵	92.3 fl oz	Apply before disease onset, continue every 14 days.
AzoxyStar	11	100	6.0 to 15.5 fl oz ⁵	92.3 fl oz	
Quadris	11	100	6.0 to 15.5 fl oz ⁵	4 apps	
Satori	11	100	6.0 to 15.5 fl oz ⁵	92.3 fl oz	
Flint	11	180	3 to 4 oz ⁵	3 apps	

¹ 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.

² Pre-harvest interval.

³ Per 100 gallons of water.

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

⁵ Use higher rate when pressure is severe.

⁶ 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 ₂ O ₅)
Low	<31	51-95
Medium	31-60	1-50
High	>60	0
Potassium		Potash (K ₂ 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			
SNAP BEANS, BUSH PLANT TYPE						
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
SNAP BEANS, POLE TYPE						
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
OTHER						
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.
VEGETABLE SOYBEANS						
Envy	X			Y/G	75	Earliest vegetable bean; 2 foot tall plant
BeSweet 292	X			Y/G	85	Top commercial variety; powdery mildew resistant.

¹ 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 ¹	Re-entry (hrs)	Harvest (days)
INSECTICIDES			
Acramite 4SC	C	12	3
Admire Pro	C	12	7/21 ³
Assail 30 SG	C	12	7
Belt 4 SC	C	12	1/14 ³
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 ³
Radiant SC	C	4	3/28 ³
Rimon 0.83 EC	W	12	1
Sevin XLR	C	12	3
Sivanto 1.67 SL	C	12	7/21 ³
Trigard 75 WP	C	12	7

PESTICIDE SAFETY: Beans

	Signal ¹	Re-entry (hrs)	Harvest (days)
Restricted Use			
Agri-Mek 0.15 EC	W	12	7 ³
Asana XL	W	12	3/21 ³
Baythroid XL	W	12	3/7 ³
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 ³
Leverage 2.7	W	12	71
Mustang Max	W	12	1/21 ³
Proaxis 0.5 EC	C	24	7/21 ³
Renounce 20 WP	C	12	7
Thimet 20 G	DP	48	60
Warrior II	W	24	7/21 ³
FUNGICIDES³			
Approach	C	12	14
Blocker 10G	C	12	45
Cannonball WP	C	12	7
Chlorothalonil ²	W	12	7/14 ³
Endura	W	12	7/21 ³
Fixed coppers ²	W	24/48	0
Fontelis	C	12	0
Headline	W	12	7/30 ³
Iprodione 4L AG	C	24	0
MetaStar 2EC AG	W	48	0

PESTICIDE SAFETY: Beans

	Signal ¹	Re-entry (hrs)	Harvest (days)
Nevado 4F	C	24	0
Omega 500F	W	12	30
PCNB ²	W	12	0
Priaxor	C	12	7/21 ³
Quadris	C	4	0
Quadris Opti	W	12	14
Quilt	W	12	7/14 ³
Quilt Xcel	W	12	7/14 ³
Ridomil Gold SL	C	48	0
Ridomil Gold PC GR	W	48	0
Rovral 4 Flowable	C	24	0
Sulfur ²	C	24	0
Switch	C	12	7
Tebuconazole ²	C	12	7/14 ³
Thiophanate-methyl ²	C	12	14/28 ³
Tilt	W	12	7

Snap beans only

Botran 75 W	C	12	2
Botran 5F	C	12	2
Rally 40 WSP	W	24	0

Dry beans only

Quadris Opti	W	12	14
Proline 480 SC	C	48	7

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

INSECT CONTROL: Beans¹

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
PREPLANT INCORPORATED			
Cutworms: 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.
AT PLANTING			
Aphids, Leafhoppers, Seedcorn Maggots: 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.
FOLIAR TREATMENTS			
Grasshoppers			
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.
Aphids, Leafhoppers			
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: Beans¹ (continued)

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
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.
Corn Earworms			
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.
Cutworms			
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.
Japanese Beetles			
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.
Mexican Bean Beetles, Bean Leaf Beetles: 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.
Spider Mites			
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.
Stink Bugs			
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.
Thrips, Whiteflies: 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: Beans¹ (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.

¹ Generic products available (Appendix E).

WEED CONTROL: Beans

Product Amt/A	Lb A.I./A	Comments
Lima, Snap Beans		
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.
Dry Beans		
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 ¹	PHI ² (days)	Amt/A	Seasonal Limits/A	Comments
Anthraxnose					
Aproach	11	14	6 to 12 fl oz ⁵	24 fl oz	Dry beans only. Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin ⁴					Apply before disease onset, continue every 7 to 14 days.
Azoxy 25C	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
AzoxyStar	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
Quadris	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
Satori	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
Chlorothalonil⁴					
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	
Fixed coppers					
					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 ⁵	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Headline	11	7/30 ³	6 to 9 fl oz ⁵	2 apps	Apply before disease onset, continue every 7 to 14 days.
Priaxor	7/11	7/21 ³	4 to 8 fl oz ⁵	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	
Thiophanate-methyl⁴					
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)

Fixed coppers					
					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 Dispers	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.

(continued on next page)

DISEASE CONTROL: Beans (continued)

Product	FRAC Code ¹	PHI ² (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.
Gray Mold, White Mold					
Aproach	11	14	8 to 12 fl oz ⁵	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 ⁴					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 ⁵	72 fl oz	Apply at beginning bloom and 7 to 10 days later at full bloom.
Iprodione ⁴					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 ⁵	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.
Thiophanate-methyl⁴					
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	
Rhizoctonia Web Blight, Pod Rot					
Azoxystrobin⁴					
Apply before disease onset, continue every 7 to 14 days.					
Azoxy 2SC	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
AzoxyStar	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
Quadris	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
Satori	11	0	6 to 15.5 fl oz ⁵	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.
Rust					
Aproach	11	14	6 to 12 fl oz ⁵	24 fl oz	Dry beans only. Apply before disease onset, continue every 7 to 14 days.
Azoxystrobin⁴					
Apply before disease onset, continue every 7 to 14 days.					
Azoxy 2SC	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
AzoxyStar	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
Quadris	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
Satori	11	0	6 to 15.5 fl oz ⁵	4 foliar apps	
Chlorothalonil⁴					
May be used on snap or dry beans for rust. Apply at early bloom or when conditions favor disease.					
Bravo Ultrex	M	7	1.25 to 1.8 lb	4 apps	Dry beans.
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 ⁵	72 fl oz	Apply before disease onset, continue every 7 to 14 days.
Headline	11	7/30	6 to 9 fl oz ⁵	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 ⁵	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 ⁴	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.
Tebuconazole⁴					
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.
Pythium Damping-off, Seedling Diseases, Root Rot					
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 ³	1 app	For preplant application only. Adjust equipment so that granules are mixed with soil before covering seed. Also provides control of Rhizoctonia.

(continued on next page)

DISEASE CONTROL: Beans (continued)

Product	FRAC Code ¹	PHI ² (days)	Amt/A	Seasonal Limits/A	Comments
Rhizoctonia Damping-off, Seedling Diseases, Stem/Root Rot					
Azoxystrobin ⁴					
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 ³	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 ³	1 app	Use as an In-furrow spray at planting; see label for directions.

¹ 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.

² Pre-harvest interval.

³ Per 1,000 row-feet.

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

⁵ 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 ₂ O ₅)	
Low	<31	121-180
Medium	31-60	61-120
High	61-80	31-60
Very High	>80	0-30
Potassium	Potash (K ₂ 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) ⁴	Comments
BROCCOLI¹		
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.
BRUSSELS SPROUTS²		
Jade Cross, E Strain	85	Plants grow to about 2 feet tall; medium sized sprouts.
CAULIFLOWER³		
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.

¹ *Italica* group

² *Gemmifera* group

³ *Botrytis* group

⁴ Days to maturity when transplanted.

VARIETIES: Cabbage¹

	Maturity (days) ²	Head Size (lb)	Yellows Resistant	Black Rot Tolerant	Tipburn Tolerant
GREEN					
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	
RED					
Scarlet King	70	4			
Rio Grande Red	73	4.5			
Rondale	75	4	X		X
Super Red 80	83	3.5			X
SAVOY					
Savoy Ace Improved	73	3.5	X		
Savoy King	80	4.5			X

¹ *Capitata* group (all are hybrids)

² 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) ⁴	Comments
PAK CHOI¹		
Joi-choi (hybrid)	47	Slow bolting, very uniform.
CHINESE CABBAGE²		
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.
KOHLRABI³		
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

¹ *B. rapa*, *Chinensis* group

² *B. rapa*, *Pekinensis* group

³ *B. oleracea*, *Gongylodes* group

⁴ 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 ¹	Re-entry (hrs)	Harvest (days)
INSECTICIDES			
Actara 25 WP	C	12	0
Admire Pro	C	12	7/21 ⁵
Assail 30 SG	C	12	7
Avaunt 30 DG	C	12	3
Belay 2.13 SC	C	12	7/21 ⁵
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 ⁵
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 ²
Malathion 8	C	12	3/7 ⁵
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
Rimon 0.83 EC	W	12	7
Scorpion 3.5 SL	C	12	1/21 ⁵
Sevin XLR	W	12	3/14 ⁵
Venom 70 SG	C	12	1/21 ⁵

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 ¹	Re-entry (hrs)	Harvest (days)
Restricted Use			
Asana XL	W	12	3
Baythroid XL	W	12	0
Brigade 2 EC	W	12	7
Capture LFR	W	12	AP ²
Danitol 2.4 EC	W	24	7
Diazinon AG500	C	24	7/10/21 ⁵
Diazinon 50 W	C	24	7/10/21 ⁵
Hero 1.24 EC	C	12	7
Lannate 90 SP	DP	48	1/3/10 ⁵
Lorsban 4 E	W	48	AP ²
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
FUNGICIDES³			
Actigard 50 WG	C	12	7
Aliette WDG ⁶	C	12	3
Blocker 10G/4F	C	12	0
Cabrio EG	C	12	0
Chlorothalonil ⁴	D	48	7
Endura	W	12	0
Fixed coppers ⁴	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 ¹	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 ⁴	C	24	0
Switch 62.5 WG	C	12	7
Terraclor	W	12	0
UltraFlourish	W	48	0
Zampro	C	12	0

¹ W: Warning, C: Caution, D: Danger; P: Poison
² AP: At planting.
³ None of these fungicides is labeled on all cole crops, so check labels carefully.
⁴ Several formulations are marketed. See the general introduction for more details on fungicides.
⁵ PHI depends on crop type and application method.
⁶ 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^{1,2,3}

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.			
PREPLANT INCORPORATED			
Cutworms, Root Maggots: 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.
TRANSPLANT WATER			
Root Maggots			
Diazinon AG 500	0.25 to 0.5 pt/50 gal	-	-
SOIL APPLICATION			
Aphids: 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 sid- edress 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	-
FOLIAR TREATMENTS			
Aphids, Harlequin Bugs, Stink Bugs, Flea Beetles			
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.
Beet Armyworms: 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.
Vetica 2.66	11 to 13 fl oz	26 fl oz	Allow 7 days between applications.
Cabbage Loopers: 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.
Vetica 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	-
Cross-Striped Cabbageworms, Imported Cabbageworms: 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.

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INSECT CONTROL: Cole Crops^{1,2,3} (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.
Vetica 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	-
Vetica 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.
Vetica 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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¹ See *Kentucky Cabbage Insect Pest Management Scout Manual (IPM-11)* for additional information on cabbage pests and their control.

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

³ 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.

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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 ¹	PHI ² (days)	Amt/A	Seasonal Limits/A	Comments
Alternaria Leaf Spot					
Azoxystrobin ⁴					
Azoxy 2SC	11	0	6 to 15.5 fl oz ⁵	3 foliar apps	Apply before disease onset, continue every 7 to 14 days.
AzoxyStar	11	0	6 to 15.5 fl oz ⁵	3 foliar apps	
Quadris	11	0	6 to 15.5 fl oz ⁵	3 foliar apps	
Satori	11	0	6 to 15.5 fl oz ⁵	3 foliar apps	
Cabrio	11	0	12 to 16 oz ⁵	4 apps	
Chlorothalonil ⁴					
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	-	Apply every 7 to 10 days after transplanting or when conditions favor disease. See label for mixing instructions and tank-mix precautions.
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 ⁵	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 ⁵	18 fl oz	Apply every 14 days.
Quadris Top	11/3	1	12 to 14 fl oz ⁵	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.
Black Leg					
Cabrio	11	0	12 to 16 oz ⁵	4 apps	Apply before disease onset, continue every 7 to 14 days.
Iprodione ⁴					
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.
Black Rot					
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	-	Apply every 7 to 10 days after transplanting or when conditions favor disease. See label for mixing instructions and tank-mix precautions.
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 ¹	PHI ² (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		-
Clubroot					
Blocker (Flowable & 4F)	14	0	3 pt ³	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 ³ 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 ³	1 app	Drench seedlings after transplanting with 1.7 fl oz of solution.
			20 fl oz		
Damping-off (Rhizoctonia), Wirestem					
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			
Damping-off (Pythium)					
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.
Downy Mildew					
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 ⁶	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.
Azoxystrobin⁴					
Azoxy 2SC	11	0	6 to 15.5 fl oz ⁵	3 foliar apps	Apply before disease onset, continue every 7 to 14 days.
AzoxyStar	11	0	6 to 15.5 fl oz ⁵	3 foliar apps	
Quadris	11	0	6 to 15.5 fl oz ⁵	3 foliar apps	
Satori	11	0	6 to 15.5 fl oz ⁵	3 foliar apps	
Cabrio	11	0	12 to 16 oz ⁵	4 apps	
Chlorothalonil⁴					
Bravo Ultrex	M	7	1.4 lb	14.5 lb	Apply before disease onset, continue every 7 to 14 days.
Bravo WeatherStik	M	7	1.5 pt	16 pt	Apply after transplanting or when conditions favor disease.
Fixed coppers					
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 ¹	PHI ² (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.
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 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 chorothalonil.
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.
Phytophthora Root Rot, Basal Stem Rot					
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.
Sclerotinia Stem Rot					
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 ⁵	72 fl oz	Apply before disease onset, continue every 7 to 14 days.

¹ 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.

² Pre-harvest interval.

³ Per 100 gal of water.

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

⁵ Use higher rate when pressure is severe.

⁶ 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 ¹	Comments
STANDARD SWEET CORN (su)			
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.
SUGAR ENHANCED (se) AND SYNERGISTICS (seq)			
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.
SUPERSWEETS (sh2 and augmented supersweets)			
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.
GENETICALLY MODIFIED²			
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.
ORNAMENTAL CORN³			
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.

¹ Y = yellow; W = white; BC = bicolor

² 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.

³ 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 ¹	Re-entry (hrs)	Harvest (days) ²
INSECTICIDES			
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
Restricted Use			
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 ⁴
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
FUNGICIDES			
Aftershock	C	12	7
Aproach	C	12	7
Avaris	W	12	14
Evito 480/Evito T	C	12	7
Fixed coppers ³	D	24/48	0
Headline	W	12	7
Headline SC	W	12	7
Headline AMP	W	12	7
Mancozeb ³	C	24	7
Priaxor	C	12	7
Propiconazole ³	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 ³	W	19 days	7
Vertisan	W	12	7
Fresh market only			
Chlorothalonil ³	D	48	14

¹ W: Warning, C: Caution, D: Danger, P: Poison

² AP: At planting, ST: Seed treatment.

³ Several formulations are marketed. See the general introduction for more details on fungicides.

⁴ Dependent on application type, see label.

⁵ 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)	
Phosphorus	Phosphate (P₂O₅)	
Low	<31	121-180
Medium	31-60	61-120
High	61-80	1-60
Very High	>80	0
Potassium	Potash (K₂O)	
Low	<201	151-200
Medium	201-300	101-150
High	>300	100
Nitrogen	N	
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*^{1,2,3}

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
PREPLANT INCORPORATED			
Wireworms: Wireworms can be a potential problem where sweet corn follows grass or grass-legume sod.			
Lorsban 15 G	13.5 lb	-	-
Cutworms: 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	-	-
PLANTING TIME			
Seedcorn Maggots, Rootworms, Seedcorn Beetles: 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.
FOLIAR TREATMENTS			
Armyworms			
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^{1,2,3} (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^{1,2,3} (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.

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

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

³ 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.

(continued on next page)

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 ¹	PHI ² (days)	Amt/A	Seasonal Limits/A	Comments
Leaf Blights, Gray Leaf Spot, Rust					
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 ⁴	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 ³					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 ³					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 ³		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.
Prostaro 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 ¹	PHI ² (days)	Amt/A	Seasonal Limits/A	Comments
Azoxystrobin ⁴					Use lower rates for rust. Apply before disease onset, continue every 7 to 14 days.
Azoxy 2SC	11	7	6 to 15.5 fl oz ⁴	6 apps	
AzoxyStar	11	7	6 to 15.5 fl oz ⁴	6 apps	
Quadris	11	7	6 to 15.5 fl oz ⁴	6 apps	
Satori	11	7	6 to 15.5 fl oz ⁴	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 ³	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.

¹ 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.

² Pre-harvest interval.

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

⁴ 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
TRADITIONAL ITALIAN		
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.
ASIAN TYPE		
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.
SPECIALTY		
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)	
Phosphorus	Phosphate (P₂O₅)	
Low	<31	181-240
Medium	31-60	121-180
High	61-80	61-120
Very High	>80	0-60
Potassium	Potash (K₂O)	
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: Eggplant¹

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.

¹ All recommendations assume starter fertilizer was used.

PESTICIDE SAFETY: Eggplant

INSECTICIDES	Signal ¹	Re-entry (hrs)	Harvest (days)
Acramite 50 WS	C	12	3
Actara 25 W	C	12	0
Admire Pro	C	12	0/21 ³
Assail 30 SG	C	12	7
Avant 30 DG	C	12	3
Belay 2.13 SC	C	12	7/21 ³
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 ³
Sevin XLR	W	12	3
Venom 70 SG	C	12	1/21 ³
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 ¹	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 ³
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 ²	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

¹ W: Warning, C: Caution, D: Danger, P: Poison

² Several formulations are marketed. See the general introduction for more details on fungicides.

³ PHI varies by type of application.

⁴ 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^{1,2}

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
AT PLANTING			
Aphids, Flea Beetles, Whiteflies, Colorado Potato Beetle: 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
FOLIAR TREATMENTS			
Aphids, Whiteflies			
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.
Colorado Potato Beetle: 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	-
Cutworms: 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	-
Flea Beetles: 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	-
Mites			
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
Stink bugs			
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	-

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

² 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 Sandaex 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 ¹	PHI ² (days)	Amt/A	Seasonal Limits/A	Comments
Alternaria, Anthracnose, Leaf Blights, Powdery Mildew, Phomopsis Fruit Rot					
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 ³					
Azoxy 25C	11	0	6 to 15.5 fl oz ⁴	4 apps	Anthracnose, powdery mildew. Apply before disease onset, continue every 7 to 14 days.
AzoxyStar	11	0	6 to 15.5 fl oz ⁴	4 apps	
Quadris	11	0	6 to 15.5 fl oz ⁴	4 apps	-
Satori	11	0	6 to 15.5 fl oz ⁴	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 ¹	PHI ² (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 ³	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.
Phytophthora Blight					
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	Surface application (preplant or at planting): 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. Drip application: 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.
Pythium Damping-off					
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		

¹ 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.

² Pre-harvest interval.

³ 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.) ¹	Between-row (in.)	No. rows/bed ²
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

¹ Final spacing after thinning or transplanting.

² Raised beds formed by Rainflo or similar bed shaper.

VARIETIES: Greens

Variety	Maturity (days) ¹	Comments
COLLARDS²		
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.
KALE²		
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
MUSTARD²		
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.
TURNIPS/TURNIP GREENS²		
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.
BROCCOLI RAAB (RAPINI)²		
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)
Phosphorus		Phosphate (P₂O₅)
Low	<31	121-180
Medium	31-60	1-120
High	>60	0
Potassium		Potash (K₂O)
Low	<201	101-150
Medium	201-300	51-100
High	301-450	1-50
Very High	>450	0
Nitrogen		N
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 ¹ (days)	Comments
Zamboni	60	Large flower buds and uniform bud set, spring.
LETTUCE³		
Leaf/Looseleaf		
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.
Bibb/Butterhead/Boston		
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.
Romaine/Cos		
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.
Endive/Escarole³		
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.
Spinach⁴		
FLAT LEAF		
Space	40	For trial, hybrid; smooth, dark green leaves; downy mildew resistant, slow to bolt.
SAVOY		
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.
Swiss Chard⁴		
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.

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

² (Brassicaceae)—mustard family

³ (Asteraceae)—sunflower family

⁴ (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

Anthraxnose, 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 ²	Re-entry (hrs)	Harvest Interval (days)					Turnips
			Collards	Kale	Lettuce	Mustard	Spinach	
INSECTICIDES								
Actara 25 WP	C	12	7	7	7	7	7	-
Admire Pro	C	12	7/21 ¹	7/21 ¹	7/21 ¹	7/21 ¹	7/21 ¹	7/21 ¹
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	-
Movement 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 ¹	-	7/21 ¹	-
Restricted Use								
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.

¹ PHI depends on the method of application.

² W: Warning, C: Caution, D: Danger, P: Poison

PESTICIDE SAFETY: Greens

	Signal ³	Re-entry (hrs)	Harvest (days)
FUNGICIDES			
Mustard, Turnips, Collards, Kale			
Actigard 50 WG	C	12	7
Aliette WDG ⁴	C	12	3
Cabrio EG	C	12	3
Endura	W	12	14
Fixed coppers ²	D	12/24 ¹	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 ²	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 ²	C	12	0
Switch 62.6 WG	C	12	7
Tebuconazole ²	C	12	7
Ultra Flourish	C	48	0
Zampro	C	12	0
Lettuce			
Actigard 50 WG	C	12	7
Aliette WDG ⁴	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 ²	D	24/48	1
Fontelis	C	12	3
Forum SC	C	12	0
Koverall	C	24	10
Mancozeb ²	C	24	10

PESTICIDE SAFETY: Greens

	Signal ³	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 ²	C	24	0
Switch 62.6 WG	C	12	0
Tanos	C	12	3
Zampro	C	12	0
Spinach			
Actigard 50 WG	C	12	7
Aliette WDG ⁴	C	12	3
Cabrio EG	C	12	0
Fixed coppers ²	D	24/48 ¹	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 ²	C	24	0
Tanos	C	12	1
Ultra Flourish	W	48	21
Zampro	C	12	0

¹ Varies by formulation. Check labels carefully.

² Several formulations are marketed. See the general introduction for more details on fungicides.

³ W: Warning, C: Caution, D: Danger, P: Poison

⁴ 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: Greens¹

Insecticide	Product Amt/A	Seasonal Limit/A	Comments and Other Restrictions
PREPLANT INCORPORATED			
Cutworms, Wireworms: 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.
SOIL APPLICATION			
Aphids, Whiteflies: 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	-
FOLIAR TREATMENTS			
Aphids: 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.
Flea Beetles			
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	-
Grasshoppers, Leafhoppers, Leafminers			
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: Greens¹ (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	-
Whiteflies			
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.

¹ Generic products available (Appendix E).

WEED CONTROL: Greens¹

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.

¹ 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 ¹	PHI ² (days)	Amt/A	Seasonal Limits/A	Comments
MUSTARD, TURNIP, COLLARDS, KALE					
Alternaria, Cercospora, Cercosporella Leaf Spots					
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	-	-

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DISEASE CONTROL: Greens (continued)

Product	FRAC Code ¹	PHI ² (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 ⁴	3	7			Apply preventively; can be tank-mixed with the lowest labeled rate of a surfactant.
Azoxystrobin ⁴					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 ⁵	4 apps	
AzoxyStar	11	0	6 to 15.5 fl oz ⁵	4 apps	
Quadris	11	0	6 to 15.5 fl oz ⁵	4 apps	
Satori	11	0	6 to 15.5 fl oz ⁵	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.
Black Rot					
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.
Fixed coppers					
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.
Basal Stem Rot, Root Rot, Wirestem (Rhizoctonia)					
Azoxystrobin ⁴					
Azoxy 25C	11	0	0.4 to 0.8 fl oz ³	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 ³	4 apps	
Quadris	11	0	0.4 to 0.8 fl oz ³	4 apps	-
Satori	11	0	0.4 to 0.8 fl oz ³	4 apps	-
Damping-off (Pythium)					
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		
Downy Mildew					
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 ⁶	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.
Fixed coppers					
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		-

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DISEASE CONTROL: Greens (continued)

Product	FRAC Code ¹	PHI ² (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.
Powdery Mildew					
Azoxystrobin ⁴					Apply before disease onset, continue every 7 to 14 days.
Azoxy 2SC	11	0	9 to 15.5 fl oz ⁵	3 apps	
AzoxyStar	11	0	9 to 15.5 fl oz ⁵	3 apps	
Quadris	11	0	9 to 15.5 fl oz ⁵	3 apps	
Satori	11	0	9 to 15.5 fl oz ⁵	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 ⁵	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 ⁴	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 ⁴	3	7			Apply preventively. Use lowest listed rate of surfactant to improve coverage.
Sclerotinia Stem Rot					
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.
LETTUCE					
Bottom Rot (Rhizoctonia)					
Azoxystrobin ⁴					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 ³	1 app (soil)	
AzoxyStar	11	0	0.4 to 0.8 fl oz ³	1 app (soil)	
Quadris	11	0	0.4 to 0.8 fl oz ³	1 app (soil)	
Satori	11	0	0.4 to 0.8 fl oz ³	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 ⁴					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	
Damping-off (Pythium)					
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.

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DISEASE CONTROL: Greens (continued)

Product	FRAC Code ¹	PHI ² (days)	Amt/A	Seasonal Limits/A	Comments
Downy Mildew					
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 ⁶	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 ⁴					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 ⁵	4 apps	
AzoxyStar	11	0	12 to 15.5 fl oz ⁵	4 apps	
Quadris	11	0	12 to 15.5 fl oz ⁵	4 apps	
Satori	11	0	12 to 15.5 fl oz ⁵	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.
Fixed coppers					
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.
Drop, Gray Mold					
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 ⁴					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.
SPINACH					
Damping-off (Pythium)					
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.
Downy Mildew, White Rust					
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 ⁶	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.

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DISEASE CONTROL: Greens (continued)

Product	FRAC Code ¹	PHI ² (days)	Amt/A	Seasonal Limits/A	Comments
Azoxystrobin⁴					
Azoxy 2SC	11	0	6 to 15.5 fl oz ⁵	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 ⁵	4 apps	
Quadris	11	0	6 to 15.5 fl oz ⁵	4 apps	
Satori	11	0	6 to 15.5 fl oz ⁵	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.
Fixed coppers					
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.
Leaf Spots (Anthracnose, Cercospora)					
Azoxystrobin⁴					
Azoxy 2SC	11	0	6 to 15.5 fl oz ⁵	4 apps	Apply before disease onset, continue every 7 to 14 days.
AzoxyStar	11	0	6 to 15.5 fl oz ⁵	4 apps	
Quadris	11	0	6 to 15.5 fl oz ⁵	4 apps	
Satori	11	0	6 to 15.5 fl oz ⁵	4 apps	
Cabrio	11	0	12 to 16 oz	4 apps	Apply before disease onset, continue every 7 to 14 days.
Fixed coppers					
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.

¹ 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.

² Pre-harvest interval.

³ Per 1,000 row-feet.

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

⁵ Use higher rate when pressure is severe.

⁶ Restricted in some Kentucky counties. See fungicide safety table on page 20.