ALABAMA FRUIT & VEGETABLE GROWERS ASSOCIATION

Mississippi Fruit and Vegetable Growers Association

LOUISIANA FRUIT AND VEGETABLE GROWERS ASSOCIATION

North Carolina Vegetable Growers Association

South Carolina FRUIT, VEGETABLE & SPECIALTY CROP ASSOCIATION

SOUTHEASTERN U.S. 2014 VEGETABLE CROP HANDBOOK

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Top Left:
Regional Extension Agent in Alabama working with a grower.
A. Majumdar - Alabama Cooperative Extension System

Top Center:
High Tunnel irrigation system in Georgia.
G. Boyhan - University of Georgia

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Multicolored Stalks of 'Celebration' Swiss Chard
J. Kemble - Auburn University

Middle:
Mature-green staked tomatoes in North Carolina.
J. Kemble - Auburn University

Bottom Left:
Female Squash bug laying eggs on squash.
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The purpose of this book is to provide the best and most up-to-date information available for commercial vegetable growers in the southeastern US: Alabama, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, Texas, Tennessee, South Carolina and Virginia. These recommendations are suggested guidelines for production in the above states. Factors such as markets, weather, and location may warrant modifications and/or different practices or planting dates not specifically mentioned in this book.

UPCOMING EVENTS FOR 2014

DATE/TIME	LOCATION	CONTACT/INFO
ALABAMA		
Alabama Fruit & Vegetable Growers Association Annual Conference and Trade Show		
7 to 8 Feb	Marriott Grand National, Opelika, AL	Jackie Cooper at 334-728-4117 http://www.afvga.aces.edu
Gulf Coast Fruit & Vegetable Conference		
21 Jan	Mobile, AL	James Miles at 251-574-8445 http://www.aces.edu/counties/Mobile
Regional Fruit & Vegetable Production Meetings & Field Days		
TBA (Jan-Mar)	Various locations	Contact a Commercial Horticulture Regional Extension agent http://www.aces.edu/directory/programAgentSearch.php?program=10
Commercial Horticultural Retailer (CHR) Program		
	8 Oct (Auburn, AL), 7 Nov (Birmingham), 5 Dec (Cullman)	http://www.aces.edu/anr/chr
FLORIDA		
Florida AgExpo		
5 Nov	Wimauma, FL	Christine Cooley at ccooley@ufl.edu http://flagexpo.ifas.ufl.edu
GEORGIA		
Southeast Regional Fruit & Vegetable Conference		
9 to 12 Jan	Savannah, GA	http://www.gfvga.org
Georgia Watermelon Associate Conference		
24 to 26 Jan	Sea Palms Resort, St Simons Island, GA	http://www.georgiawatermelonassociation.org
Georgia Organics Conference		
21 to 22 Feb	Jekyll Island, GA	http://georgiaorganics.org
Sunbelt Ag. Expo		
14 to 16 Oct	Moultrie, GA	http://www.sunbeltexpo.com
KENTUCKY		
2014 Kentucky Fruit & Vegetable Conference and Trade Show		
6-7 Jan	Embassy Suites Hotel, Lexington, KY	John Strang at jstrang@uky.edu http://www.kyvga.org
LOUISIANA		
Garden Fest		
21 June from 8AM to 1PM	Burden Museum and Gardens 4560 Essen Lane, Baton Rouge LA 70809	Jeff Kuehny at 225-763-3990 or jkuehny@agcenter.lsu.edu
Commercial Producers Field Days		
TBD (Mid June and late Nov)	Burden Museum and Gardens, 4560 Essen Lane, Baton Rouge LA 70809	Kiki Fontenot at 225-235-9968 or kkfontenot@agcenter.lsu.edu
MISSISSIPPI		
Greenhouse Tomato Short Course		
4-5 March	Eagle Ridge Conference Center, Raymond, MS	Rick Snyder at Rick.Snyder@msstate.edu http://greenhousetomatosc.com
Fall Flower & Garden Fest		
TBA (Oct, Friday and Saturday) 9 am to 2 pm (both days)	Truck Crops Experiment Station, 2024 Experiment Station Road, Crystal Springs, MS	Rick Snyder at Rick.Snyder@msstate.edu
Mississippi Fruit & Vegetable Growers Conference and Trade Show in conjunction with the Mississippi Agritourism Association		
TBA (Nov)	TBD (location)	Rick Snyder at Rick.Snyder@msstate.edu http://msucares.com
NORTH CAROLINA		
SE Fruit and Vegetable Expo		
2 to 4 Dec	Myrtle Beach, SC	Bonnie Hollowman at 919-334-0099 http://www.ncvga.com
Greenhouse Vegetable Growers Annual Meeting		
TBA (Annually end of Oct/Beginning Nov)	Raleigh, NC	Cathy Price at 919-334-0099 http://www.ncagr.gov/markets/assoc/ghvga
Winter Vegetable Conference and Trade Show		
19-20 Feb Starts noon Wednesday through lunch Thursday	Crowne Plaza Resort, Asheville, NC	Ellen Sprague at 828-685-3989 or ellen_moss@yahoo.com http://www.ncagr.gov/markets/commodit/horticul/tomatoes

UPCOMING EVENTS FOR 2014 (cont'd)

DATE/TIME	LOCATION	CONTACT/INFO
NORTH CAROLINA (cont'd)		
Organic Growers School		
8-9 March (Starts Saturday morning through 5pm Sunday)	University of North Carolina - Asheville	Meredith McKissick at meredith@organicgrowersschool.org http://organicgrowersschool.org
Northern Piedmont Specialty Crops School		
7 March	Person County Extension Center, 304 S. Morgan St., Roxboro, NC	Carl Cantaluppi at carl_cantaluppi@ncsu.edu http://granville.ces.ncsu.edu
Mountain Research Station Field Day		
July	Mountain Research Station, Waynesville, NC	Kaleb Rathbone at 828-456-3943 http://www.cals.ncsu.edu/agcomm/writing/Field_Days
Asparagus Twilight Meeting		
21 Aug at 6 PM	980 Flem Clayton Road, Roxboro, NC	Carl Cantaluppi at carl_cantaluppi@ncsu.edu http://granville.ces.ncsu.edu
Tomato and Vegetable Field Day		
August	Mountain Horticultural Crops Research Station, Mills River, NC	http://www.cals.ncsu.edu/agcomm/writing/Field_Days Jeanine Davis at jeanine_davis@ncsu.edu
Sweetpotato Field Day		
TBA (Sept)	Cunningham Research Station, Kinston, NC	http://www.cals.ncsu.edu/agcomm/writing/Field_Days Jonathan Schultheis at jonathan_schultheis@ncsu.edu
Cucurbit Field Day		
TBA (Sept)	Upper Mountain Research Station, Laurel Springs, NC	Travis Birdsell at travis_birdsell@ncsu.edu http://www.cals.ncsu.edu/agcomm/writing/Field_Days
OKLAHOMA		
2014 Horticulture Industry Show (HIS)		
10-11 Jan	NE Tulsa Community College (TCC), 3727 East Apache Street Tulsa, OK	Donna Dollins at (405) 744-6460 or Donna.dollins@okstate.edu http://www.hortla.okstate.edu
Oklahoma Market Gardening School		
16 Jan to 6 Mar 8 consecutive Thursday	Cleveland County OSU Extension, 601 E. Robinson, Norman, OK	Stephanie Larimer (405) 744-5404 at or Stephanie.larimer@okstate.edu http://www.hortla.okstate.edu
SOUTH CAROLINA		
Watermelon and Specialty Melon Field Day		
10 July from 8:30 am to 2:00 pm	Edisto Research and Education Center (EREC), 64 Research Road, Blackville, SC 29817	Gilbert Miller at 803-284-3343 or gmllr@clemson.edu http://www.clemson.edu/public/rec/edisto
Pumpkin Field Day		
TBA (September)	Edisto Research and Education Center (EREC), 64 Research Road, Blackville, SC 29817	Gilbert Miller at 803-284-3343 or gmllr@clemson.edu http://www.clemson.edu/public/rec/edisto
Southeastern Fruit and Vegetable Expo		
2 to 3 Dec	Kingston Plantation, Myrtle Beach, SC	Bonnie Holloman at bonnie.holloman@yahoo.com http://www.ncvga.com
TENNESSEE		
Tennessee Horticultural Expo		
30 Jan to 1 Feb	Nashville Airport Marriott, Nashville, TN	http://tnthe.com
UT Steak and Potatoes Field Day		
5 Aug	Plateau AgResearch and Education Center, Crossville, TN	http://plateau.tennessee.edu
UT Pumpkin Field Day		
25 Sept	West Tennessee AgResearch and Education Center, Jackson, TN	http://west.tennessee.edu
UT Organic Crops Field Tour		
23 Oct	East Tennessee Ag Research and Education Center, Knoxville, TN	http://east.tennessee.edu
VIRGINIA		
Eastern Shore Ag Conference and Trade Show		
7 to 8 Jan	Eastern Shore Workforce Development Center, Melfa, VA	Theresa Long at 757-787-1361 ext. 14 or tmjlong@vt.edu
Virginia Biological Farming Conference		
31 Jan to 1 Feb	Doubletree by Hilton Hotel, Richmond, VA	http://vabf.org/dates-location
Virginia Tech Eastern Shore AREC Research Field Day		
TBA (mid/late July)	Virginia Tech Eastern Shore Agricultural, Research & Extension Center, Painter, VA	Mark Reiter at 757-414-0724 ext. 16 or mreiter@vt.edu
Northern Neck Vegetable Conference		
TBA (mid-Dec)	Warsaw, VA	Stephanie Romelczyk at 804-493-8924 or sromelcz@vt.edu

Vegetable Production Information Web Sites

ALABAMA

Alabama SARE Program
http://www.southernsare.org/SARE-in-Your-State/Alabama

Alabama Cooperative Extension System
http://www.aces.edu

Commercial Vegetable Information
http://www.aces.edu/dept/com_veg

AU Plant Diagnostic Lab
http://www.aces.edu/dept/plantdiagnosticlab

AL IPM Newsletter
http://www.aces.edu/go/273

Certified Horticultural Retailer Training Program
http://www.aces.edu/anr/chr

Vegetable IPM Info
http://www.aces.edu/go/87

ARKANSAS

Arkansas Cooperative Extension Service
http://www.uaex.edu

FLORIDA

University of Florida Cooperative Extension Service
http://edis.ifas.ufl.edu

GEORGIA

University of Georgia Cooperative Extension Service
http://extension.uga.edu

UG Fruits & Vegetable Info
http://extension.uga.edu/agriculture/ag-fruits-vegetables

University of Georgia College of Agriculture and Environmental Sciences Publications
http://www.caes.uga.edu/publications

KENTUCKY

University of Kentucky Cooperative Extension Service
http://ces.ca.uky.edu/ces

LOUISIANA

Louisiana SARE Program
http://www.lasare.agcenter.lsu.edu

LSU AgCenter Research & Education
http://www.lsuagcenter.com

LSU Horticulture Pathology
http://www.lsuagcenter.com/hortpathology
http://facebook.com/HortPathology

Louisiana Fruit & Vegetable Growers Association
http://www.facebook.com/LAFVGA

MISSISSIPPI

Mississippi State University Extension Service
http://msucares.com

MS Greenhouse Tomato Production FAQ
http://msucares.com/crops/comhort/greenhouse.html

MS Greenhouse Tomato Short Course
http://greenhousetomatosc.com

MISSISSIPPI (cont'd)

Mississippi Commercial Horticulture Information
http://msucares.com/crops/comhort

Organic Fruit and Vegetable Production
http://msucares.com/crops/comhort/organic_veg_fruit.html

NORTH CAROLINA

North Carolina Cooperative Extension Service
http://www.ces.ncsu.edu

Information on Herbs, Organics, & Specialty Crops
http://ncherb.org

NCSU Vegetable Pathology
http://go.ncsu.edu/veggiepathology

NCSU Plant Disease Fact Sheets
http://www.cals.ncsu.edu/plantpath/extension/clinic/fact_sheets/index.php

North Carolina Pest News
http://ipm.ncsu.edu/current_ipm/pest_news.html

National IPM Network NC Component
http://ipm.ncsu.edu

Horticulture Information Leaflets
http://www.ces.ncsu.edu/depts/hort/hil

NC Organic Agriculture Internet Resource
http://ncorganic.org

Fresh Produce Safety
http://ncfreshproducesafety.ncsu.edu

OKLAHOMA

Oklahoma Cooperative Extension Service
http://www.oces.okstate.edu

OK Dept. of Horticulture Vegetable Info
http://www.hortla.okstate.edu/industry/vegetables/index.htm

SOUTH CAROLINA

Clemson University Cooperative Extension Service
http://www.clemson.edu/extension

TENNESSEE

University of Tennessee Extension
https://utextension.tennessee.edu

UT Vegetable Production
http://vegetables.tennessee.edu

UT Organic & Sustainable Crop Production
http://organics.tennessee.edu

UT Weed Info for HortWeeds
http://hortweeds.tennessee.edu

TEXAS

Texas Agricultural Extension Service
http://agrilifeextension.tamu.edu

VIRGINIA

Virginia Cooperative Extension
http://www.ext.vt.edu

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General Production Recommendations

VARIETIES

New varieties and strains of particular varieties of vegetables are constantly being developed throughout the world. Since it is impossible to list and describe all of them, only some of the better performing commercial types are listed in the specific crop section, either alphabetically or in order of relative maturity from early to late. These varieties are believed to be suitable for commercial production under most conditions.

The ultimate value of a variety for a particular purpose is determined by the grower, the variety's performance under his or her management, and environmental conditions. Strains of a particular variety may perform better than the standard variety under certain conditions. Several years of small trial plantings are suggested for any variety or strain not previously grown. For a true comparison, always include a standard in the same field or planting.

Disease Resistance or Tolerance. Any particular crop may deviate from the predicted response to a disease. This deviation may be due to different strains and races of disease-causing organisms and environmental conditions. Plant scientists have taken advantage of this natural variation to develop varieties that are resistant or tolerant. Superscripts appearing after the variety names refer to the disease resistance or tolerance and are spelled out in the "Abbreviations" section in the front of this book or following the listed recommended varieties.

Specialty Vegetables. Many producers are considering growing specialty or "gourmet" vegetables of which several are highly perishable crops.

A very limited number of pesticides are registered for many specialty vegetables and herbs. Successful pest control in these crops is dependent on sanitation, seed treatment, crop rotation, planting site, mechanical cultivation, and the use of resistant varieties when available.

Promising perishable crops include asparagus, Belgian endive, dandelion (blanched), kale, Swiss chard, tyfon, herbs, ethnic vegetables, red leaf lettuce, romaine lettuce, scallions, snap peas, and snow peas.

Less perishable types that offer promise are bok choy, Chinese cabbage, endive and escarole (blanched), garlic (pink skin), Japanese melons, leeks, pak choi, pepper, Irish potato (red, blue, yellow, and golden), red radicchio, rhubarb, sweet onions, and sweetpotatoes (moist and dry types with unusual color).

Miniature or baby vegetables that can be grown are beets (harvested less mature), carrots (finger and round types), cucumbers (harvested less mature), eggplant (little fingers type), Jersey Golden acorn squash (immature with blossom attached), baby lettuce, pickling corn, snap beans (small sieve types harvested less mature), summer squash (immature with blossom attached), and winter squash (Oriental and Little Dumpling).

Before planting a specialty crop, however, **growers must determine that specific retail, wholesale, restaurant, or processing markets exist.**

CROP ROTATION

Crop rotation is an effective and widely used cultural practice to prevent or reduce the buildup of populations of soil-borne plant pathogens. An effective rotation sequence includes crops from different families that are poor or non hosts of the pathogen(s) of concern. In general, the longer the rotation, the better the results; a 3- to 5-year rotation is generally recommended. However, from a practical standpoint this will depend upon the availability of land, the markets, the selection of alternate crops suited to grow in the area, the pathogen(s), and the purpose of the rotation (prevention versus reduction). When used to reduce pathogen populations, rotations of longer than 5 years may be required (see Table 1A).

SOILS AND SOIL FERTILITY

The best soils for growing vegetables are well-drained, fairly deep, and relatively high in organic matter. These soils should have good structure and have been adequately limed and fertilized for the past few years. Loamy sand and sandy loam soils are generally better suited for growing early market crops. Loam and silt loam soils are generally better suited for growing crops for later fresh-market

TABLE 1A. VEGETABLE FAMILIES

Grass Family	**Pea Family**
Sweet corn	English Pea
Popcorn	Bean (lima, snap)
Ornamental Corn	Cowpea or Southern pea
Allium Family	Soybean
Onion	**Parsley Family**
Leek	Carrot
Garlic	Parsley
Shallot	Celery
Chive	Cilantro
Goosefoot Family	**Solanaceae Family**
Beet	Irish Potato
Chard	Eggplant
Spinach	Tomato
Mustard Family	Pepper
Kale	**Gourd Family**
Collard	Pumpkin
Brussels Sprout	Squash
Cabbage	Watermelon
Cauliflower	Cucumber
Broccoli	Muskmelon
Kohlrabi	Cantaloupe
Rutabaga	**Composite Family**
Turnip	Chicory
Mustard	Endive & Escarole
Upland cress	Dandelion
Radish	Lettuce
Mallow Family	Artichoke
Okra	Jerusalem artichoke
Bindweed Family	
Sweetpotato	

use or for processing. Deep, well-drained organic soils are ideal for leafy vegetables, bulb and root crops that offer a high return per acre.

The grower who matches the crop to the soil has the best chance of producing a successful crop. For example, if a crop that requires well-drained soil is planted on poorly drained soil, it's doomed to failure regardless of a grower's other efforts.

A large percentage of the vegetables grown in mineral soils of the Coastal Plain are grown in soils with essentially no structure. At best these soils possess weak granular structures. In many areas, sand is preferred because it drains quickly so fields can be worked soon after rains or irrigation without damaging the structure of the soil.

Soil Management. In a good soil management program, proper liming and fertilization, good tillage practices, crop rotation, annual additions of organic matter with cover crops, and adequate irrigation are all necessary to maintain high levels of production. Winter cover crops and periodically resting the land with summer cover crops between vegetable plantings are essential in preventing deterioration of the soil structure. In soil management, this is vital for maintaining highly productive soils.

Nutrient Management and the Environment. The sandy soils preferred for vegetable production in the southeastern US result in an aerated root zone and enable timely tillage, planting, and harvesting. The same drainage allows water and dissolved nutrients to move through the soil profile. Even with loams or clays, nutrients retained in surface soil may be carried with sediment or as dissolved run-off to the surface waters. Nitrates and phosphorus remain the two agricultural nutrients of greatest environmental concern. Even agronomically small losses of N & P can impact water quality, especially in eco-sensitive regions. Other issues of potential concern include K fertilizer losses and accumulation of heavy metals such as copper, zinc, etc. supplied with organic amendments.

Ongoing research has documented increased costs and reduced profits, as well as natural resource degradation and human health risks, due to over-fertilization. It is therefore critical that both nutrients and irrigation are managed to optimize vegetable production while minimizing impact on the environment. Careful nutrient management includes at least the following four issues: rate, timing, placement, and source. Land-grant university recommendations are based on calibrated crop response studies that can differ substantially across the region. Producers should consult guidelines prepared specifically for their state for the most appropriate nutrient management recommendations. A well-balanced nutrient management plan represents good stewardship and should satisfy any applicable environmental regulations.

Soil Acidity and Liming. Many soils in the southeast are naturally acidic, or become acidic with cropping, and need liming to attain optimum production levels. Soil acidity is the term used to express the quantity of hydrogen (H^+) and aluminum (Al^{3+}) cations (positively charged ions) in soils. Soil pH is determined by using a 1:1 soil-to-water solution. The pH of the solution is measured by a pH meter (potentiometer). Soil pH is an indicator of "soil acidity". Combined, the use of the soil pH and soil textural class determines the lime requirement. A pH of 7.0 is defined as neutral, with values below 7.0 being acidic and above 7.0 being basic or alkaline. Root growth and plant development may be severely restricted if acidic catwions, especially aluminum, occupy a large percentage of the negatively charged soil cation exchange capacity (CEC). This negative charge is due to the chemical makeup of the soil clay and organic matter, and means that they can attract positively charged ions. Soils become acidic due to the leaching of calcium (Ca^{2+}) and magnesium (Mg^{2+}), especially in sandy coastal plain soils. Acidification also occurs when H^+ is added to soils by decomposition of plant residues and organic matter, and during the nitrification of ammonium when added to soils as fertilizer (UAN solutions, urea, ammonium nitrate, ammonium sulfate, anhydrous ammonia), manures, or plant residues. Declines of one pH unit can occur even in properly fertilized beds. The H^+ added to soils reacts with the clay minerals (aluminum silicates) and releases Al^{3+}, the most deleterious component of soil acidity. Lime is applied to neutralize soil acidity by releasing a base (HCO_3^-, OH^-) into the soil solution, which reacts with acid (H^+). Increasing soil pH reduces the concentration of dissolved aluminum, as well as influencing the concentrations of other ions.

Lime recommendations must take into account differences in acidity among soils as well as differences among various crops' tolerance to acidity. Both the soil pH and some measure of residual or exchangeable acidity are needed to calculate lime recommendations. Although portable soil test kits determine pH rapidly, it is not possible to make an accurate lime recommendation based solely on a pH measurement. Another issue to consider is that different soil laboratories may use different testing methods developed for their particular soil conditions. Due to these differences, producers should consult with their local Extension office about laboratory methods and target pH assumptions used in determining lime recommendations. Consult your state guidelines for a description of the current soil test method and interpretation guidelines.

If soil pH is too high for the desired crop, elemental sulfur (S) is the most effective soil acidulant. The amount of acidity generated by 640 pounds of elemental S is the same as that neutralized by 1 ton of lime. In addition to lime, soil pH can be lowered by applying aluminum sulfate or iron sulfate. Whether trying to increase or decrease the pH of your soil, always follow the manufacturer's instructions for appropriate rates. A slight pH reduction can be produced by using ammonium sulfate, ammonium nitrate, or urea as a fertilizer source of nitrogen.

Liming materials containing only calcium carbonate ($CaCO_3$), calcium hydroxide [$CA(OH)_2$], or calcium oxide (CaO) are called calcitic limes. Pure calcium carbonate is used as the standard for liming materials and is assigned a rating of 100 percent. This rating is also known as the "calcium carbonate equivalent, and is referred to as the CCE. All other liming materials are rated in relationship to pure calcium carbonate. Liming materials with significant amounts of magnesium carbonate ($MgCO_3$) are called dolomitic limes. Dolomitic limes should be used on soils low in magnesium, as indicated by the soil test report. It is possible to use a magnesium fertilizer instead of dolomitic lime, but the costs of this source of magnesium are almost always considerably higher. Because lime dissolves very slowly, it must be finely ground to effectively neutralize soil acidity. Lime laws in most states describe standards for composition and particles sizes.

The most commonly used liming materials are finely ground dolomitic or calcitic rock. Most agricultural lime is sold in bulk as a damp powder because dry lime is very dusty and difficult to handle and spread. However, lime is occasionally excessively wet. Lime is sold by the ton, thus be aware that you may be purchasing a substantial amount of water and should adjust lime rates accordingly. Additional liming materials include burnt lime or hydrated lime, pelleted lime, liquid lime, wood ash, ground seashells, and industrial slags. Lime pellets and lime suspensions (liquid lime) can be convenient and fast-acting, but are usually considerably more expensive than ground limestones. Industrial by-product liming materials can be useful soil amendments capable of reducing soil acidity and supply a variety of nutrients including calcium, magnesium, potassium, phosphorus, and micronutrients. Each lot of such materials should be analyzed as considerable variation in CCE, fineness, and nutrient composition may occur.

Within a one to three year time-period, lime moves little in the soil and neutralizes acidity only in the zone where it is applied. To be most effective, lime must be uniformly spread and thoroughly incorporated. In practice, rates are adjusted after checking the spreader pattern and making appropriate corrections. If the application is not correct, strips of under-limed soil could result, possibly reducing crop yields. The most commonly used lime incorporation tool is the disk. It will not incorporate lime as well as offset disks that throw the soil more vigorously. The best incorporation implement is a heavy-duty rotary tiller that mixes the soil throughout the root zone.

Lime and Fertilizer. Lime and fertilizer work together synergistically to produce high yields and better crops. Lime is not a substitute for fertilizer, and fertilizer is not a substitute for lime.

How to Use Plant Nutrient Recommendation Table #1 and #2. Use Table 1 to determine the relative levels of phosphorus and potassium in the soil based on the soil test report from the laboratory. Use Table 2 as a guide in conjunction with specific soil test results. Plant nutrient recommendations listed in Table 2 are expressed in terms of nitrogen (N), phosphate (P_2O_5), and potash (K_2O), rather than in specific grades and amounts of fertilizer. When soil test results are not available, use recommended amounts of P_2O_5 and K_2O listed under medium phosphorus and medium potassium soil test levels for the crop to be grown. When soil test results are available, the phosphate (P_2O_5) and potash (K_2O) needs for each cropping situation can be determined by selecting the appropriate values under the relative soil test levels for phosphorus and potassium: very low, low, medium, high, or very high.

The cropping and manuring history of the field must be known before a fertilization program can be planned (see Table 3). This history is very important in planning a nitrogen fertilization program, because a reliable soil test for nitrogen is not available.

Plant nutrient recommendations listed in Table 2 were developed for fields where no manure is being applied and where no legume crop is being turned under prior to the planting of a new crop. If manure and/or legume crops are being used, the plant nutrient recommendations listed in Table 2 should be reduced by the amounts of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) being contributed from these sources. See Table 3 for nutrient values for manure applications and legume crop residues.

Once the final fertilizer-plant nutrient needs are known, determine the grade and rate of fertilizer needed to fulfill these requirements. For example, if the final plant nutrient requirements that need to be added as a commercial fertilizer are 50 pounds of nitrogen (N), 100 pounds of phosphate (P_2O_5), and 150 pounds of potash (K_2O), a fertilizer with a 1-2-3 ratio, such as 5-10-15, 6-12-18, 7-14-21, is needed. Once the grade of fertilizer is selected, the quantity needed to fulfill the plant nutrient requirements can be determined by dividing the percentage of N, P_2O_5, or K_2O contained in the fertilizer into the quantity of the respective plant nutrient needed per acre and multiplying the answer by 100.

For example, if a 5-10-15 fertilizer grade is chosen to supply the 50 pounds of N, 100 pounds of P_2O_5, and 150 pounds of K_2O needed, calculate the amount of 5-10-15 fertilizer needed as follows: Divide the amount of nitrogen (N) needed per acre (50 pounds) by the percentage of N in the 5-10-15 fertilizer (5 percent), and multiply the answer (10) by 100, which equals 1,000 pounds. This same system can be used for converting any plant nutrient recommendations into grades and amounts.

NUTRIENT MANAGEMENT AND MAXIMIZING PRODUCTION

Plants remove substances from the soil and air to enable them to grow and reproduce. The specific substances they remove are termed nutrients. Certain of these are generally required in larger quantities, and termed macronutrients. Those needed in smaller quantities, micronutrients, are as important as macronutrients for achieving required metabolic processes in the plant. Most commercial fertilizers include macronutrients nitrogen (N), phosphorus (P), and/or potassium (K), expressed as a weighted percentage (N-P-K). Micronutrients may be supplied along with macronutrients.

TABLE 1. SOIL TEST INTERPRETATIONS AND RECOMMENDATIONS BASED ON SOIL TEST RESULTS

Soil Test Rating	Relative Yield without Nutrient (%)	Recommendations
Low	50–75	Annual application to produce maximum response and increase soil fertility.
Medium	75–100	Normal annual application to produce maximum yields.
High*	100	Small applications to maintain soil level. Amount suggested may be doubled and applied in alternate years.
Very high*	100	None until level drops back into high range. This rating permits growers, without risk of loss in yields, to benefit economically from high levels added in previous years. Where no P or K is applied, soils should be resampled in 2 years. When phosphorus is extremely high, further additions may limit the availability of Fe and/or Zn.

* Some states recommend that no fertilizer P or K be added when the soil test rating is either “High” or “Very High”, in order to minimize runoff in nutrient-sensitive watersheds

Nitrogen Management. Nitrogen is one of the most difficult nutrients to manage in vegetable production systems. Nitrogen is readily leached in sandy textured soils that dominate vegetable production regions of the Southeast US. Nitrogen can be immobilized by soil microbes, volatilized if not quickly incorporated, or lost via denitrification under water-saturated soil conditions. Nitrogen recommendations are based on years of fertilizer trials and yield potential. Nitrogen application timings, application methods, and sources are also commonly tested in state university fertilizer trials and have resulted in recommendations for splitting nitrogen fertilizer application for increased fertilizer use efficiency.

Heavy rainfall, higher than normal yields, and following non-legume cover crops are just a few examples where nitrogen fertilizer may be immobilized or lost from the production system. When these nitrogen reduction scenarios arise, an additional application of nitrogen is warranted. Leaf tissue testing is the best option when deciding if and how much more nitrogen is needed to meet expected yields and is described below. Leaf tissue testing can help identify any "*hidden hunger*" that might exist in the crop. A "*hidden hunger*" develops when a crop needs more of a given nutrient but has shown no deficiency symptoms. With most nutrients on most crops, responses can be obtained even though no recognizable symptoms have appeared.

Evaluating the Effectiveness of Your Fertility Program—Using Plant Analysis/Leaf Tissue Testing. Plant analysis is the chemical evaluation of essential element concentrations in plant tissue. Essential elements include those that are required to complete the life cycle of a plant. The elements carbon (C), oxygen (O), and hydrogen (H) are supplied by the atmosphere and water and generally are not considered limiting. Scientists place most emphases on essential elements supplied by soil or feeding solutions. Macronutrients — nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S) — are required in greatest quantities. Micronutrients — iron (Fe), manganese (Mn), zinc (Zn), copper (Cu), boron (B), molybdenum (Mo), and chlorine (Cl) — are required in very small quantities. Toxicities of micronutrients are equally important and yield limiting as deficiencies. Plant analysis is also effective in diagnosing toxicities of micronutrients. The interpretation of plant analysis results is based on the scientific principle that healthy plants contain predictable concentrations of essential elements.

State and private soil testing laboratories can provide nitrogen concentrations as well as those of the other macro- and micronutrients of the plant materials to aid in mid-season fertilizer application decisions. A program of periodic leaf tissue sampling and analysis will help you optimize your fertility program and often can allow you to correct deficiencies before symptoms become apparent. The best indicator samples have been identified for most economically important vegetable crops. In turn this has provided the basis for developing data for which we can compare values from our analysis to those of established, recognized values. These are called *Sufficiency Ranges* or *Critical Values*. For those crops such as tomatoes which receive the greatest research support, indicator samples have been identified by stage of growth. In tomato we have sufficiency ranges established for plant tissue samples taken at mid-bloom of the first, second, third, fourth, fifth, and sixth flower clusters.

Critical values have been defined as the concentration at which there is a 5–10% yield reduction. The use of critical values for practical interpretation has limited value. It is best suited to diagnose severe deficiencies and has little application in identifying hidden hunger. Symptoms are generally visibly evident when nutrient concentrations decrease below the critical value. Critical values play an important role in establishing lower limits of sufficiency ranges.

Sufficiency range interpretation offers significant advantages over the use of critical values. First, hidden hunger in plants can be identified since the beginning of the sufficiency range is clearly above the critical value. Sufficiency ranges also have upper limits, which provide some indication of the concentration at which the element may be in excess.

Method for Collecting Leaf Tissue Samples for Analysis

- Each vegetable crop has a specific corresponding plant part that is collected and used to determine foliar nutrient levels. Often this corresponds to sampling the most recently matured or fully expanded leaves. Careful sampling ensures the effectiveness of plant analysis as a diagnostic tool. For major crops, best indicator samples have been identified by stage of growth. For young seedlings, the entire plant is sampled 2.5 cm above the soil level. For larger plants, the most recent fully expanded or mature leaf is the best indicator of nutritional status. As some crops, including corn, approach flowering and fruiting, the best indicator of nutritional status is the leaf adjacent to the uppermost fruit (ear leaf). When unfamiliar with sampling protocol for a specific crop, it is generally acceptable to select the most recent mature leaf as the best indicator of nutritional status. Detailed information for sampling most vegetable crops can be found at http://www.ncagr.gov/agronomi/saaesd/scsb394.pdf.
- Sample from 20 to 30 plants.
- Sample across the field, from different rows, and avoid problem areas (low spots, ridges, washed out areas, etc.).
- Sample when the plants are actively growing (typically between 9 a.m. and 4 p.m.).
- Do not collect samples from water stressed plants.
- Send samples to a laboratory in a paper bag. DO NOT SEND SAMPLES IN A PLASTIC BAG. Plastic bags will cause your samples to spoil and will impact results. Contact your local Extension office for information on how to submit leaf tissue samples to you state diagnostic labs.

Phosphorus Management. Crops are very likely to respond to P fertilization when the soil test indicates that P is *deficient—very low* or *low*. A soil testing *deficient—medium* will sometimes respond to P fertilization and will sometimes not. Soils testing *optimum* or *exceeds crops needs* are unlikely to respond to P fertilizer, but P may be applied to maintain the fertility level in the *optimum* range. Crops are more likely to respond to P fertilizer when growing conditions are favorable for high yields.

It is often recommended that a band of P fertilizer be placed near the seed as a starter fertilizer regardless of the P fertility level. Banded P is especially helpful at low soil test levels. Even at P soil test levels that exceed crop needs, a small amount of banded P may benefit crop establishment. When the soil test level is *deficient*, P should generally be applied as a combination of broadcast and banded methods. When the level exceeds crop needs, only a small amount of P should be applied as a band. Many soils test exceeds crop needs category for P due to previous fertilizer and manure applications. When applied in excess of crop removal, P accumulates in the soil. Phosphorus is strongly adsorbed to soil particles and very little is subject to loss via leaching. When the soil test level exceeds crop needs, growers can benefit economically by withholding P fertilizers.

Potassium Management. Crops are very likely to respond to K fertilizer when the soil test indicates that K is *deficient—very low* or *low*. A soil testing *deficient—medium* in K may or may not respond to K fertilizer. Crops are more responsive to K when growing under drought stress or when growing under favorable conditions. Soils testing *optimum* or *exceeds crop needs* are unlikely to respond to K fertilizer, but K may be applied to maintain the soil fertility level in the *optimum* range.

In general, most of the K fertilizer should be broadcast. When the fertility level is *deficient*, it may be advantageous to apply a portion of the total K application as a band. There is generally no benefit to applying banded K when soil fertility levels are *optimum* or *exceeds crop needs*. Crops remove larger amounts of K than P from the soil during a growing season. In addition, sandy soils have low reserves of K, and K is susceptible to leaching. Therefore, frequent applications of K are needed to maintain K at an optimum fertility level.

Secondary Nutrients. Calcium (Ca), magnesium (Mg), and sulfur (S) are included in the secondary element group. Calcium may be deficient in some soils that have not been properly limed, where excessive potash fertilizer has been used, and/or where crops are subjected to drought stress. Magnesium is the most likely of these elements to be deficient in vegetable soils. Dolomitic or high-magnesium limestones should be used when liming soils that are low in magnesium. Magnesium should be applied as a fertilizer source on low-magnesium soils where lime is not needed (Table 4). Magnesium may be applied as a foliar spray to supply magnesium to the crop in emergency situations (2 TBSP of Epsom salts per gallon of water).

Sulfur is known to be deficient in vegetable crop soils in coastal plain soils. Sulfur deficiencies may develop as more air pollution controls are installed and with the continued use of high-analysis fertilizers that are low in sulfur content.

Micronutrients. Boron is the most widely deficient micronutrient in vegetable crop soils. Deficiencies of this element are most likely to occur in the following crops: asparagus, most bulb and root crops, cole crops, and tomatoes. Excessive amounts of boron can be toxic to plant growth. This problem can occur when snap beans (a sensitive crop) follow sweetpotatoes (a crop where boron is applied late in the season). Do NOT exceed recommendations listed in Table 2.

Manganese deficiency often occurs in plants growing on soils that have been overlimed. In this case, broadcast 20 to 30 pounds or band 4 to 8 pounds of manganese sulfate to correct this. Do not apply lime or poultry manure to such soils until the pH has dropped below 6.5, and be careful not to overlime again.

Molybdenum deficiency of cauliflower (which causes whiptail) may develop when this crop is grown on soils more acid than pH 5.5. An application of 0.5 to 1 pound of sodium or ammonium molybdate per acre will usually correct this. Liming acid soils to a pH of 6.0 to 6.5 will usually prevent the development of molybdenum deficiencies in vegetable crops.

Deficiencies of other micronutrients in vegetable crops in the Southeast are rare; and when present, are usually caused by overliming or other poor soil management practices. Contact Extension if a deficiency of zinc, iron, copper, or chlorine is suspected. Sources of fertilizers for the essential plant nutrients are found in Table 4.

Municipal Biosoilds. *Biosolids Should Not Be Applied to Land on Which Crops Will Be Grown That Will Be Entering the Human Food Chain.* Municipal biosolids are the solid material removed from sewage in treatment processes. Biosolids treated by one of the digestive or similar processes to reduce pathogens is a low-analysis fertilizer suitable for application to nonfood crops under specific soil conditions. It should not be applied to sloping land, to highly leachable soils, to poorly drained soils, to soils with high water tables or near surface water, or to soils having a pH less than 6.2. Check with your local or state department of environmental management for latest regulations. The time required to wait prior to planting a food crop varies from state to state.

Foliar Fertilization. Foliar feeding of vegetables is usually not needed. Plants usually obtain their nutrients from the soil through their roots. It is known that plants can also absorb a limited amount of some nutrients through aerial organs such as leaves. Properly managed soils are usually able to supply the essential mineral nutrients the crop will need during its development. If, for some reason, one or more soil-supplied nutrients becomes limiting or unavailable during the development of the crop, foliar nutrient applications may then be advantageous but likely only with the micronutrients.

TABLE 2. GENERAL FERTILIZER SUGGESTIONS FOR VEGETABLE CROPS*

CROP	Desirable pH	Nitrogen (N) lb/acre	Recommended Nutrients Based on Soil Tests								Nutrient Timing and Method
			Soil Phosphorus Level				Soil Potassium Level				
			Low	Med	High	Very High	Low	Med	High	Very High	
			P_2O_5 lb/acre				K_2O lb/acre				
ASPARAGUS											
	6.5 to 7.0	100	250	150	100	0	250	225	150	0	Total recommended.
		50	250	150	100	0	150	100	75	0	Broadcast before cutting season.
		50	0	0	0	0	100	125	75	0	Sidedress after cutting.
		Apply 2 lb boron (B) per acre every 3 years on most soils.									
BEAN, Lima											
...Single crop	6 to 6.5	70 to 110	120	80	40	20	160	120	80	20	Total recommended.
		25 to 50	80	40	20	0	120	80	60	0	Broadcast and disk-in.
		20	40	40	20	20	40	40	20	20	Band-place with planter.
		25 to 40	0	0	0	0	0	0	0	0	Sidedress 3 to 5 weeks after emergence.
BEAN, Snap											
	6 to 6.5	40 to 80	80	60	40	20	80	60	40	20	Total recommended.
		20 to 40	40	40	0	0	40	40	0	0	Broadcast and disk-in.
		20 to 40	40	20	40	20	40	20	40	20	Band-place with planter.
BEET											
	6 to 6.5	75 to 100	150	100	50	0	150	100	50	0	Total recommended.
		50	150	100	50	0	150	100	50	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress 4 to 6 weeks after planting.
		Apply 2 to 3 lb boron (B) per acre with broadcast fertilizer.									
BROCCOLI											
	6 to 6.5	125 to 175	200	100	50	0	200	100	50	0	Total recommended.
		50 to 100	150	100	50	0	150	100	50	0	Broadcast and disk-in.
		50	50	0	0	0	50	0	0	0	Sidedress 2 to 3 weeks after planting.
		25	0	0	0	0	0	0	0	0	Sidedress every 2 to 3 weeks after initial sidedressing.
		Apply 2 to 3 lb boron (B) per acre with broadcast fertilizer.									
BRUSSEL SPROUTS, CABBAGE, and CAULIFLOWER											
	6 to 6.5	100 to 175	200	100	50	0	200	100	50	0	Total recommended.
		50 to 75	200	100	50	0	200	100	50	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress 2 to 3 weeks after planting.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress if needed, according to weather.
		Apply 2 to 3 lb boron (B) per acre and molybdenum per acre as 0.5 lb sodium molybdate per acre with broadcast fertilizer.									
CARROT											
	6 to 6.5	50 to 80	150	100	50	0	150	100	50	0	Total recommended.
		50	150	100	50	0	150	100	50	0	Broadcast and disk-in.
		25 to 30	0	0	0	0	0	0	0	0	Sidedress if needed.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilzer.									
CUCUMBER											
...Bareground	6 to 6.5	80 to160	150	100	50	25	200	150	100	25	Total recommended.
		40 to 100	125	75	25	0	175	125	75	0	Broadcast and disk-in.
		20 to 30	25	25	25	25	25	25	25	25	Band-place with planter 7 to 14 days after planting.
		20 to 30	0	0	0	0	0	0	0	0	Sidedress when vines begin to run, or apply in irrigation water.
...Plasticulture		120 to 150	150	100	50	25	150	100	50	25	Total recommended.
		25	125	25	25	0	150	100	50	0	Broadcast and disk-in.
		95 to 125	0	0	0	0	0	0	0	25	Fertigate
		Drip fertilization: See “cucumber” in specific recommendations later in this handbook.									
EGGPLANT											
...Bareground	6 to 6.5	100 to 200	250	150	100	0	250	150	100	0	Total recommended.
		50 to 100	250	150	100	0	250	150	100	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress 3 to 4 weeks after planting.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress 6 to 8 weeks after planting.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer.									
...Plasticulture		145	250	150	100	0	240	170	100	0	Total recommended.
		50	250	150	100	0	100	100	100	0	Broadcast and disk-in.
		95	0	0	0	0	140	70	0	0	Fertigate.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer. Drip fertilization: See “eggplant” in specific recommendations later in this handbook.									

* Nitrogen rates should be based on your local fertilizer recommendations.

TABLE 2. GENERAL FERTILIZER SUGGESTIONS FOR VEGETABLE CROPS* (cont'd)

CROP	Desirable pH	Nitrogen (N) lb/acre	Recommended Nutrients Based on Soil Tests								Nutrient Timing and Method
			Soil Phosphorus Level				Soil Potassium Level				
			Low	Med	High	Very High	Low	Med	High	Very High	
			P_2O_5 lb/acre				K_2O lb/acre				
ENDIVE, ESCAROLE, LEAF AND ROMAINE LETTUCE											
	6 to 6.5	75 to 150	200	150	100	0	200	150	100	0	Total recommended.
		50 to 100	200	150	100	0	200	150	100	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress 3 to 5 weeks after planting.
ICEBERG LETTUCE											
	6 to 6.5	85 to 175	200	150	100	0	200	150	100	0	Total recommended.
		60 to 80	200	150	100	0	200	150	100	0	Broadcast and disk-in.
		25 to 30	0	0	0	0	0	0	0	0	Sidedress 3 times beginning 2 weeks after planting.
LEAFY GREENS, COLLARD, KALE, and MUSTARD											
	6 to 6.5	75 to 80	150	100	50	0	150	100	50	0	Total recommended.
		50	150	100	50	0	150	100	50	0	Broadcast and disk-in.
		25 to 30	0	0	0	0	0	0	0	0	Sidedress, if needed.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer.									
LEEK											
	6 to 6.5	75 to 125	200	150	100	0	200	150	100	0	Total recommended.
		50 to 75	200	150	100	0	200	150	100	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress 3 to 4 weeks after planting, if needed.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer.									
CANTALOUPES & MIXED MELONS											
...Bareground	6 to 6.5	75 to 115	150	100	50	25	200	150	100	25	Total recommended.
		25 to 50	125	75	25	0	175	125	75	0	Broadcast and disk-in.
		25	25	25	25	25	25	25	25	25	Band-place with planter.
		25 to 40	0	0	0	0	0	0	0	0	Sidedress when vines start to run.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer.									
...Plasticulture		75 to 150	125	75	25	25	200	150	100	25	Total recommended.
		25	125	75	25	0	100	75	50	25	Broadcast and disk-in.
		50 to 100	0	0	0	25	100	75	50	0	Fertigate.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer. Drip fertilization: See "cantaloupe" in specific commodity recommendations later in this handbook.									
OKRA											
	6 to 6.5	100 to 200	250	150	100	0	250	150	100	0	Total recommended.
		50 to 100	250	150	100	0	250	150	100	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress 3 to 4 weeks after planting.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress 6 to 8 weeks after planting.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer.									
		NOTE: Where plastic mulches are being used, broadcast 50 to 100 lb nitrogen (N) per acre with recommended P_2O_5 and K_2O and disk incorporate prior to laying mulch. Drip fertilization: See "okra" in specific commodity recommendations later in this handbook.									
ONION											
...Bulb	6 to 6.5	125 to 150	200	100	50	0	200	100	50	0	Total recommended.
		50 to 75	200	100	50	0	200	100	50	0	Broadcast and disk-in.
		75 to 100	0	0	0	0	0	0	0	0	Sidedress twice 4 to 5 weeks apart.
		Apply 1 to 2 lb boron (B) and 20 lb sulfur (S) per acre with broadcast fertilizer.									
...Green		150 to 175	200	100	50	0	200	100	50	0	Total recommended.
		50 to 75	200	100	50	0	200	100	50	0	Broadcast and disk-in.
		50	0	0	0	0	0	0	0	0	Sidedress 4 to 5 weeks after planting.
		50	0	0	0	0	0	0	0	0	Sidedress 3 to 4 weeks before harvest.
		Apply 1 to 2 lb boron (B) and 20 lb sulfur (S) per acre with broadcast fertilizer.									
PARSLEY											
	6 to 6.5	100 to 175	200	150	100	0	200	150	100	0	Total recommended.
		50 to75	200	150	100	0	200	150	100	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress after first cutting.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress after each additional cutting.

* Nitrogen rates should be based on your local fertilizer recommendations.

TABLE 2. GENERAL FERTILIZER SUGGESTIONS FOR VEGETABLE CROPS* (cont'd)

CROP	Desirable pH	Nitrogen (N) lb/acre	Recommended Nutrients Based on Soil Tests								Nutrient Timing and Method
			Soil Phosphorus Level				Soil Potassium Level				
			Low	Med	High	Very High	Low	Med	High	Very High	
			P_2O_5 lb/acre				K_2O lb/acre				
PARSNIP											
	6 to 6.5	50 to 100	150	100	50	0	150	100	50	0	Total recommended.
		25 to 50	150	100	50	0	150	100	50	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress 4 to 5 weeks after planting.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer.									
PEA, English											
	5.8 to 6.5	40 to 60	120	80	40	0	120	80	40	0	Total recommended. Broadcast and disk-in before seeding.
PEA, Southern											
	5.8 to 6.5	16	96	48	0	0	96	48	0	0	Broadcast and disk-in.
PEPPER											
...Bareground	6 to 6.5	100 to 130	200	150	100	0	200	150	100	0	Total recommended.
		50	200	150	100	0	200	150	100	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress after first fruit set.
		25 to 30	0	0	0	0	0	0	0	0	Sidedress later in season, if needed.
...Plasticulture		100 to 185	320	250	100	0	350	250	100	40	Total recommended.
		50	200	150	100	0	200	150	100	40	Broadcast and disk-in.
		50 to 135	120	100	0	0	150	100	0	0	Fertigate.
		Drip fertilization: See "pepper" in specific commodity recommendations later in this handbook.									
POTATO, Irish											
...Loams and silt loams	5.8 to 6.2	100 to 150	110	90	70	50	200	150	50	50	Total recommended.
		85 to 135	60	40	20	0	200	150	50	50	Broadcast and disk-in.
		15	50	50	50	50	0	0	0	0	Band-place with planter at planting.
...Sandy loams and loamy sands		150	200	150	100	50	300	200	100	50	Total recommended.
		50	200	150	100	50	300	200	100	50	Broadcast and disk-in.
		100	0	0	0	0	0	0	0	0	Sidedress 4 to 5 weeks after planting.
PUMPKIN and WINTER SQUASH											
...Bareground	6 to 6.5	80 to 90	150	100	50	0	200	150	100	0	Total recommended.
		40 to 50	150	100	50	0	200	150	100	0	Broadcast and disk-in.
		40 to 45	0	0	0	0	0	0	0	0	Sidedress when vines begin to run.
...Plasticulture		80 to 150	150	100	50	0	200	150	100	0	Total recommended.
		25 to 50	150	100	50	0	100	75	50	0	Disk in row.
		55 to 100	0	0	0	0	100	75	50	0	Fertigation.
RADISH											
	6 to 6.5	50	150	100	50	0	150	100	50	0	Total recommended. Broadcast and disk-in.
		Apply 1 2 lb boron (B) per acre with broadcast fertilizer.									
RUTABAGA and TURNIP											
	6 to 6.5	50 to 75	150	100	50	0	150	100	50	0	Total recommended.
		25 to 50	150	100	50	0	150	100	50	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress when plants are 4 to 6 in. tall.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer.									
SPINACH											
...Fall	6 to 6.5	75 to 125	200	150	100	0	200	150	100	0	Total recommended.
		50 to 75	200	150	100	0	200	150	100	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Sidedress or topdress.
...Overwinter		80 to 120	0	0	0	0	0	0	0	0	Total recommended for spring application to an overwintered crop.
		50 to 80	0	0	0	0	0	0	0	0	Apply in late February.
		30 to 40	0	0	0	0	0	0	0	0	Apply in late March.
SQUASH, Summer											
	6 to 6.5	100 to 130	150	100	50	0	150	100	50	0	Total recommended.
		25 to 50	150	100	50	0	150	100	50	0	Broadcast and disk-in.
		50	0	0	0	0	0	0	0	0	Sidedress when vines start to run.
		25 to 30	0	0	0	0	0	0	0	0	Apply through irrigation system.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer.									
		Drip fertilization: See "summer squash" in specific commodity recommendations later in this handbook.									

* Nitrogen rates should be based on your local fertilizer recommendations.

TABLE 2. GENERAL FERTILIZER SUGGESTIONS FOR VEGETABLE CROPS* (cont'd)

CROP	Desirable pH	Nitrogen (N) lb/acre	Recommended Nutrients Based on Soil Tests								Nutrient Timing and Method
			Soil Phosphorus Level				Soil Potassium Level				
			Low	Med	High	Very High	Low	Med	High	Very High	
			P_2O_5 lb/acre				K_2O lb/acre				
SWEET CORN											
	6 to 6.5	110 to 155	160	120	80	20	160	120	80	20	Total recommended.
		40 to 60	120	100	60	0	120	100	60	0	Broadcast before planting.
		20	40	20	20	20	40	20	20	20	Band-place with planter.
		50 to 75	0	0	0	0	0	0	0	0	Sidedress when corn is 12 to 18 in. tall.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer. NOTE: On very light sandy soils, sidedress 40 lb N per acre when corn is 6 in. tall and another 40 lb N per acre when corn is 12 to 18 in. tall.									
SWEETPOTATO											
	5.8 to 6.2	50 to 80	200	100	50	0	300	200	150	120	Total recommended.
		0	150	60	30	0	150	50	30	0	Broadcast and disk-in.
		50 to 80	50	40	20	0	150	150	120	120	Sidedress 21 to 28 days after planting.
		Add 0.5 lb of actual boron (B) per acre 40 to 80 days after transplant.									
TOMATO											
...Bareground for Sandy loams and loamy sands	6 to 6.5	80 to 90	200	150	100	0	300	200	100	0	Total recommended.
		40 to 45	200	150	100	0	300	200	100	0	Broadcast and disk-in.
		40 to 45	0	0	0	0	0	0	0	0	Sidedress when first fruits are set as needed.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer.									
... Bareground for Loam and clay		75 to 80	200	150	100	0	250	150	100	0	Total recommended.
		50	200	150	100	0	250	150	100	0	Broadcast and plow down.
		25 to 30	0	0	0	0	0	0	0	0	Sidedress when first fruits are set as needed.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer.									
...Plasticulture	6 to 6.5	130 to 210	200	150	100	0	420	325	275	0	Total recommended.
		50	200	150	100	0	125	125	125	0	Broadcast and disk-in.
		80 to 160	0	0	0	0	295	220	150	0	Fertigate.
		Apply 1 to 2 lb boron (B) per acre with broadcast fertilizer. Drip fertilization: See "tomato" in specific commodity recommendations later in this handbook.									
WATERMELON											
...Nonirrigated	6 to 6.5	75 to 90	150	100	50	0	200	150	100	0	Total recommended.
		50	150	100	50	0	200	150	100	0	Broadcast and disk-in.
		25 to 40	0	0	0	0	0	0	0	0	Topdress when vines start to run.
...Irrigated		100 to 150	150	100	50	0	200	150	100	0	Total recommended.
		50	150	100	50	0	150	150	100	0	Broadcast and disk-in.
		25 to 50	0	0	0	0	0	0	0	0	Topdress when vines start to run.
		25 to 50	0	0	0	0	0	0	0	0	Topdress at first fruit set.
...Plasticulture		125 to 150	150	100	50	0	200	150	100	0	Total recommended.
		25 to 50	150	100	50	0	100	75	50	0	Disk in row.
		100	0	0	0	0	100	75	50	0	Fertigation.
		NOTE:Excessive rates of N may increase the incidence of hollow heart in seedless watermelon. Drip fertilization: See "watermelon" in specific commodity recommendations later in this handbook.									

* Nitrogen rates should be based on your local fertilizer recommendations.

MINIMUM TILLAGE FOR VEGETABLE PRODUCTION

The development of various types of tillage practices was an integral part of the evolution of modern farming practices. Tillage is helpful in crop production systems for purposes of weed management, incorporation of amendments such as lime and fertilizer, burial of crop residues to facilitate other field operations, disease management and the preparation of a seedbed that is conducive to crop establishment. While the use of tillage practices provides a number of benefits to crop producers, agronomists have also learned that the soil disturbance associated with tillage has some drawbacks. In a nutshell, tillage over time results in the degradation of several soil properties that are important to crop productivity.

One of these properties is organic matter content. Organic matter is important because it contributes appreciably to the water and nutrient holding capacity of soil and to the maintenance of a desirable soil structure. These soil properties, in turn, allow soil to better support the weight of equipment and workers. In warm southern climates the loss of organic matter due to tillage is even more pronounced than in cooler climates. Tilled soil is also less hospitable

TABLE 3. NUTRIENT VALUES FOR MANURE APPLICATIONS AND CROP RESIDUES

	N	P_2O_5	K_2O		N	P_2O_5	K_2O
	Pounds per Ton				Pounds per Ton		
Cattle manure	5-10[1]	3	3	Ladino clover sod	60	0	0
Poultry manure	25-50[1]	20	10	Crimson clover sod	50	0	0
Pig manure	5-10[1]	2	2	Red clover sod	40	0	0
Horse manure	6-12[1]	3	6	Birdsfoot trefoil	40	0	0
Liquid poultry manure (5 - 15% solids)	7-15[1]	5-10	5-10	Lespedeza	20	0	0
Alfalfa sod	50-100[2]	0	0	Soybeans			
Hairy vetch	50-100	0	0	Tops and roots	40	0	0
				Grain harvest residue	15	0	0

[1] Lower values for fall - and winter - applied manure and higher values for spring - applied manure. Use these figures only if manure being used has not been analyzed.
[2] 75% stand = 100 - 0 - 0, 50% stand = 75 - 0 - 0, and 25% stand = 50 - 0 - 0.

TABLE 4. PERCENTAGE EQUIVALENTS AND CONVERSION FACTORS FOR MAJOR, SECONDARY, AND MICRONUTRIENT FERTILIZER SOURCES

Fertilizer Source Material	Plant Food Contents,%	Lb of Material Required to Supply 1 Lb of the Initially Listed Plant Nutrient
Nitrogen Materials		
Monoammonium phosphate*	11 (N) and 48 (P_2O_5)	9.1
Nitrate of potash*	13 (N) and 44 (K_2O)	7.7
Nitrate of soda-potash*	15 (N) and 14 (K_2O)	6.7
Calcium nitrate*	15 (N) and 19 (Ca)	6.7
Nitrate of soda	16 (N)	6.3
Diammonium phosphate*	18 (N) and 46 (P_2O_5)	5.6
Nitrogen solution	20 (N)	5.0
Ammonium sulfate*	20.5 (N) and 23 (S)	4.9
Nitrogen solution	30 (N)	3.3
Nitrogen solution	32 (N)	3.1
Ammonium nitrate	33.5-34.0 (N)	3.0
Nitrogen solution	40 (N)	2.5
Urea	45-46 (N)	2.2
Anhydrous ammonia	82 (N)	1.2
Phosphorus Materials		
Normal superphosphate*	20 (P_2O_5) and 11 (S)	5.0
Triple superphosphate*	44-46 (P_2O_5)	2.2
Monoammmonium phosphate*	11 (N) and 48 (P_2O_5)	2.1
Diammonium phosphate*	18 (N) and 46 (P_2O_5)	2.2
Potassium Materials		
Nitrate of soda-potash*	13 (N) and 14 (K_2O)	7.1
Sulfate of potash-magnesia*	21.8 (K_2O) and 11.1 (Mg)	4.6
Nitrate of potash*	13 (N) and 44 (K_2O)	2.3
Sulfate of potash*	50 (K_2O) and 17 (S)	2.0
Muriate of potash*	60 (K_2O)	1.7
Magnesium Materials		
Epsom salts*	10 (Mg) and 13 (S)	9.6
Sulfate of potash-magnesia*	21.8 (K_2O) and 11.1 (Mg)	9.0
Kieserite*	18.1 (Mg)	5.5
Brucite	39 (Mg)	2.6
Sulphur Materials		
Granulated sulfur	90-92 (S)	1.1
Ammonium sulfate*	23 (S) and 20.5 (N)	4.3
Gypsum*	15-18 (S) and 19-23 (Ca)	6.1
Epsom salts*	13 (S) and 10 (Mg)	7.7
Boron Materials		
Fertilizer Borate Granular*	14.30 (B)	7.0
Fertilizer Borate-48	14.91 (B)	6.7
Solubor	20.50 (B)	4.9
Fertilizer Borate-68	21.13 (B)	4.7
Manganese Materials		
Manganese sulfate*	24.0 (Mn)	4.2
Manganese sulfate*	25.5 (Mn)	3.9
Manganese sulfate*	29.1 (Mn)	3.4
Manganese oxide	48.0 (Mn)	2.1
Manganese oxide	55.0 (Mn)	1.8
Zinc Materials		
Zinc sulfate*	36 (Zn)	2.8
Zinc oxide	73 (Zn)	1.4
Molybdenum Materials		
Sodium molybdate	39.5 (Mo)	2.5
Sodium molybdate	46.6 (Mo)	2.1
Ammonium molybdate*	56.5 (Mo)	1.8

* Supplies more than one essential nutrient.

to a variety of soil organisms including microbes, insects and other small animals. When present in adequate numbers these are beneficial for various reasons. When minimum tillage is used, soil structure is improved by the release of exudates of various organisms that glue soil particles together into larger, more desirable aggregates, plant roots benefit from the increased presence of pore spaces in the soil such as earthworm channels, and plant diseases may also be reduced by the increased diversity of soil microorganisms.

Adoption of minimum tillage in vegetable production is possible but requires careful planning and preparation. Making a transition to minimum tillage will affect a number of vegetable production field operations. For example, one common objective of minimum tillage is to retain crop residues on the soil surface. These residues are beneficial for reducing soil erosion but also may interfere with the seeding of crops, particularly small-seeded vegetable crops. Similarly, cultivation, often an important measure for controlling weeds in vegetables, may require different equipment than what the farmer is able to use in conventionally tilled fields. In general, it may be best to start with those vegetables that are grown similarly to agronomic row crops or to use crops that can be established by transplanting through crop residues. Row crop examples include sweet corn and cowpeas. Examples of vegetables that are easily transplanted include tomato, pepper, squash and watermelon. By starting with these crops there will likely be more minimum-tillage technology available, which will give the grower more flexibility as the transition is made to minimum tillage.

Growers interested in adopting minimum tillage practices should begin by learning about the practices currently employed by agronomic crop producers and others who grow vegetables using reduced tillage. One such practice is to limit tillage and seedbed preparation to a narrow strip where the crop will be planted. This may be done in combination with the use of cover crops that are killed by rolling and crimping prior to tilling the strip. This method has been used successfully for vegetables such as tomatoes and cucurbits.

Additional Resources

Reduced Tillage Fact Sheet #1: Zone Tillage. (2007) By J. Idowu, A. Rangarajan, H. van Es and B. Schindelbeck. http://www.vegetables.cornell.edu/reducedtillage/ZTFactSheet_1.pdf

Minimum Tillage Vegetable Production in California. (2004) By J. Mitchell, L. Jackson and G. Miyao. http://anrcatalog.ucdavis.edu/pdf/8132.pdf

No-till Cropping Systems in Oklahoma. (2007) J. Malone, Editor. http://notill.okstate.edu/publications/notillcroppingsystemsoklahoma/index.htm

Reduced Tillage and Cover Cropping Systems for Organic Vegetable Production. (2007) M. Schonbeck and R. Morris. http://vabf.files.wordpress.com/2012/03/reducedtillage_sm.pdf

COVER CROPS

Many soils that are not productive due to poor physical properties can be restored and made more productive through the continued use of cover crops. Using cover crops can reduce or limit the buildup of many soilborne disease and insect pests that damage vegetable crops.

With intensive cropping, working the soil when it is too wet and excessive traffic from using heavy-tillage equipment all will contribute to severely damaging soils. These practices cause soils to become hard and compact, resulting in poor seed germination, loss of transplants, and shallow root formation of surviving plants. Such soils can easily form crusts becoming compact, making them difficult to irrigate properly. Combined, all of these practices will yield negative consequences for your soil; poor plant stands, poor crop growth, low yields, and loss of income. In some cases, subsoiling in the row might help improve aeration and drainage but its effect is limited and short term. Continued and dedicated use of cover crops will aid in preventing these conditions.

Cover crops can also be planted in strips for wind protection during the early part of the next growing season. Annual rye seeded before November can be a good choice for use in wind protection. Cover crops reduce nutrient loss during the winter and early spring. When using a cover crop, covers crops should be disked or plowed before they seriously deplete soil moisture.

Seeding dates suggested in the following section are for the central part of the Southeastern United States and will vary with elevation and northern or southern locations. For state specific recommendations for planting dates for cover crops, consult your local Extension office.

Summer Cover Crops

Summer cover crops can be useful in controlling weeds, soil borne diseases, and nematodes. They also provide organic matter and can improve soil tilth while reducing soil erosion. There are many potential summer cover crops available but you will need to find one that will work well in your area and into your overall production scheme. Sudex (sorghum-sudan grass cross) (do not allow to exceed 3 ft. before mowing), southern peas (cowpeas), millet, and Lab Lab are summer cover crops that provide organic matter, control erosion and will enhance the natural biota of your soil.

Summer cover crops, such as sudangrass or sudex, seeded at 20 to 40 pounds per acre are good green manure crops. Sunhemp and pearl millet also provide a good green manure; can be planted as early as field corn is planted and as late as 15 August. These crops should be clipped, mowed, or disked to prevent seed development that could lead to weed problems. Summer cover crops can be disked and planted to wheat or rye in September or allowed to winter-kill and tilled-in the following spring.

Soil test to determine lime and fertilizer needs. For state specific recommendations for planting dates, seeding dates and management for cover crops, consult your local Extension office.

Types of Summer Cover Crops: Small Grains
SEEDING RATES AND DEPTHS

SORGHUM-SUDANGRASS: broadcast 50 to 60 lbs/A; drill 45 to 50 lbs/A (seeding depth: ½ - 1½ in.)

SUDANGRASS: broadcast 40 to 50 lbs/A; drill 35 to 40 lbs/A (seeding depth: ½ - 1 in.)

JAPANESE MILLET: broadcast 25 to 35 lbs/A; drill 20 to 25 lbs/A (seeding depth: ½ - 1 in.)

GERMAN FOXTAIL MILLET: broadcast 30 to 40 lbs/A; drill 25 to 30 lbs/A (seeding depth: ½-1 in.)

PEARL MILLET: broadcast 10-25 lbs/acre; drill 5 to 15 lbs/acre (seeding depth: ½ - 1 in.)

BUCKWHEAT: broadcast 50 to 100 lbs/A; drill 30 to 90 lbs/A (seeding depth: ½ in.)

Types of Summer Cover Crops: Legumes
SEEDING RATES AND DEPTHS

COWPEAS: broadcast 70 to 120 lbs/A; drill 40 to 50 lbs/A (seeding depth: 1- 1½ in.)

SESBANIA: broadcast 25 to 40 lbs/A; drill 20 to 25 lbs/A (seeding depth: ½ - 1 in.)

SOYBEAN: broadcast 80 to 100 lbs/A; drill 60 to 80 lbs/A (seeding depth: 1- 1½ in.)

SUNNHEMP: broadcast 30 to 40 lbs/A; drill 25 to 35 lbs/A (seeding depth: ½ - 1 in.)

VELVETBEAN: broadcast 30 to 40 lbs/A; drill 25 to 35 lbs/A (seeding depth: ½ - 1½ in.)

LAB LAB: broadcast 50 to 60 lbs/A; drill 40 to 45 lbs/A (seeding depth: ½ - 1½ in.)

For further information on summer cove crops, refer to "Summer Cover Crops" by N. Creamer and K. Baldwin at http://www.ces.ncsu.edu/depts/hort/hil/hil-37.html

Winter Cover Crops

Choosing a grass cover crop is a little easier than choosing a legume. Rye, triticale, barley, wheat, oats, and ryegrass can be planted in the fall; expect to harvest or plow under anywhere from 1/2 ton to 4 tons of dry matter per acre. Soil test to determine lime and fertilizer needs.

Types Of Winter Cover Crops: Small Grains

RYE: Rye is probably used more as a winter cover than any other grain. Rye can be sown from late September through mid-November. Most ryes will grow well in the fall (even late fall) and in late winter/early spring. This makes rye a top choice for farmers who have late-season vegetable crops with little time left before winter to sow a cover. Spring growth provides excellent biomass to turn under for use in early potatoes, Cole crops, etc. Rye also provides a forage source for grazing animals and a straw source if harvested before mature seeds are formed or after rye seed harvest (typical seeding rate: 60-120 lbs/A).

BARLEY: Barley provides an excellent source of biomass in the spring. It grows shorter than rye, will tiller, and potentially produces as much straw/forage/plow-down as rye. Barley takes longer to catch up with equivalent rye biomass in the spring, and the possibility of winter kill will be greater with barley. Late fall planting of barley will often result in winter kill. Plant in September or early October for greatest survival (typical seeding rate: 80-120 lbs/A broadcast; 60-110 lbs/A drilled).

WHEAT: Using wheat as a cover crop works well and provides the additional option of a grain harvest. Wheat can be seeded late September through mid-November. Wheat needs to be planted in September or October and probably produces biomass similar to barley but will be a week or two later. It can be grazed before turning under or harvested for grain and the straw removed. Problems may occur if the Hessian fly is abundant, so choose another small grain in areas where Hessian fly is present. (typical seeding rate: 60-120 lbs/A)

OATS: Oats can be managed to provide many options for the cover crop and good late spring biomass. Seeding spring oats during September or October provides a good cover crop that will winterkill in the colder areas but may overwinter in warmer areas. It can be grazed, made into excellent hay, or the grain harvested and oat straw produced. Planting spring oats in the early fall can provide good winter-killed mulch that could benefit perennial vegetables or small fruits. Spring oats have survived through some milder winters; thus, herbicides may be necessary to kill spring oats in perennial plantings (typical seeding rate: 80-120 lbs/A).

RYEGRASS: This grass has great potential use as a green manure and as a forage/hay material, but ryegrass can potentially become a difficult pest in some farm operations. In the mountain region, ryegrass grows rather slowly in the fall and provides only moderate winter erosion protection, but in late spring it produces an abundant supply of biomass.

Grazing and spring hay from ryegrass can be excellent, and a fine, extensive root system makes it a great source for plow-down. (typical seeding rate: 5-10 lbs/A drilled; 15-30 lbs/A broadcast)

TRITICALE: Triticale is a small grain resulting from a cross between wheat and rye. Triticale has similar characteristics to wheat, while the plant has the overall vigor and winter-hardiness of rye. Fall planting of triticale should follow similar recommendations as wheat, sowing 60 to 120 lbs/acre. Triticale biomass can exceed wheat, thus plowing under or killing for no-till culture should occur at an earlier time in the spring.

NOTES on SMALL GRAINS: Determine small grain fertilizer and lime needs based on soil test results. Successful stand establishment generally can be obtained with planting dates later than those of legumes, even as late as early December in coastal plain regions. This permits establishment of the cover crop after a late-fall-harvested crops such as sweetpotatoes. Remember, that some soil erosion protection may be sacrificed with late seeding dates. For sandier coastal plain soils, rye is the preferred small grain cover crop. As previously discussed, seeding depth varies from ½ to 1½ inches, depending on soil texture. Planting methods are the same as described for legumes.

Types Of Winter Cover Crops: Legumes

A wide range in planting dates exists for most legumes, though best results are obtained with early plantings. Early seeding dates are easy to meet with legume cover crops following spring vegetables.

Because Cahaba White Vetch possesses little winter hardiness, it is not adapted to western NC and the northern regions of other southeastern states. Freeze damage has also occurred with Austrian Winter Pea in higher elevations (above 2,500 feet). Avoid planting late otherwise you increase the risk of winter kill. For state specific recommendations for planting dates, seeding dates and management for legume cover crops, consult your local Extension office.

SEEDING RATES AND DEPTHS

CRIMSON CLOVER: broadcast 20 to 25 lbs/A;
drill 15 to 20 lbs/A (seeding depth: ¼ - ½ in.)

HAIRY VETCH: broadcast 20 to 30 lbs/A;
drill 15 to 20 lbs/A (seeding depth: ½ - 1½ in.)

CAHABA WHITE VETCH: broadcast 20 to 30 lbs/A;
drill 15 to 20 lbs/A (seeding depth: ½ - 1½ in.)

AUSTRIAN WINTER PEA: broadcast 25 to 35 lbs/A;
drill 20 to 25 lbs/A (seeding depth: ¾ - 1½ in.)

When seeding, use shallow planting depths for finer-textured, clayey soils and deeper depths for coarse-textured, sandy soils. Drilling into a conventional seedbed is the most reliable way to obtain a uniform stand. A no-till grain drill can be used successfully; however, provided residue from the previous crop is not excessive and soil moisture is sufficient to allow the drill to penetrate to the desired planting depth. Seeds can be broadcast if the soil has been disked and partially smoothed. Cultipacking after broadcasting will encourage good soil/seed contact. Crimson clover, in particular, responds favorably to cultipacking.

MIXING GRASS AND LEGUMES: Planting a single grass or legume may be necessary, but combining a grass and legume together may prove better than either one alone. Grasses provide soil protection during the winter and also produce great forage or plowdown organic matter. Legumes do not grow well during the winter, but late spring growth is abundant and produces high protein forage and nitrogen for the following crop. Crimson clover is a legume to grow in companion with a grass. Crimson clover's height matches well with barley, wheat, and oats, but may be shaded and outcompeted by rye. Hairy vetch has been sown with grass cover crops for many years, using the grass/vetch combination as a hay or plowdown.

BIOFUMIGATION AND COVER CROPS: Biofumigation is the horticultural practice of using naturally produced volatile chemicals or allelochemicals to suppress soil-borne pathogens, pest, and weeds. These allelochemicals (specifically isothiocyanates produced when glucosinolates break down) are produced when crops in the Brassica family decompose in the soil.

Brassica crops have been used extensively as winter cover crops and as "break crops" where the residues are tilled into the soil for their biofumigation effect. They have also been used in rotations, where the Brassica crop is harvested for sale and then the remaining residue is tilled-in for the biofumigation effect. There are several commercially available cover crops that have been used for biofumigation. "Caliente 119" (a mixture of oilseed radish and mustard), oilseed radish, "Caliente Mustard 99", "Florida Broadleaf mustard", garden cress, penny cress, "Dwarf Essex" rape, and several Canola varieties have been reported to have biofumigation potential.

In much of the Southeast region of the U.S., these crops can be seeded in fall and over-wintered, or direct seeded in early spring. In either case, the crop should be chopped and tilled-in when it is in the early flowering stage in order to achieve the maximum biofumigation potential. The early flowering stage is the point at which the allelochemical concentrations are their highest. Seeding rates range from 4 to 20 lbs/A and will vary with location and seed size (generally, the smaller the seed size, the lower the rate).

These crops respond and produce more biomass and more biofumigation potential when provided 30 to 90 lbs/A N fertilizer at planting. These crops grow rapidly and can normally be plowed down in 6 to 10 weeks. In areas where the average last spring frost is 1 May or later, only spring planting is recommended. Optimal results occur when the Brassica cover crop is chopped, and tilled completely into the top 6 to 8 inches of soil and then watered in thoroughly. Watering in will help trap the volatile compounds into the soil. Brassica seed meals (specifically Mustard seed meal) may also be utilized for biofumigation. Mustard seed meal is highly concentrated in volatiles and also provides a partial source of organic fertilizer for the following crop. Mustard seed meal can be used as a biofumigant by spreading it like a fertilizer, tilling into the soil, and then watering in in order to trap the volatiles.

PLOWDOWN: Plowing early defeats the purpose of growing cover crops as little biomass will have been produced by the cover crop. In the case of legume cover crops, they require sufficient time to develop biomass which an early plowdown would prevent. If you need to plow early, use a grass cover crop (rye) that produces good fall growth and will provide maximum biomass for incorporation. Allow 3-6 weeks between plowdown and planting.

TRANSPLANT PRODUCTION

These recommendations apply to plants grown under controlled conditions IN GREENHOUSES OR HOTBEDS. (Field-grown plants are covered under the specific crop.) A transplant is affected by factors such as temperature, fertilization, water, and spacing. A good transplant is one that has been grown under the best possible conditions.

Table 5 presents optimum and minimum temperatures for seed germination and plant growth, time and spacing (area) requirements, and number of plants per square foot for a number of economically important vegetable crops in the southeastern US.

Commercial Plant-growing Mixes. A number of commercial media formulations are available for growing transplants. Most of these mixes will produce high-quality transplants when used with good management practices. However, these mixes can vary greatly in composition, particle size, pH, aeration, nutrient content, and water-holding capacity. Avoid formulations having fine particles, as these may hold excessive water and have poor aeration. Have mix formulations tested by your state's soil test laboratory to determine the pH and the level of nutrients the mix contains.

Treatment of Flats. Flats used in the production of transplants should be new or as clean as new to avoid damping-off and other

disease problems. If flats are to be reused, they should be thoroughly cleaned after use and completely submerged in a household bleach solution for at least 5 minutes. Use 5 gallons of 5.25% sodium hypochlorite (such as Chlorox) for each 100 gallons of solution required. Permit flats to dry completely prior to use. Never treat flats with creosote or pentachlorophenol.

Plant Containers: There are a wide variety of containers available for starting seeds for transplants. Most growers start seeds either in flats or in cell packs.

The main advantage of using flats is that more plants can fit into the same space if plants are in flats. However, if you start seeds in flats, you will need to transplant to larger cell packs or to individual pots as the seedlings get bigger.

Seeding directly into cell packs saves time, because transplanting into a larger container later is not necessary. Cell packs come in many different cell sizes; the overall tray size is standardized. For tomatoes and peppers, 72-cell packs work well. For larger-seeded vegetables; such as cucumbers, squash, and watermelons, 48-cell packs work better.

Each vegetable crop has specific cell sizes for containerized transplant production and requires a certain number of weeks before they are ready for transplanting (Table 5). For example: broccoli, Brussels sprouts, cabbage, cauliflower, and collards require a 0.8 to 1.0 inch cell and 5 to 7 weeks to reach an adequate size for transplanting; cantaloupe and watermelons require a 1.0 inch cell and 3 to 4 weeks; eggplant and tomato require a 1.0 inch cell and 5 to 7 weeks; pepper requires a 0.5 to 0.8 inch cell and 5 to 7 weeks. Other options are available depending on the crop and your situation.

Seed Germination. Seed that is sown in flats to be "pricked out" at a later date should be germinated in vermiculite (horticultural grade, coarse sand size) or a plug growing mix. However, it is recommended that no fertilizer be included in the mix or the vermiculite and avoid fertilizing the seedlings until the seed leaves (cotyledons) are fully expanded and the true leaves are beginning to unfold. Fertilization should be in the liquid form and at one-half the rate for any of the ratios listed in the following section on "Liquid Feeding." Seedlings can be held for a limited time if fertilization is withheld until 3 to 4 days before "pricking out." Seed that is sown in pots or other containers and will not be "pricked out" later can be germinated in a mix that contains fertilizer.

To get earlier, more uniform emergence, germinate and grow seedlings on benches or in a floor-heated greenhouse. Germination can be aided by using germination mats which provide heat directly to the trays. With supplemental heating such as this, seedling emergence and uniformity can be enhanced decreasing the amount of time required to produce a transplant. If floor heating or benches is not available, seed the trays, water, and stack them off the floor during germination. Be sure to unstack trays before seedlings emerge.

TABLE 5. OPTIMUM AND MINIMUM TEMPERATURES FOR TRANSPLANT PRODUCTION

	°F Opt. Day	°F Min. Night	Weeks to Grow
Broccoli	65-70	60	5-7
Cabbage	65	60	5-7
Cantaloupe[1]	70-75	65	3-5
Cauliflower	65-70	60	5-8
Cucumber	70-75	65	2-3
Eggplants	70-85	65	5-8
Endive & Escarole	70-75	70	5-7
Lettuce	60-65	40	5-6
Onions	65-70	60	8-12
Peppers	70-75	60	5-8
Summer squash	70-75	65	2-3
Sweetpotato	75-85	ambient	4-5
Tomatoes	65-75	60	5-6
Watermelon, seeded	85-90	80	3-5
Watermelon, seedless	85-90	85	3-6

[1] Cantaloupe and other melons

Heating and Venting. Exhaust from heaters must be vented to the outside. It is also recommended to have an outside fresh air intake for the heaters. Be sure vents and fans are properly designed and positioned to avoid drawing exhaust gases into the greenhouse. Exhaust gases from oil and improperly adjusted gas heating systems can cause yellowing, stunting, and death of seedlings. Do not grow or hold seedlings in an area where pesticides are stored.

Liquid Feeding. The following materials dissolved in 5 gallons of water and used over an area of 20 square feet are recommended for use on the transplants if needed:

20-20-20 1.2-1.6 oz/5 gal water
15-15-15 2 oz/5 gal water
15-30-15 2 oz/5 gal water

Rinse leaves after liquid feeding. Fertilizers used for liquid feeding must be 100% water soluble.

When transplanting to the field, use a "starter fertilizer" being sure to follow the manufacture's recommendations.

Watering. Keep these mixes moist but not continually wet. Water less in cloudy weather. Watering in the morning allows plant surfaces to dry before night and reduces the possibility of disease development.

Hardening and Transplant Height Control. Proper hardening of transplants, stiffens stems, and hardens the transplants increasing their survival.

There are several methods – chemical and cultural – used to harden transplants and the choice of which to use is often crop-dependent. At this time there is one chemical plant growth regulator available for use in producing vegetable transplants but its use is limited to several Solanaceous crops.

Transplant Height Control. The goal of a transplant producer should be to produce a strong transplant with sturdy growth that can withstand transplanting into the field. Tall, spindly, or overgrown transplants can be difficult to remove from the transplant tray and might become entangled in the transplanting equipment. There are a few methods available that can aid the producer to control the top growth of developing transplants. One method is to use cold water for irrigation, 33-34°F, which has been shown in some species to control top growth.

Another method is to control the difference between day and night temperatures (DIF). Raising the temperature just before day-

break (2 hours) or lowering the temperature just after daybreak (2 hours) by 10 F can result in shorter plants. Brushing the plants, or setting up fans so that the plants are moved (brushed by air) is another method. This results in a mechanical stress of the plant stem and can result in shorter plants overall. The intensity and frequency of brushing will have to be adjusted to avoid damage to developing foliage while still achieving height control. In some crops, chemical growth regulators may be labeled for use. Care should be taken with the use of these products, as they are often used in very low rates. Low rates should be used until familiarity with these products is gained by the producer. Always follow the label directions when using any of these growth regulating products. These products will control height but can cause growth stunting once they get to the field.

Chemical Hardening. Recently, a supplemental label for Sumagic™ (uniconazole) has been released allowing foliar sprays on the following vegetable transplants: tomato, pepper, ornamental pepper, eggplant, tomatillo, ground cherry, and pepino. But the new label is rather restrictive; the maximum total allowed application is 10 ppm at 2 quarts per 1,000 square feet. This means only one 10-ppm spray, two 5-ppm, or four 2.5-ppm sprays are allowed, and so on. The final spray must be made no later than two weeks after the two- to four-leaf stage, about four to six weeks after sowing.

For production of retail tomato transplants in six-packs to 4-inch pots, we recommend an initial uniconazole spray at 1 to 2.5 ppm two weeks after sowing. If additional height control is needed, up to three additional applications of 1 to 2.5 ppm can be made at seven-day intervals. Until we know more about the post-harvest effects and the range of sensitivity each cultivar demonstrates, we recommend growers avoid the use of higher rates in excess of 5 ppm. Uniconazole is a highly active PGR (plant growth regulator), it is critical to emphasize that caution is paramount while implementing uniconazole for vegetable transplant height control.

Cultural Methods for Hardening. Cultural methods used to harden transplants employ reducing water and altering the ambient temperatures. Combinations of these two methods are often used. By reducing the amount of water used and lowering ambient temperatures, one can cause a "check" in plant growth (a "slow down") to prepare plants for field setting. Never reduce or limit fertilizer as a means to harden transplants because it will often delay maturity. If ambient temperatures are too low, chilling injury can result causing plant damage and delayed re-growth after transplanting. Caution: Lowering air temperature on some crops, such as cool season crops, might induce bolting.

DIF. Plant height can be held in check and hardening can be improved by using a process that reduces or increases ambient temperatures in the early morning over the course of several days. Plants elongate most at daybreak. Raising the temperature before daybreak (2 hours before) or lowering the temperature just after daybreak (2 hours after) by 10°F will cause plants to be shorter and more hardened. This process is called DIF, because you are employing a difference in temperature. DIF can be positive or negative, but positive DIF is more commonly used for hardening transplants. Negative DIF can cause crop injury on cold sensitive crops or bolting on cool season crops.

GRAFTING IN VEGETABLE CROPS

The phase-out of methyl bromide fumigation is driving the search for alternative methods to manage soilborne pathogens in vegetable crops. Although alternative pesticides and other physical treatments are being tested and developed, grafting with resistant rootstocks offers one of the best methods to avoid soilborne diseases. Grafting involves combining a desirable scion which is the fruit bearing portion of a grafted plant with a rootstock which provides resistance to various soilborne pathogens. The scion is generally from a plant that produces highly desirable fruit. As well as managing soilborne diseases, grafting can influence vegetative growth and flowering; affect fruit ripening and fruit quality; enhance abiotic stress resistance; and enhance yield especially under low-temperature conditions.

At present, most research is being conducted on grafting tomato and watermelon. The primary motive for grafting tomato and watermelon (and other cucurbits) is to manage soilborne pests and pathogens when genetic or chemical approaches for management of these diseases are not available. Grafting a susceptible scion onto a resistant rootstock can provide a resistant cultivar without the need to breed a resistant cultivar. Furthermore, grafting allows a rapid response to new pathogens races, and, in the short-term, provides a less expensive and more flexible solution for controlling soilborne diseases than by breeding new, resistant cultivars.

Grafted transplants are more expensive than non-grafted transplants due to labor, material costs (grafting supplies, seed costs of rootstock and scion), and specialized facilities. These specialized facilities include healing chambers and trained personnel both to produce the grafted transplant and to care for it. Potential changes in fruit quality, which occur with some rootstocks, must also be considered. Some commercial transplant producers offer grafting services and with improved grafting techniques and mechanization, costs will begin to decrease.

Another potential added cost with grafting can be from transplanting into areas with high-wind conditions. Grafted transplant can be more easily damaged by wind decreasing transplant survival rates by up to 60%. This resultant loss will greatly increase costs.

Cucurbit Grafting. From its research beginnings in the 1920's, Cucurbit grafting in Asia has now become the predominantly practiced growing method; currently 95% of watermelons and Oriental melons are grafted in Japan, Korea, and Taiwan. Grafting has only recently been considered as a practice for Cucurbits in the United States for reasons described above. Grafting presents an option for soil-borne pathogen management for diseases such as *Fusarium* wilt, *Monosporascus* Vine Decline, *Phytophthora* blight, and Root-knot nematode.

Additionally, grafting can enhance tolerance to abiotic stress; increase water and nutrient use efficiency; extend harvest periods; and improves fruit yield and quality in certain Cucurbits. There is a wide array of potential rootstocks: *Lagenaria* spp. (Bottled Gourd), interspecific squash hybrids, wild watermelon or melon. The rootstocks can produce vigorous plants with resistances to many soilborne diseases.

Grafting Watermelons: *Hole Insertion Grafting Method.* Sow rootstock seeds into a square, 1.2 to 1.6 in. cell, 2-in deep. Sow scion seeds into a smaller cell size (0.4 to 0.8 in. 2-in deep). Trays

sown with the rootstock(s) and triploid scions should be well watered but carefully monitored as overwatering can lead to poor germination. Maintain trays at 86°F. When both cotyledons and first true leaves start to develop, the rootstock plant is ready to graft (~7 to 10 day after sowing) depending on greenhouse conditions. Remove the growing point with a sharp probe, and then open a hole on the upper portion of the rootstock hypocotyl at an angle to penetrate the side of the hypocotyl. A bamboo needle, tooth pick, or 1.4-mm drill bit works best. Cut the scion at a 35° to 45° angle, both sides, on the hypocotyls. The scion is then inserted into the hole made into the rootstock. The cut surfaces are matched together and held with or without a grafting clip. Transfer grafted plants into a humidity chamber or healing room. After the healing process is complete (after approximately seven days), transfer the grafted plants into the greenhouse at 72 to 79°F until the scion is well connected with the rootstock. Transplants should not be older than 33 days before transplanting. For step-by-step instructions, go to: R. Hassell, F. Memmott, and D. Liere (2008) *Grafting methods for watermelon production* in HortScience 43(6):1677-1679.

Grafting Tomatoes. There are three primary techniques used for grafting tomatoes, ***Tongue Approach Grafting***, ***Cleft Grafting*** and ***Tube (or Clip) Grafting***. Cleft grafting and tube grafting are very similar in that the shoot of the fruit producing scion is completely cut off from its own roots and attached to the severed stem of the rootstock. The name 'Tube Grafting' originated because when the technique was first developed; a tube was used to attach the shoot to the root. Clips are now used to make this graft. Tube grafting is quicker and less complicated to do than cleft grafting because it only requires a single, straight cut on both the rootstock and scion. Also, because fewer intricate cuts are involved, this technique can be used on very small seedlings. Grafting can be performed at various stages of seedling growth. Grafting at the 2-3 true leaf stage is common. With both cleft and tube grafting, the newly grafted plants must be protected from drying out until the graft union is healed. This usually involves covering the plants with a plastic cover or protecting them in some type of healing chamber where temperature and humidity can be regulated. Some method should be employed to reduce light intensity to the grafted plants for several days after the procedure. It is critical to increase the humidity in the chamber to near 100% for the first two days. Humidity must then be reduced incrementally over the next five days to prohibit the formation of adventitious roots from the scion and to properly heal the graft. Tomato grafts heal quickly and the seedlings can begin to be acclimated back into the greenhouse after 4 - 5 days.

With both cleft and tube grafting, it is important that the diameter of the cut ends (of the scion and the rootstock) match up perfectly. If the diameter does not match, the graft may not heal properly, if at all. Rootstock cultivars tend to have different growth habits than scion cultivars so it is important to grow a small amount of rootstock and scion seed at first to determine their growth rate relative to each other. Rootstock cultivars tend to be more vigorous than scion cultivars. Another critical factor is to cut rootstock seedlings below the cotyledons. If the cotyledons are left they will generate suckers that will compete with the scion requiring pruning. For step by step instructions, go to http://graftvegetables.org/ .

DISEASE CONTROL IN PLANT BEDS

For the best control of all soil-borne diseases, use a good commercial plant-growing mix. If this is not possible, use one of the following procedures:

Preplant. The only practice that ensures complete sterilization of soil is the use of steam. When steam is used, a temperature of 180°F must be maintained throughout the entire mass of soil for 30 minutes.

Soil treated with recommended chemicals will be pasteurized but rarely completely sterilized. A list of recommended chemicals used for seed and plant bed fumigation can be found on the table entitled "SANITIZING GREENHOUSES AND PLANT BEDS" on page 235.

In any case, be sure to follow the manufacture's recommendations for use. Soil temperature should be at least 55°F, and soil moisture should be adequate for planting so that environmental condition are favorable to the overall effectiveness of the fumigant. Most soil fumigants will linger in the soil, so a 14 to 21-day waiting period may be necessary. The use of a tarp covering the soil area to be treated is generally required. Nitrate forms of fertilizer are advisable following soil fumigation.

Seed Treatment. Seed treatment is important to control seed-borne diseases. Use of untreated seed could lead to diseases in the plant bed which could reduce plant stands or result in diseased transplants and potential crop failure. See the specific crop sections of this handbook for specific seed treatment recommendations.

Postplant. Damping-off and foliar diseases can be a problem in plant beds. To prevent these diseases, it may be necessary to apply fungicide sprays especially as plants become crowded in plant beds. Refer to label clearance before use. The use of sphagnum moss as a top dressing will reduce damping-off because it keeps the surface dry.

SEED STORAGE AND HANDLING

Both high temperature and relative humidity will reduce seed germination and vigor of stored seed. Do not store seed in areas that have a combined temperature and humidity value greater than 100 [e.g., 50°F + 50% relative humidity]. In addition, primed seed does not store well after shipment to the buyer. Therefore, if you do not use all the primed seed ordered in the same season, have the seed tested before planting in subsequent seasons.

Corn, pea, and bean seed are especially susceptible to mechanical damage due to rough handling. Bags of these seed should not be dropped or thrown because the seed coats can crack and seed embryos can be damaged, resulting in a nonviable seed. When treating seed with a fungicide, inoculum, or other chemical, use only gentle agitation to avoid seed damage.

PLANT POPULATIONS

For vegetable seed sizes and plant populations see Tables 6 and 7.

TABLE 6. VEGETABLE SEED SIZES

Crop	Seeds/Unit Weight
Asparagus	13,000-20,000/lb
Beans:	
small seeded lima	1,150-1,450/lb
large seeded lima	440-550/lb
snap	1,600-2,200/lb
Beets	24,000-26,000/lb
Broccoli	8,500-9,000/oz
Brussels sprouts	8,500-9,000/oz
Cabbage	8,500-9,000/oz
Cantaloupes	16,000-19,000/lb
Carrots	300,000-400,000/lb
Cauliflower	8,900-10,000/oz
Collards	7,500-8,500/oz
Cucumbers	15,000-16,000/lb
Eggplants	6,000-6,500/oz
Endive, Escarole	22,000-26,000/oz
Kale	7,500-8,900/oz
Kohlrabi	9,000/oz
Leeks	170,000-180,000/lb
Lettuce:	
head	20,000-25,000/oz
leaf	25,000-31,000/oz
Mustard	15,000-17,000/oz
Okra	8,000/lb
Onions:	
bulb	105,000-144,000/lb
bunching	180,000-200,000/lb
Parsnips	192,000/oz
Parsley	240,000-288,000/lb
Peas	1,440-2,580/lb
Peppers	4,000-4,700/oz
Pumpkins	1,900-3,200/lb
Radishes	40,000-50,000/lb
Rutabaga	150,000-192,000/lb
Spinach	40,000-50,000/lb
Squash:	
summer	3,500-4,800/lb
winter	1,600-4,000/lb
Sweet corn:	
normal and sugary enhanced	1,800-2,500/lb
supersweet (sh2)	3,000-5,000/lb
Tomatoes:	
fresh	10,000-11,400/oz
processing	160,000-190,000/lb
Turnip	150,000-200,000/lb
Watermelons:	
small seed	8,000-10,400/lb
large seed	3,200-4,800/lb

TABLE 7. POPULATION OF PLANTS PER ACRE AT SEVERAL BETWEEN-ROW AND IN-ROW SPACINGS

Between-row spacing (in.)	In-row spacing (in.)												
	2	4	6	8	10	12	14	16	18	24	30	36	48
7	448,046	224,023	149,349	112,011	89,609	74,674	64,006						
12	261,360	130,680	87,120	65,340	52,272	43,560	37,337	32,670	29,040	21,780	17,424	14,520	10,890
18	174,240	87,120	58,080	43,560	34,848	29,040	24,891	21,780	19,360	14,520	11,616	9,680	7,260
21	149,349	74,674	49,783	37,337	29,870	24,891	21,336	18,669	16,594	12,446	9,957	8,297	6,223
24	130,680	65,340	43,560	32,670	26,136	21,780	18,669	16,335	14,520	10,890	8,712	7,260	5,445
30	104,544	52,272	34,848	26,136	20,909	17,424	14,935	13,068	11,616	8,712	6,970	5,808	4,356
36 (3 ft)	87,120	43,560	29,040	21,780	17,424	14,520	12,446	10,890	9,680	7,260	5,808	4,840	3,630
42 (3.5 ft)	74,674	37,337	24,891	18,669	14,934	12,446	10,668	9,334	8,297	6,223	4,978	4,149	3,111
48 (4 ft)	65,340	32,670	21,780	16,335	13,068	10,890	9,334	8,167	7,260	5,445	4,356	3,630	2,722
60 (5 ft)			17,424	13,068	10,454	8,712	7,467	6,534	5,808	4,356	3,485	2,904	2,178
72 (6 ft)			14,520	10,890	8,712	7,260	6,223	5,445	4,840	3,630	2,904	2,420	1,815
84 (7 ft)			12,446	9,334	7,467	6,223	5,334	4,667	4,149	3,111	2,489	2,074	1,556
96 (8 ft)			10,890	8,167	6,534	5,445	4,667	4,084	3,630	2,722	2,178	1,815	1,361

TABLE 8. CRITICAL PERIODS OF WATER NEED FOR VEGETABLE CROP

Crop	Critical Period
Asparagus	Brush
Beans, Lima	Pollination and pod development
Beans, Snap	Pod enlargement
Broccoli	Head development
Cabbage	Head development
Carrots	Root enlargement
Cauliflower	Head development
Corn	Silking and tasseling, ear development
Cucumbers	Flowering and fruit development
Eggplants	Flowering and fruit development
Lettuce	Head development
Melons	Flowering and fruit development
Onions, Dry	Bulb enlargement
Peas, Southern	Seed enlargement and flowering and English
Peppers	Flowering and fruit development
Potatoes, Irish	Tuber set and tuber enlargement
Radishes	Root enlargement
Squash, Summer	Bud development and flowering
Sweetpotato	Root enlargement
Tomatoes	Early flowering, fruit set, and enlargement
Turnips	Root enlargement

TABLE 9. AVAILABLE WATER-HOLDING CAPACITY BASED ON SOIL TEXTURE

Soil Texture	Available Water Holding Capacity (water/inches of soil)
Coarse sand	0.02–0.06
Fine sand	0.04–0.09
Loamy sand	0.06–0.12
Sandy loam	0.11–0.15
Fine sandy loam	0.14–0.18
Loam and silt loam	0.17–0.23
Clay loam and silty clay loam	0.14–0.21
Silty clay and clay	0.13–0.18

TABLE 10. SOIL INFILTRATION RATES BASED ON SOIL TEXTURE

Soil Texture	Soil Infiltration Rate (inch/hour)
Coarse sand	0.75–1.00
Fine sand	0.50–0.75
Fine sandy loam	0.35–0.50
Silt loam	0.25–0.40
Clay loam	0.10–0.30

IRRIGATION

Basic Principles. Vegetables are 80 to 95% water. Maintaining proper soil moisture levels is important in order to maximize the productivity of vegetable crops. Plant stress caused by too much or too little soil moisture can lead to decreased size and weight of individual fruit and to defects such as: toughness; strong flavor; poor tipfill and podfill; cracking; blossom-end rot; and misshapen fruit. Saturated soil conditions can reduce soluble solids in cantaloupes and other small melons as well as capsaicin in hot peppers.

It is imperative that soil moisture level be maintained near field capacity at all times during the growing season. Field capacity is the soil moisture *status/content/tension* when water will no longer drain due to the force of gravity. To maintain field capacity at all times requires good soil drainage (both surface and subsurface), and that your irrigation system is capable of making uniform, *frequent*, and precisely timed applications (time/length of irrigation determines the amount/depth applied). More than one irrigation cycle per day may be needed to ***maintain*** field capacity. This is particularly true for fast growing crops grown in soils with little water holding capacity, such as sandy loams.

Different soil types have different moisture holding capacities. It is important that irrigation events be scheduled properly and based on measured soil moisture contents throughout the soil profile. In some cases, water supplies might not be adequate to meet the crop's peak demand. In these cases, it is a better use of the available water to irrigate only a portion of the planting and sacrifice the remaining area, rather than practicing deficit irrigation on the entire planting. Vegetable crops have a high peak water requirement. To prevent plant stress, irrigation systems should be able to apply a minimum of 2.0 inches per week over the entire field area (6 gpm/acre if operated 24/7).

For sprinkler systems used on vegetable crops, droplet size and application rate are also important. Large droplets resulting from low pressure at the sprinkler head can cause damage to young vegetable plants and can contribute to soil crusting when the soils dry. Water is more readily held in clay soils; however, clay soils have a lower water infiltration rate as compared to sandy soils. Irrigation rate is dependent on soil type, and application rates should follow values in Table 10. Depending on the soil structure, high application rates will result in irrigation water running off the field, contributing to erosion and fertilizer runoff particularly on heavy clay soils.

Even relatively short periods of inadequate soil moisture can adversely affect many crops. Thus, irrigation is beneficial in most years, since rainfall is rarely uniformly distributed even in years with above-average precipitation. Moisture deficiencies occurring early in the crop cycle may delay maturity and reduce yields. Shortages later in the season often lower quality and yield. Over-irrigating, however, especially late in the season, can reduce quality and postharvest life of the crop. Table 8 shows the critical periods of crop growth when an adequate supply of water is essential for the production of high-quality vegetables.

Applying the proper amount of water at the correct time is critical for achieving the optimum benefits from irrigation. The crop water requirement, termed evapotranspiration, or *ET*, is equal to the quantity of water lost from the plant (transpiration) plus water that evaporated from the soil surface. The ET rate is important in effectively scheduling irrigations. Numerous factors must be considered when estimating ET. The amount of solar radiation, which provides the energy to evaporate moisture from the soil and plant surfaces, is the major factor. Other factors include: crop growth stage; day length; air temperature; wind speed; and humidity level.

Plant factors that affect ET are crop species; canopy size and shape; leaf size, and shape. Soil factors must also be considered. Soils having high levels of silt, clay, and organic matter have greater water-holding capacities than sandy soils or compacted soils (Table 9). Soils with high water-holding capacities require less frequent irrigation than soils with low water-holding capacities. When such soils are irrigated less frequently, a greater amount of water must be applied per application.

Another soil factor influencing irrigation practices is the soil infiltration rate. Water should not be applied to soils at a rate greater than the rate at which soils can absorb water. Table 10 lists the typical infiltration rates of several soil types.

Without the use of soil moisture monitoring devices, there is no way to accurately schedule irrigation because all the above factors interact to determine water loss. The following factors should be kept in mind when deciding when and how much to irrigate:

Soils vary greatly in their water-holding capacities and infiltration rates. Silt and clay soils and those high in organic matter can hold much more available water than sandy soils, low in organic matter.

Water loss from plants is much greater on clear, hot windy days than on cool, overcast days. During periods of hot, dry weather, ET rates may reach 0.25 inch per day or higher. ET can be estimated by the use of a standard evaporation pan. Check with your

TABLE 11. HOURS REQUIRED TO APPLY 1" WATER BASED ON ROW SPACING.

Drip Tube Flow Rate		Row Spacing (Ft.)				
gph/100 ft.	*gpm/100 ft.*	*4*	*5*	*6*	*8*	*10*
11.4	0.19	21.9	27.3	32.8	43.7	54.7
13.2	0.22	18.9	23.6	28.3	37.8	47.2
20.4	0.34	12.2	15.3	18.3	24.4	30.6
27.0	0.45	9.2	11.5	13.9	18.5	23.1
40.2	0.67	6.2	7.8	9.3	12.4	15.5
80.4	1.34	3.1	3.9	4.7	6.2	7.8

TABLE 12. MAXIMUM APPLICATION TIME IN MINUTES FOR DRIP IRRIGATED VEGETABLES.

	Drip Tubing Flow Rate (*gpm/100 ft.*)				
	0.2	0.3	0.4	0.5	0.6
Available Water Holding Capacity[1] *Inch Of Water/Inch Soil Depth*	Maximum Number of Minutes per Application[2]				
0.02	20	14	10	8	7
0.04	41	27	20	16	14
0.06	61	41	31	24	20
0.08	82	54	41	33	27
0.10	102	68	51	41	34
0.12	122	82	61	49	41
0.14	143	95	71	57	48
0.16	163	109	82	65	54
0.18	183	122	92	73	61

[1] Refer to Table 9 for Available Water Holding Capacity based on soil texture.

[2] Assumes a 10-inch deep root zone and irrigation at 25% soil moisture depletion.

local Extension office for information on how to use evaporation pans.

Recent research indicates that maintaining soil moisture levels in a narrow range, just slightly below field capacity (75% to 90% available soil moisture), maximizes crop growth. This may mean that more frequent irrigations of smaller amounts are better than delaying irrigations until the soil moisture reaches a lower level (40% to 50% available soil moisture) and then applying a heavy irrigation.

Plastic mulches reduce evaporation from the soil but also reduce the amount of rainwater that can reach the root zone. Thus, the much of the natural precipitation should be ignored when scheduling irrigations for crops grown under plastic mulch.

Drip Irrigation. *Drip irrigation is used to* ***maintain*** *soil moisture whereas other types of irrigation are used more to* ***replace*** *depleted soil moisture*. Drip irrigation is a method of slowly applying water directly to the plant's root zone. Water is applied frequently, often daily, to maintain favorable soil moisture conditions. Even so, field operations can continue uninterrupted. Water is applied without wetting the foliage, thereby decreasing evaporative losses and decreasing disease pressure due to damp foliage. Additionally, the use of drip irrigation can limit waste and potential contamination from overuse (or unnecessary use) of agricultural chemicals. In most cases, drip irrigation is considerably more uniform and efficient in its distribution of water to the crop than other irrigation methods. Still, drip irrigated crops can require up to 10% more water than sprinkler or furrow irrigated crops because of increased plant vigor, larger canopies, and heavier fruit setting. In addition, fertilizers applied through the drip irrigation system are conserved.

Drip irrigation is used on a wide range of fruit and vegetable crops. It is especially effective when used with mulches; on sandy soils; and on high value crops, such as cantaloupes, watermelons, squash, peppers, eggplants, and tomatoes. Drip irrigation systems have several other advantages over sprinkler and surface irrigation systems. Low flow rates and operating pressures are typical of drip systems. These characteristics lead to lower energy costs. Once in place, drip systems require little labor to operate, can be automatically controlled, and can be managed to apply the precise amount of water and nutrients needed by the crop. These factors also reduce operating costs. The areas between rows remain dry reducing weed growth between rows and reducing the amount of water lost to weeds.

There are several potential problems unique to drip irrigation systems. Most drip systems require a higher level of management than other irrigation systems. Moisture distribution in the soil is limited with drip systems. In most cases, a smaller soil water reserve is available to plants. Under these conditions, the potential to stress plants is greater than with other types of irrigation systems. *In order to use drip irrigation successfully, the system must be carefully managed and maintained*.

The equipment used for drip irrigation systems must be routinely monitored and maintained in order to prevent any challenges. Drip irrigation tape and tubing can be damaged by insects, rodents, and laborers, and often has a higher initial investment cost than other irrigation system types. Pressure regulation and filtration require equipment not commonly used with sprinkler or surface systems. The drip system, including a pump, headers, filters, and various connectors, must be checked and be ready to operate *before* planting. Failure to have the system operational could result in costly delays, poor plant survival, and irregular stands, reducing yield.

Calculating the length of time required to apply a specific depth of water with a drip irrigation system is more difficult than with sprinkler systems. Unlike sprinkler systems, drip systems apply water to only a small portion of the total crop acreage. Usually, a fair assumption to make is that the mulched width approximates the extent of the plant root zone. Although the root zone is confined, the plant canopy is vigorous and water use and loss from evapotranspiration (*Et*) can far exceed the water applied if application is based on a banded or mulch width basis. Table 11 calculates the length of time required to apply 1-inch of water with drip irrigation based on the drip tape flow rate and crop row spacing. The use of this table requires that the drip system be operated at the pressure recommended by the manufacturer.

Excessive application of water can move nutrients, water and pesticides below the plant root zone. Table 12 has been prepared to calculate the maximum recommended irrigation period for drip irrigation systems. The irrigation periods listed are based on the assumption that 25 percent of the available water in the plant root zone is depleted. Soil texture directly influences the water-holding capacity of soils and the consequential depth reached by irrigation water.

In drip tape systems, water is carried through plastic tubing (which expands when water flows through it) and distributed along the drip tape through built-in outlets or devices called emitters. The pressure-reducing flow path also allows the emitter to remain relatively large, allowing particles that could clog an emitter to be discharged.

Although modern emitter design reduces the potential for trapping small particles, emitter clogging can be a common occurrence with drip irrigation systems. Clogging can be attributed to physical, chemical, or biological contaminants. Proper filtration is a must and occasional water treatment might be necessary in order to keep drip systems from clogging. Further information on drip irrigation systems can be obtained from manufacturers, dealers, and your local Extension office.

Chlorination. Bacteria can grow inside drip irrigation tapes, forming a slime that can clog emitters. Algae present in surface waters can also clog emitters. Bacteria and algae can be effectively controlled by chlorination of the drip system. Periodic treatment **before** clogs develop can keep the system functioning efficiently. The frequency of treatments depends on the quality of the water source. Generally two or three treatments per season are adequate. Irrigation water containing high concentrations of iron (greater than 1 ppm) can also cause clogging problems due to a type of bacteria that "feeds" on iron. In consuming the dissolved (ferrous) form of iron, the bacteria secrete a slime called ochre, which may combine with other solid particles in the drip tape and plug emitters. The precipitated (ferric) form of iron, known commonly as rust, can also physically clog emitters. In treating water containing iron, chlorine will oxidize the iron dissolved in water, causing the iron to precipitate so that it can be filtered and removed from the system.

Chlorine treatment **should take place upstream of filters** in order to remove the precipitated iron and microorganisms from the system. Chlorine is available as a gas, liquid, or solid. Chlorine gas is extremely dangerous and caution should be exercised if this method of treatment is chosen. Solid chlorine is available as granules or tablets containing 65% to 70% calcium hypochlorite but might react with other elements in irrigation water to form precipitates which could clog emitters. Liquid chlorine is available in many forms, including household bleach (sodium hypochlorite), and is the easiest and often safest form to use for injection. **Stock solutions can be bought that have concentrations of 5.25%, 10%, or 15% available chlorine. Use chlorine only if the product is labeled for use in irrigation systems.**

Since chlorination is most effective at pH 6.5 to 7.5, some commercial chlorination equipment also injects buffers to maintain optimum pH for effective kill of microorganisms. This type of equipment is more expensive, but more effective than simply injecting sodium hypochlorite solution.

The required rate of chlorine injection is dependent on the amount of microorganisms present in the water source, the amount of iron in the irrigation water, and the method of treatment being used. To remove iron from irrigation water, start by injecting 1 ppm of chlorine for each 1 ppm of iron present in the water. For iron removal, **chlorine should be injected continuously**. Adequate mixing of the water with chlorine is essential. For this reason, be certain to mount the chlorine injector a distance upstream from filters. An elbow between the injector and the filter will ensure adequate mixing.

For treatment of algae and bacteria, a chlorine injection rate that results in the presence of 1 to 2 ppm of "free" chlorine at the end of the furthest lateral will assure that the proper amount of chlorine is being injected. Free, or residual, chlorine can be tested using an inexpensive DPD (diethyl-phenylene-diamine) test kit. A swimming pool test kit can be used, but only if it measures free chlorine. Many pool test kits only measure total chlorine.

If a chlorine test kit is unavailable, one of the following schemes is suggested as a starting point:

For iron treatment:

- Inject liquid sodium hypochlorite continuously at a rate of 1 ppm for each 1 ppm of iron in irrigation water. In most cases, 3 to 5 ppm is sufficient.

For bacteria and algae treatment:

- Inject liquid sodium hypochlorite continuously at a rate of 5 to 10 ppm where the biological load is high.
- Inject 10 to 20 ppm during the last 30 minutes of each irrigation cycle where the biological load is medium.
- Inject 50 ppm during the last 30 minutes of irrigation cycles two times each month when biological load is low.
- Superchlorinate (inject at a rate of 200 to 500 ppm) once per month for the length of time required to fill the entire system with this solution and shut down the system. After 24 hours, open the laterals and flush the lines.

The injection rates for stock solutions that contain 5.25%, 10% and 15% can be calculated from the following equations:

FOR 5.25% STOCK SOLUTION:

Injection rate of chlorine, gph = [(Desired available chlorination level, ppm) x (Irrigation flow rate, gpm)] divided by 971.

FOR A 10% STOCK SOLUTION:

Injection rate of chlorine, gph = [(Desired available chlorination level, ppm) x (Irrigation flow rate, gpm)] divided by 1850.

FOR A 15% STOCK SOLUTION:

Injection rate of chlorine, gph = [(Desired available chlorination level, ppm) x (Irrigation flow rate, gpm)] divided by 2775.

It is important to note that chlorine will cause water pH to rise. This is critical because chlorine is most effective in acidic water. If your water pH is above 7.5 before injection, it must be acidified for chlorine injection to be effective.

IMPORTANT NOTES.

- Approved backflow control valves, low pressure drains, and interlocks must be used in the injection system to prevent contamination of the water source.

- Chlorine concentrations above 30 ppm may kill plants.

Fertilization. Before considering a fertilization program for mulched-drip irrigated crops, be sure to have the soil pH checked. If a liming material is needed to increase the soil pH, the material should be applied and incorporated into the soil as far ahead of mulching as practical. For most vegetables, adjust the soil pH to around 6.5. When using drip irrigation in combination with mulch, apply the recommended amount of preplant fertilizer and incorporate it 5 to 6 inches into the soil before laying the mulch. If equipment is available, apply the preplant fertilizer to the soil area that will be covered by the mulch. This is more efficient than a broadcast application to the entire field.

The most efficient method of fertilizing an established mulched crop is through a drip irrigation system, which is installed during the mulching operation. Due to the very small holes or orifices in the drip tape, high quality liquid fertilizers, or water-soluble fertilizers must be used. Since phosphorous is a stable non-mobile soil nutrient and can cause clogging of the drip tape emitters, it is best to apply 100% of the crop's phosphorous needs pre-plant. Additionally, apply 20 to 40% of the crops's nitrogen and potassium needs pre-plant. The remainder of the crop's nutrient needs can be applied through the drip system with a high quality liquid fertilizer such as 8–0–8, 7–0–7, or 10–0–10. Generally, it is not necessary to add micronutrients through the drip system. Micronutrients can be best and most economically applied pre-plant or as foliar application if needed.

The amount of nutrients to apply through the drip system depends upon the plant's growth stage. In general, smaller amounts of nutrients are needed early in the plant's growth with peak demand occurring during fruit maturation. The frequency of nutrient application is most influenced by the soil's nutrient holding capabilities. Clay soils with a high nutrient holding capacity could receive weekly nutrient applications through the drip system while a sandy soil with low nutrient holding capacity will respond best with a daily fertigation program. Fertigation rates are provided under crop specific recommendations later in this handbook.

MULCHES AND ROW COVERS

Mulches. The most widely used mulches for vegetable production are black, white on black, clear and metalized polyethylene mulches. Black mulch is most widely used for spring applications where both elevated soil temperatures and weed control are desired. Clear plastic mulch is used when maximum heat accumulation is desired and weed control is not as critical. White on black plastic (with white-side of plastic facing up) is used for late spring and summer plantings where the benefits of moisture retention and weed control are valued and heat accumulation may be detrimental. Growers often will apply white latex paint to black mulch when double cropping.

Metallized mulch, commonly referred to as reflective or silver mulch, is used to combat aphids and thrips that vector viral diseases. Metalized mulch should reflect a recognizable image (that is, be mirror-like) to be most effective.

Organic mulches such as straw, pine straw, compost, and coarse hay provide weed control and moisture retention and keep soils cooler than bare ground. Using hay often introduces weeds into a field. One benefit of using organic mulches is that they add organic matter to the soil when incorporated after the growing season. When using these mulches, supplemental nitrogen may be needed to compensate for the nitrogen that is lost to soil microbes in the process of breaking down the organic mulch.

Bed formation and moisture are critical to the success of growing vegetables with plastic mulch. Beds should be smooth, free of clods and sticks, and of uniform height. Black plastic mulch warms the soil by conduction, so as much contact as possible should be made between the mulch and soil. Raised beds allow the soil to drain and warm more quickly. Drip tape is commonly laid under the plastic in the same field operation. The soil should be moist when the plastic is applied since it is difficult to add enough water to thoroughly wet the width of the bed when using drip irrigation. Steep slopes may limit row length when using drip tape, normally row lengths should not exceed 300 to 600 feet depending on the specifications of drip tape.

Follow label directions for fumigants and herbicides used with plastic mulches. Fumigants have a waiting period before seeds or transplants can be planted. Transplanters and seeders are available to plant through plastic mulch. In fields with a history of nutsedge, appropriate measures must be taken in order to reduce or eliminate infestations as plastic mulches cannot control nutsedge. Nutsedge will compromise plastic mulch by piercing it.

Fertilization. Vegetables produced on plastic mulch, but without the ability to supply nutrients through the drip system, should have all of their required fertilizer incorporated into the beds prior to applying the mulch. Broadcasting the fertilizer before bedding has been shown to be an effective method of application since the bedding process moves most of the fertilizer into the bed. Growers using fertigation should follow the recommendations for each specific crop. Fertigation schedules are listed for cantaloupe, cucumber, eggplant, okra, pepper, summer squash, tomato, and watermelon later in this handbook. Also, refer to the previous section on this page for further information on fertilization.

Double cropping. Growers frequently grow two crops on black plastic mulch. The spring crop is killed and removed, then the plastic is generally painted with white latex paint diluted with water (1 part paint to 5 parts water). After painting, a second crop is planted through the mulch. The new crop should be planted into new holes and fertilizer added based on soil test results and the new crop's nutrient requirements.

Degradable mulches. Photodegradable and biodegradable plastic mulches are available, but usually cost more than conventional films. This additional expense is offset to an extent by reduced disposal costs. They have many of the properties and provide the usual benefits of standard polyethylene mulches. Photodegradable mulches begin to break down after the film has received a predetermined amount of sunlight. When a photodegradable film has received sufficient light, it becomes brittle and develops cracks, tears, and holes. Small sections of film may tear off and be blown around by the wind. Finally, the film breaks down into small flakes and disappears into the soil. **The edges covered by the soil retain their strength and break down very slowly.**

Biodegradable plastic mulches are weakened by exposure to sunlight, but are designed to degrade in the soil by microorganisms when soil moisture and temperatures are favorable for biological activity. Biodegradable film will usually be retained on the surface of the soil rather than be blown away from the application site. In addition, all of the biodegradable film will eventually decompose, including the tucked edges buried in the soil. It is recommended that biodegradable mulch be incorporated into the soil at the end of the harvest or growing season. Cover crops can be planted the next day after biodegradable plastic mulch has been rototilled into the soil.

Plastic Mulch Removal and Disposal

Commercial mulch lifters are available. Plastic can be removed by hand by running a coulter down the center of the row and picking the mulch up from each side. Sanitary landfills may accept plastic mulch in some areas. There are a few recycling projects which accept plastic mulch. Some states allow burning of mulch with a permit.

Row covers. Row covers are used to hasten the maturity of the crop, exclude certain insect pests, and provide a small degree of frost protection. There are two main types of row covers: vented clear or translucent polyethylene that is supported by wire hoops placed at regular (5 to 6 ft) intervals, and floating row covers that are porous, lightweight spunbonded materials placed loosely over the plants. In addition, plastic can be placed loosely over the plants with or without wire supports. Floating covers are more applicable to the low-growing vine crops. Upright plants like tomatoes and peppers have been injured by abrasion when the floating row cover rubs against the plant or excess temperatures build-up. Erratic spring temperatures require intensive management of row covers to avoid blossom shed and other high temperature injuries.

In particular, clear plastic can greatly increase air temperatures under the cover on warm sunny days, resulting in a danger of heat injury to crop plants. Therefore, vented materials are recommended. Even with vents, clear plastic has produced heat injury, especially when the plants have filled a large portion of the air space in the tunnel. This has not been observed with the translucent materials.

Usually, row covers are combined with plastic mulch.

High Tunnels. High tunnels are unheated polyethylene covered greenhouse structures that provide a larger degree of frost protection than row covers. A properly built high tunnel with one or two layers of plastic, should afford 5-8 °F (supposed to be degree symbol) of frost protection for growers. As with row covers, high tunnels require intensive management to ensure that they are vented properly when warm spring temperatures can cause excessive heat to build up in tunnels, resulting in damage to the crop. Tomatoes are commonly produced in high tunnels as well as a variety of leafy greens crops, due to the premium prices obtained. Row covers are often combined with the use of high tunnels and plastic mulch.

In some northern regions, high tunnels can provide 3-4 weeks of season extension for spring and fall crops such as tomatoes as well as year-round production of Cole crops and lettuce. High tunnels can reduce the incidence of certain diseases and insects due to protection from rain and changes in light interception, respectively, inside the tunnel; however, traditional greenhouse pests, such as leaf mold, aphids, spider mites, and white flies may be more prevalent in high tunnels. In many states high tunnels are considered a greenhouse structure for the application of pesticides, which may reduce the number of chemicals available compared to field production. Be sure to determine if the pesticides you are applying are acceptable for use in high tunnels in your state.

Extensive information regarding construction, specifics of crop production, soil management, and economics of production for many fruit, vegetable, and cut flowers grown in high tunnels can be found at http://www.hightunnels.org/.

Considerations for Using Mulch, Drip Irrigation, and Row Covers. Each grower considering mulches, drip irrigation, and/or row covers must weigh the economics involved. The long-term versus short-term opportunities must be considered.

Does the potential increase in return justify the additional costs?

Are the odds in favor of the grower getting the most benefit in terms of earliness and yield from the mulch, drip irrigation, and/or row covers?

Does the market usually offer price incentives for early produce? Will harvesting early allow competition against produce from other regions?

For planting on 5 to 6-foot centers, polyethylene mulch costs $200 to $250 per acre, respectively When using plastic mulch, drip irrigation must also be used. With 5 to 6-foot centers, drip irrigation materials will cost $300 to $350 per acre, respectively. Row covers can cost over $400 per acre. Growers must determine these costs for their situations and calculate their potential returns.

POLLINATION

European honeybees and native wild bees visit the flowers of several flowering vegetables. Cucumbers, squash, pumpkins, and watermelons have separate male and female flowers, while cantaloupes and other speciality melons have male and hermaphroditic (perfect or bisexual) flowers. The sticky pollen of the male flowers must be transferred to the female flowers to achieve fruit set. One to two hives of bees per acre will increase the yield of cucurbits. Lack of adequate pollination usually results in small or misshapen fruit in addition to low yields. The size and shape of the mature fruit is related to the number of seeds produced by pollination; each seed requires one or more pollen grains.

Even though bumblebees and other species of wild bees are excellent pollinators, populations of these native pollinators usually are not adequate for large acreages grown for commercial production. Colonies of wild honeybees have been decimated by Tracheal and Varroa mites and cannot be counted on to aid in pollination. One of the best way to ensure adequate pollination is to own or rent strong colonies of honey bee from a reliable beekeeper. Another option for pollination is the bumblebee. Bumblebees are becoming a popular grower's choice over the past decade and are being used more often and more effectively as a pollinator alternative to honeybees. Commercial bee attractants, have not proven to be effective in enhancing pollination. Growers are advised to increase numbers of honeybee or bumblebee colonies and not to rely on such attractants. Bees are essential for commercial production of all vine crops and may improve the yield and quality of fruit in beans, eggplants, peas, and peppers.

Moving honeybees into the crop at the correct time will greatly enhance pollination. Cucurbit flowers are usually open and attractive to bees for only a day or less. The opening of the flower, release of pollen, and commencement of nectar secretion normally precede bee activity. Pumpkin, squash, cantaloupe, and watermelon flowers normally open around daybreak and close by noon; whereas, cucumbers, and melons generally remain open the entire day. Pollination must take place on the day the flowers open because pollen viability, stigmatic receptivity, and attractiveness to bees lasts only that day.

Honeybee activity is determined, to a great extent, by weather and conditions within the hive. Bees rarely fly when the temperature is below 55°F. Flights seldom intensify until the temperature reaches 70°F. Wind speed beyond 15 miles per hour seriously slows bee activity. Cool, cloudy weather and threatening storms greatly reduce bee flights. In poor weather, bees foraging at more distant locations will remain in the hive, and only those that have been foraging nearby will be active. Ideally, colonies should be protected from wind and be exposed to the sun from early morning until evening. Colony entrances facing east or southeast encourage bee flight. The hives should be off the ground and the front entrances kept free of grass and weeds. For best results, hives should be grouped together. A clean water supply should be available within a quarter mile of the hive.

Bumblebees have some advantages compared to honeybees in that the former fly in cool, rainy, and windy weather and often forage to plants earlier in the morning than honeybees, and later in the day when temperatures cool. Bumblebees also have a larger body size than honeybees requiring fewer visits to achieve good pollination and fruit set.

The number of colonies needed for adequate pollination varies with location, attractiveness of crop, density of flowers, length of blooming period, colony strength, and competing blossoms of other plants in the area. In vine crops, recommendations are one to two colonies per acre, with the higher number for higher density plantings. Each honeybee hive or colony should contain at least 40,000 - 50,000 bees. Multiple bee visits of eight or more visits per flower are required to produce marketable fruit.

Bumblebee hives are sold as a quad or four hives per quad. A quad is the minimum order that can be purchased from a supplier. Generally one bumblebee hive contains 200 to 250 bees and is equivalent to one honeybee hive; however, research that can specifically document this is lacking. Thus, one quad of bumblebees (minimum order, contains 4 bumblebee hives) would provide good pollination for four acres of a Cucurbit crop if the recommendation is to use 1 bumblebee hive per acre. In some instances, two hives per acre or more may be recommended (i.e. triploid watermelon). In this case, one quad would provide good pollination for two acres. Bumblebee hives should not be placed in direct sunlight so that the bees work more efficiently. No more than two bumblebee quads should be placed in one location so that pollination is more uniform in the field. The quad locations should be at least 650 to 700 feet from each other.

Insecticides applied during bloom are a serious threat to bees visiting flowers. If insecticides must be applied, select an insecticide that will give effective control of the target pest but pose the least danger to bees. Apply these chemicals near evening when the bees are not actively foraging and avoid spraying adjacent crops. Give the beekeeper 48 hours notice, if possible, when you expect to spray so that necessary precautions can be taken. Avoid leaving puddles of water around chemical mixing areas, as bees pick up water, which may result in bee kills.

As with honeybees, one must carefully plan when to spray insecticides so that the bumblebees are not killed. Because bumblebees are most active from dawn until late morning and from about 4 PM until sunset, the hives need to be closed around 11 AM so that the bumblebees remain in the hive and are protected during a late evening spray application.

The supplier of both honey- and bumblebee colonies need ample notice prior to when the bees are needed for a given crop. Approximately 3 to 4 months notice is usually sufficient so that crop pollinator needs can be met. A written contract between the grower and beekeeper/supplier can prevent misunderstandings and, thus, ensure better pollinator service. Such a contract should specify the number and strength of colonies, the rental/purchase fee, time of delivery, and distribution of bees in the field.

HOW TO IMPROVE PEST CONTROL

Failure to control an insect, mite, disease, or weed pest is often blamed on the pesticide when the cause frequently lies elsewhere. The more common reasons for failure are the following:

1. Delaying applications until pest populations become too large or damaging.
2. Poor coverage caused by insufficient volume, inadequate pressure, or clogged or poorly arranged nozzles.
3. Selecting the wrong pesticide for the target pests.

THE FOLLOWING STEPS ARE SUGGESTED FOR MORE EFFECTIVE PEST CONTROL:

1. *Scout fields regularly.* Know the pest situation and any buildups in your fields. Frequent examinations (at least once or twice per week) help determine the proper timing of the next pesticide application. Do not apply a pesticide simply because a neighbor does.
2. *Integrated Pest Management (IPM).* Use an ongoing program of biological, physical, cultural, and chemical methods in an integrated approach to manage pests. IPM involves scouts visiting fields to collect pest population data. Use this updated information to decide whether insecticide applications or other management actions are needed to avoid economic loss from pest damage. Control decisions also are based on many factors, such as:
   - The economic action threshold level (when the cost of control equals or exceeds potential crop losses attributed to real or potential damage)
   - Other factors are listed in the Recommended Control Guidelines section following

To employ an IPM program successfully, basic practices need to be followed. Whether participating in a university- or grower-supported IPM program, hiring a private consultant, or doing the work personally, the grower still practices:

- frequent and regular examination of fields to assess pest populations
- applying a control measure only when the economic threshold level has been reached
- where possible, employing a cultural practice or a biological control or using a pesticide that is less harmful to natural enemies of the target pest

Resistance management. The way pesticides are used affects the development of resistance. Resistance develops because intensive pesticide use kills the susceptible individuals in a population, leaving only resistant ones to breed. Adopting the following practices will reduce the development of pest resistance:

1. Rotate crops to a nonhost crop, thus reducing the need for pesticide treatment and, thereby reducing the ratio of resistant to susceptible individuals in the breeding population.
2. Use control guidelines as an important tactic for reducing the pesticide resistance problem. For more information concerning control guidelines, refer to the next section.
3. Spot treat when possible. Early-season insects are often concentrated in areas near their overwintering sites. Diseases often can be first detected in favorable microclimates, such as low or wet areas of the field. Perennial weeds and newly introduced or resistant annual weeds often occur first in small numbers in a part of a field. Spot treating these areas, rather than the entire field, will reduce problems with resistance.
4. Control pests early, because seedling weeds and immature insects are more susceptible to pesticides and less likely to develop resistance compared to older and more mature crop pests.
5. Do not overspray. Attempts to destroy every pest in the field by multiple applications or by using higher than labeled rates often eliminate the susceptible pests but not the resistant pests.
6. Rotate pesticides to reduce the development of resistance, particularly with pesticides that differ in their mechanism of action. Rotation among different chemical groups is an excellent method of reducing resistance problems.

7. Use appropriate additives when recommended on the pesticide's label. For example, adding a crop oil concentrate or a surfactant to certain postemergence herbicides will increase the effectiveness of the herbicides.

Control Pests According to Recommended Control Guidelines or Schedule. Control guidelines provide a way to decide whether pesticide applications or other management actions are needed to avoid economic loss from pest damage. Guidelines for pests are generally expressed as a count of a given insect stage or as a crop damage level based on certain sampling techniques. They are intended to reflect the pest population that will cause economic damage and thus would warrant the cost of treatment. Guidelines are usually based on pest populations, field history, stage of crop's development, variety, weather conditions, life stage of the pest, parasite, and/or predator populations, resistance to chemicals, time of year, and other factors. Specific thresholds are given in this handbook for a number of pests of many crops.

Insect population sampling techniques include:

- *Visual observation*. Direct counts of any insect stages (eggs, larvae, adults, etc.) are accomplished by examining plants or plant parts (leaves, stems, flowers, fruits). Counts can be taken on single plants or a prescribed length of row, which will vary with the crop. Usually, quick moving insects are counted first, followed by those that are less mobile.
- *Shake cloth* (also known as a ground cloth). This sampling procedure consists of using a standard 3-foot by 3-foot shake cloth to assess insect populations. Randomly choose a site without disturbing the plants and carefully unroll the shake cloth between two rows. Bend the plants over the cloth one row at a time and beat the plants vigorously to dislodge insects held on stems, leaves, and branches. Count only insects that have landed on the shake cloth. The number of sampling sites per field will vary with the crop.
- *Sweep net*. This sampling procedure uses a standard 15-inch diameter sweep net to assess insect populations. While walking along one row, swing the net from side to side with a pendulum-like motion to face the direction of movement. The net should be rotated 180 degrees after each sweep and swung through the foliage. Each pass of the net is counted as one sweep. The number of sweeps per field will vary with the crop.

Weed population sampling techniques include:

- *Weed identification*. This first step is frequently skipped. Perennial weeds and certain serious annual weeds should be controlled before they can spread. Common annual weeds need only be controlled if they represent a threat to yield, quality, or harvestability.
- *Growth stage determination*. The ability of weeds to compete with the crop is related to size of the weed and size of the crop. Control of the weed using herbicides or mechanical methods is also dependant on weed size. A decision to control or not to control a weed must be carried out before the crop is affected and before the weed is too large to be controlled easily. It is critical to know the weed history of a field prior to planting as many herbicides need to be applied pre-plant.
- *Weed population*. Weeds compete for light, water, nutrients, and space. The extent of this competition is dependant on population and is usually expressed as *weeds per foot of row or weeds per square meter.* Control measures are needed when the weed population exceeds the maximum tolerable population of that species.

Disease monitoring involves determining the growth stage of the crop, observing disease symptoms on plants, and/or the daily weather conditions in the field.

Disease control is often obtained by applying crop protectants on a regular schedule. For many diseases, application must begin at a certain growth stage and must be repeated every 7 to 10 days. When environmental conditions are favorable for disease development, delaying a spray program will result in a lack of control if the disease has progressed too far. For certain diseases that do not spread rapidly, fields should be scouted regularly.

Predictive systems are available for a few diseases. Temperature, rainfall, relative humidity, and duration of leaf wetness period are monitored, and the timing of fungicide application is determined by predicting when disease development is most likely to occur.

Weather Conditions. These are important to consider before applying a pesticide. Spray only when wind velocity is less than 10 miles per hour. Do not spray when sensitive plants are wilted during the heat of the day. *If possible, make applications when ideal weather conditions prevail*.

Certain pesticides, including biological insecticides (eg. BT's) and some herbicides, are ineffective in cool weather. Others do not perform well or may cause crop injury when hot or humid conditions are prevalent. Optimum results can frequently be achieved when the air temperature is in the 70°F range during application.

Strive for Adequate Coverage of Plants.

Improved control of aphids can be achieved by adding and arranging nozzles so that the application is directed toward the plants from the sides as well as from the tops (also see *Alkaline Water and Pesticides*, which follows). In some cases, nozzles should be arranged so that the application is directed beneath the leaves. As the season progresses, plant size increases, as does the need for increased spray gallonage to ensure adequate coverage.

Applying insecticide and fungicide sprays with sufficient spray volume and pressure is important. Spray volumes should increase as the crop's surface area increases. Sprays from high-volume-high-pressure rigs (airblast) should be applied at rates of 40 to 200 gallons per acre at 200 psi or greater. Sprays from low-volume-low-pressure rigs (boom type) should be applied at rates of 50 to 100 gallons per acre at 20 psi. The addition of a spreader-sticker improves coverage and control when wettable powders are applied to smooth-leaved plants, such as cole crops and onions.

Use one sprayer for herbicides and a different sprayer for fungicides and insecticides. Herbicide sprays should be applied at between 15 and 50 gallons of spray solution per acre using low

pressure (20 to 40 psi). Never apply herbicides with a high-pressure sprayer that was designed for insecticide or fungicide application because excessive drift can result in damage to nontarget plants in adjacent fields and areas. **Do not** add oil concentrates, surfactants, spreader-stickers, or any other additive unless **specified** on the label, or crop injury is likely.

Select the Proper Pesticide. Know the pests to be controlled and choose the recommended pesticide and rate of application. When in doubt, consult your local Extension office. The herbicide choice should be based on weed species or cropping systems.

For insects that are extremely difficult to control or are resistant, it is essential to alternate labeled insecticides, especially with different classes of insecticides. Be alert for a possible aphid or mite buildup following the application of certain insecticides such as carbaryl.

Caution: Proper application of soil systemic insecticides is extremely important. The insecticide should be placed according to the label instructions (which, in general, indicate application should be directed away from the seed) or crop injury may occur.

Be sure to properly identify the disease(s). Many fungicides control specific diseases and provide no control of others. For this reason, on several crops, fungicide combinations are recommended.

Pesticide Compatibility. To determine if two pesticides are compatible, use the following "jar test" before you tank-mix pesticides or tank-mix pesticides with liquid fertilizers:

1. Add 1 pint of water or fertilizer solution to a clean quart jar, then add the pesticides to the water or fertilizer solution in the same proportion as used in the field.

2. To a second clean quart jar, add 1 pint of water or fertilizer solution. Then add 1/2 teaspoon of an adjuvant to keep the mixture emulsified. Finally, add the pesticides to the water-adjuvant or fertilizer adjuvant in the same proportion as used in the field.

3. Close both jars tightly and mix thoroughly by inverting 10 times. Inspect the mixtures immediately and after standing for 30 minutes. If a uniform mix cannot be made, the mixture should not be used. If the mix in either jar remains uniform for 30 minutes, the combination can be used. If the mixture with adjuvant stays mixed and the mixture without adjuvant does not, use the adjuvant in the spray tank. If either mixture separates but readily remixes, constant agitation is required. If nondispersible oil, sludge, or clumps of solids form, do not use the mixture.

Note: For compatibility testing, the pesticide can be added directly or premixed in water first. In actual tank-mixing for field application, unless label directions specify otherwise, add pesticides to the water in the tank in this order: first, wettable granules or powders, then flowables, emulsifiable concentrates, water solubles, and companion surfactants. If tank-mixed adjuvants are used, these should be added first to the fluid carrier in the tank. Thoroughly mix each product before adding the next product.

Select Correct Sprayer Tips. The choice of a sprayer tip for use with many pesticides is important. Flat fan-spray tips are designed for preemergence and postemergence application of herbicides. These nozzles produce a tapered-edge spray pattern that overlaps for uniform coverage when properly mounted on a boom. Standard flat fan-spray tips are designed to operate at low pressures (20-40 psi) to produce small-to medium-sized droplets that do not have excessive drift. Flat fan-nozzle tips are available in brass, plastic, ceramic, stainless steel, and hardened stainless steel. Brass nozzles are inexpensive and are satisfactory for spraying liquid pesticide formulations. Brass nozzles are least durable, and hardened stainless steel nozzles are most durable and are recommended for wettable powder formulations, which are more abrasive than liquid formulations. When using any wettable powder, it is essential to calibrate the sprayer frequently because, as a nozzle wears, the volume of spray material delivered through the nozzle increases.

Flood-type nozzle tips are generally used for complete fertilizers, liquid N, etc., and sometimes for spraying herbicides onto the soil surface prior to incorporation. They are less suitable for spraying postemergence herbicides or for applying fungicides or insecticides to plant foliage. Coverage of the target is often less uniform and complete when flood-type nozzles are used, compared with the coverage obtained with other types of nozzles. Results with postemergence herbicides applied with flood-type nozzles may be satisfactory if certain steps are taken to improve target coverage. Space flood-type nozzles a maximum of 20 inches apart, rather than the suggested 40-inch spacing. This will result in an overlapping spray pattern. Spray at the maximum pressure recommended for the nozzle. These techniques will improve target coverage with flood-type nozzles and result in more satisfactory weed control.

Full and hollow-cone nozzles deliver circular spray patterns and are used for application of insecticides and fungicides to crops where thorough coverage of the leaf surfaces is extremely important and where spray drift will not cause a problem. They are used when higher water volumes and spray pressures are recommended. With cone nozzles, the disk size and the number of holes in the whirl plate affect the output rate. Various combinations of disks and whirl plates can be used to achieve the desired spray coverage.

Alkaline Water and Pesticides. At times applicators have commented that a particular pesticide has given unsatisfactory results. Usually, these results can be attributed to poor application, a bad batch of chemical, pest resistance, weather conditions, etc. However, another possible reason for unsatisfactory results from a pesticide may be the pH of the mixing water.

Some materials carry a label cautioning the user against mixing the pesticide with alkaline materials. The reason for this caution is that some materials (in particular the organophosphate insecticides) undergo a chemical reaction know as "alkaline hydrolysis." This reaction occurs when the pesticide is mixed with alkaline water; that is, water with a pH greater than 7. The more alkaline the water, the greater the breakdown (i.e., "hydrolysis").

In addition to lime sulfur, several other materials provide alkaline conditions: caustic soda, caustic potash, soda ash, magnesia or dolomitic limestone, and liquid ammonia. Water sources in agricultural areas can vary in pH from less than 3 to greater than 10.

To check the pH of your water, purchase a pH meter or in most states you can submit a water sample to your state's soil or

water testing lab. If you have a problem with alkaline pH, there are several products available that are called nutrient buffers that will lower the pH of your water.

There are some instances when materials should not be acidified, namely, sprays containing fixed copper fungicides, including: Bordeaux mixture, copper oxide, basic copper sulfate, copper hydroxide, etc.

BENEFICIAL INSECTS

A number of environmental factors, such as weather, food availability, and natural enemies combine to keep insect populations under control naturally. In some human-altered landscapes, such as in agricultural crop fields, the levels of natural control are often not acceptable to us, and we have to intervene in order to lower pest populations. While some environmental factors, such as weather, cannot be altered to enhance control of pests, others such as populations of natural enemies, can be effected. The practice of taking advantage of and manipulating natural enemies in order to suppress pest populations is called *biological control*.

Approaches To Biological Control. There are three general approaches to biological control: importation, augmentation, and conservation of natural enemies. Each of these techniques can be used either alone or in combination in a biological control program.

Importation: Importation of natural enemies, sometimes referred to as classical biological control, is used when a pest of exotic origin is the target of the biocontrol program. Pests are constantly being imported into countries where they are not native, either accidentally, or in some cases, intentionally. Many of these introductions do not result in establishment or if they do, the organism may not become a pest. However, it is possible for some of these introduced organisms to become pests due to a lack of natural enemies to suppress their populations. In these cases, importation of natural enemies can be highly effective.

Once the country of origin of the pest is determined, exploration in the native region can be conducted to search for promising natural enemies. If such enemies are identified, they may be evaluated for potential impact on the pest organism in the native country or alternatively imported into the new country for further study. Natural enemies are imported into the U.S. only under permit from the U.S. Department of Agriculture. They must first be placed in quarantine for one or more generations to be sure that no undesirable species are accidentally imported (diseases, hyperparasitoids, etc.). Additional permits are required for interstate shipment and field release.

Augmentation: Augmentation is the direct manipulation of natural enemies to increase their effectiveness. This can be accomplished by one of two general methods or a combination of these methods: mass production and/or periodic colonization of natural enemies. The most commonly used of these approaches is the first, in which natural enemies are produced in insectaries, then released either inoculatively or inundatively. For example, in areas where a particular natural enemy cannot overwinter, an inoculative release each spring may allow the population to establish and adequately control a pest. Inundative releases involve the release of large numbers of a natural enemy such that their population completely overwhelms the pest.

Augmentation is used where populations of a natural enemy are not present or cannot respond quickly enough to the pest population. Therefore, augmentation usually does not provide permanent suppression of pests, as may occur with importation or conservation methods. An example of the inoculative release method is the use of the parasitoid wasp, *Encarsia formosa* Gahan, to suppress populations of the greenhouse whitefly, *Trialeurodes vaporariorum* (Westwood). The greenhouse whitefly is a ubiquitous pest of vegetable and floriculture crops that is notoriously difficult to manage, even with pesticides. Releases of relatively low densities (typically 0.25 to 2 per plant, depending on the crop) of *Encarsia* immediately after the first whiteflies have been detected on yellow sticky cards can effectively prevent populations from developing to damaging levels. However, releases should be made within the context of an integrated crop management program that takes into account the low tolerance of the parasitoids to pesticides. It is important to bear in mind that *Encarsia* can provide effective control of greenhouse whitefly, but not sweetpotato whitefly. Therefore, it is critical to identify which whitefly is present before releasing *Encarsia*. Another parasitoid, *Eretmocerus californicus* has shown promise against sweetpotato whitefly.

Because most augmentation involves mass-production and periodic colonization of natural enemies, this type of biological control has lent itself to commercial development. There are hundreds of biological control products available commercially for dozens of pest invertebrates (insects, spidermites, etc.), vertebrates (deer, rodents, etc.), weeds, and plant pathogens. A summary of these products and their target pests is presented in Table 13. The efficacy of these predators and parasites is dependent on many factors. Management of the target pest is more likely than 100% control. It is critical to familiarize yourself with proper usage of these predators and parasites otherwise you may not achieve satisfactory results and obtain inconsistent results. Selection of products and suppliers should be done with care, as with purchasing any product. Review publications for guidelines on how to purchase and utilize natural enemies.

Conservation: The most common form of biological control is conservation of natural enemies which already exist in a cropping situation. Conservation involves identifying the factor(s) which may limit the effectiveness of a particular natural enemy and modifying these factor(s) to increase the effectiveness of natural enemies. In general, this involves either reducing factors which interfere with natural enemies or providing resources that natural enemies need in their environment. The most common factor that interferes with natural enemy effectiveness is the application of pesticides. Some cultural practices such as tillage or burning of crop debris can also kill natural enemies or make the crop habitat unsuitable. In some crops, accumulation of dust deposits on leaves from repeated tillage or a location near roadways may kill small predators and parasites and cause increases in certain insect and mite pests. In some cases, the chemical and physical defenses that plants use to protect themselves from pests may reduce the effectiveness of biological control.

An example of how conservation can work involves the diamondback moth, *Plutella xylostella* (L.). This insect has developed into the most important pest of crucifers in recent years due to the

TABLE 13. PREDATORS AND PARASITES OF VEGETABLE PESTS

Predators and Parasites	Approx. # North American Species	Pest(s) Controlled or Impacted
WASPS		
Aphelinid Wasps *	1,000	Aphids on some greenhouse and vegetable crops; mummies of parasitized aphids will be black.
Aphidiid Wasps *	114	Aphid parasites; mummies turn tan or golden.
Braconid Wasps *	1,000	Caterpillars on Cole crops and Irish potatoes, leafminers in greenhouse crops.
Chalcid Wasps *	1,500	Internal and external parasite of fly and moth larvae and pupae. A few species attack beetles.
Cotesia Wasps (Braconid Family) *	200	Parasites of caterpillars including armyworms, Alfalfa caterpillar, loopers, cabbageworms.
Encarsia formosa *	1	A commercially available Aphelinid wasp, whiteflies on greenhouse/some field crops.
Encyrtid Wasps	500	Aphids on some greenhouse crops, Cabbage looper, root maggot.
Eulophid Wasps	3,400	Colorado Potato Beetle, Mexican Bean beetle, Asparagus beetle, leafminers in field crops.
Ichneumonid Wasps *	3,100	Caterpillars, eggs, and beetle larvae in: Cole crops, corn, Asparagus whiteflies on Cole crops and tomato.
Mymarid Egg Wasps	1,300	Lygus bug, Tarnished Plant bug, carrot weevil. Egg parasite of beetles, flies, grasshoppers, leafhoppers and many true bugs (Stink bugs, lygeids). Adults are 1/25 inch in size.
Pteromalid Wasps	3,000	Parasites of beetles, flies, and other wasps, cabbage worm, diamondback moth.
Scelionid Egg Wasps	300	Parasite of true bug and moth eggs.
Tiphiid Wasps	225	Parasites of Japanese beetles and Tiger beetles.
Trichogramma Wasps *	650	Moth eggs on Cole crops, peppers, sweet corn, and tomatoes. Because only eggs are parasitized, releases must be timed to coincide with egg laying (use pheromone trap to determine timing).
Thripobius semiluteus (Eulophidae Family)*	1	Controls thrips via parasitism.
Vespid Wasps (hornets, yellowjackets, etc.)	200	Caterpillars, flies, true bugs, beetles, and other wasps are fed to Vespid larvae.
FLIES		
Aphid Flies (Chamaemyiid Flies)	36	Feed on aphids, mealybugs, and soft scales.
Bombyliid Flies (Bee Flies)	250	Internal and external parasites of various caterpillars and wasp larvae, beetle larvae, some eggs.
Nemestrinid Flies (Tangle Veined Flies)	250	Internal parasites of locusts and beetle larvae and pupae.
Phorid Flies (Humpbacked Flies)	350	Internal parasites of ants, bees, caterpillars, moth pupae, and fly larvae.
Pipunculid Flies (Big-Headed Flies)	100	Internal parasites of leafhoppers and planthoppers.
Predatory Midges (Cecidomyiid Flies)*	10	Aphids and mites on some greenhouse crops.
Pyrgotidae (Pyrgotid Flies)	5	Internal parasites of June beetles and related Scarab beetles; nocturnal and rarely seen.
Syrphid Flies	1,000	Most larvae are predaceous upon aphids, whitefly pupae, and soft-bodied small insects.
Tachinid Flies	1,300	Internal parasite of beetle, butterfly, and moth larvae, earwigs, grasshoppers and true bugs. Tachinids lay eggs directly on host or on a leaf that is then eaten by the host insect. Some species parasitize Japanese beetles.
TRUE BUGS		
Assassin Bugs (Reduviidae)	160	Generalist predators against small and soft-bodied insects, eggs, and pupae.
Big-Eyed Bug, *Geocoris* spp.	25	Generalist predators feeding on a wide variety of insect eggs and small larvae. Both immature and adults are predaceous and feed on over 60 species of other insects.
Damsel Bugs (Nabidae)	34	Mites, aphids, caterpillars, leafhoppers, and other insects, especially soft-bodied insects.
Minute Pirate Bug, *Orius insidiosis* (aka Flower Bug)*	1	Thrips, spider mites, aphids, small caterpillars small insects in sweet corn, Irish potato, and on some greenhouse crops.
Predatory Stink Bug (*Perillus, Podisus* spp.)	14	Look similar to plant feeding Stink bugs, but feed on caterpillar pests, small insects and insect eggs, and Colorado Potato beetle (larvae). Effective in Solanaceous crops, beans, Cole crops and asparagus.
Spined Soldier Bug, *Podisus maculiventris**	1	Generalist predator on many vegetables (i.e. Irish potato, tomato, sweet corn, Cole crops, beans, eggplant, cucurbits, asparagus, onions). Attacks larvae of European Corn borer, Diamondback moth, Corn Earworm, Beet Armyworm, Fall Armyworm, Colorado Potato beetle, Cabbage Looper, Imported Cabbageworm, and Mexican Bean beetle. A pheromone to attract Spined Soldier Bug is also available.
BEETLES		
Ground Beetles (Carabid Beetles)	2,200	Both larvae and adults predaceous, nocturnal. Feed on mites and snails, soil dwelling beetle and fly eggs and pupae, some caterpillars, and other soft bodied insects. Most beneficial in Cole crops, root crops, and onions.
Lady Beetles (Coccenelidae)*	400	Aphids, mites, whitefly, small insects, and insect eggs in most vegetable crops (especially Irish potatoes, tomatoes, sweet corn and Cole crops. Release purchased lady beetles in evening, in vicinity of pest, and cover with a light sheet or cloth overnight for best predator retention.
Rove Beetles (Staphylinidae)	3,100	Distinguished by short outer wings and exposed abdomens, Rove beetles feed on a variety of eggs, pupae, larvae, and soft bodied insects (aphids, mites, whitefly).
Soft-Winged Flower Beetles (Melyridae)	450	Adults and larvae feed on aphids, leafhoppers, and other immature insects. Covered in fine hairs that give the insect a velvety appearance.
Soldier Beetles (Cantharids, aka Leather-Winged Beetles)	100	All larvae, and some adults, are predaceous. Other adults feed on nectar and pollen, so can be attracted by flower plantings. Predators of eggs and larvae of beetles, butterflies moths, aphids, others. Most effective in Cole crops, cucurbits, and sweet corn.
Tiger Beetles (Cicindelid Beetles)	40	Adults and larvae prey on a wide variety of insects.

* Insects marked with an asterisk represents species that are available commercially for purchase.
For a list of Biological Control (Beneficial Insects) Suppliers, see http://wiki.bugwood.org/Commercially_available_biological_controls

TABLE 13. PREDATORS AND PARASITES OF VEGETABLE PESTS (cont'd)

Predators and Parasites	Approx. # North American Species	Pest(s) Controlled or Impacted
OTHER BENEFICIAL ORGANISMS		
Praying Mantis *		Flies, crickets, bees, moths. All life stages are predatory. Commercially available mantis are usually Tenodera aridifolia, a Chinese species.
Lacewings*	27	Aphids, thrips, small caterpillars, leafhoppers, mealybugs, psyllids, whiteflies, and insect eggs. Release purchased lacewings as soon as target pest is noticed in field to achieve good results.
Parasitic nematodes*		Cutworms, beetle larvae, root maggots.
Predatory mites (Phytoseiidae & 3 other families)*	6	Releases most beneficial in strawberries and greenhouse vegetables; avoid carbamates and organophosphates to encourage natural populations in field. Primarily effective against spider mites and thrips.

* Insects marked with an asterisk represents species that are available commercially for purchase.
For a list of Biological Control (Beneficial Insects) Suppliers, see http://wiki.bugwood.org/Commercially_available_biological_controls

pest's development of resistance to most pesticides. Two parasitoids, the Ichneumonid wasp *Diadegma insulare* (Cresson) and the braconid wasp *Cotesia plutellae* (Kurdjunov), can help reduce diamondback moth populations if excessive pesticide applications are avoided, especially with reductions in the use of pyrethroids. BT products can work well to suit this purpose. Therefore, by simply being selective in the type of pesticide used, and by spraying only when threshold levels are reached, free control can be provided by natural enemies already present in the field.

Incorporating Biological Control Into A Pest Management Program: Biological control can be an effective, environmentally sound method of managing pests. However, when trying to make the best use of natural enemies in your crop, it may be helpful to consider the following suggestions.

First, make sure you have your pest(s) accurately identified. Extension can help with this. Consulting your local Extension office is a good practice regardless of which pest control method you use.

Second, determine if natural enemy releases are appropriate for your specific situation. Sometimes knowledge of crop and cultural practices that encourage naturally-occurring biological control agents can allow you to maximize the control they provide. By conserving these natural enemies, pesticide use (and therefore expense) can be minimized.

Usually, released natural enemies work best as a preventative pest management method. That is, if they are introduced into your crop at the *beginning* of a pest infestation, they can prevent that population from developing to damaging levels. If you wait until pests have become a problem *before* releasing natural enemies, the use of natural enemies usually will not work. Therefore, pest problems must be anticipated and planned for by carefully monitoring pest population development. Effective trapping, monitoring, and field scouting should be used to determine when pests appear, and to determine the timing of natural enemy releases.

If you decide to use commercially available biological control agents, you should choose your product and supplier carefully. Once you have received your natural enemies, handle them with care, following all instructions provided by your supplier. The number or rate of natural enemies to release can be determined through consultation with a reliable supplier, as can the timing of application. Because natural enemies are living organisms, adverse conditions (e.g. stormy weather, pesticide residues) can kill them or reduce their effectiveness. Because the actions of natural enemies are not as obvious as those of pesticides, it may be important to work with your supplier to develop a procedure to evaluate the effectiveness of your releases.

Further details of the above suggestions are provided in Table 13. Remember, just because an organism is sold as a "natural" or "biological" control does not mean it will work as you expect. For example, praying mantids are general "ambush" predators that will eat anything small enough (usually mobile insects) that pass in front of them. They do not specifically attack pests that growers are usually interested in removing. Another example is ladybeetle adults that have been "pre-conditioned." These ladybeetles will just as readily leave the area that you have treated as ladybeetles that have been collected and not pre-conditioned.

This does not mean that biological control will not work for your situation. There are a number of products and approaches that can provide very satisfactory results.

For the most current information about suppliers of organisms and related products, the purchase of natural enemies, and how to effectively use them, consult with Extension:

DIAGNOSING VEGETABLE CROP PROBLEMS

When visiting a vegetable field, follow the steps outlined below to help solve any potential problems. All vegetable problems, such as poor growth, leaf blemishes, wilts, rots, and other problems should be promptly diagnosed. This is necessary for the grower to implement prompt and effective corrective measures or to help reduce the probability of its reoccurrence in following crops or its spread to susceptible neighboring crops.

1. Describe the problem.
2. Determine whether there is a pattern of symptomatic plants in the field.
   a. Does the pattern correlate with a certain area in the field, such as a low spot, poor-drainage area, or sheltered area?
   b. Does the pattern correlate with concurrent field operations, such as certain rows, time of planting, method of fertilization, or rate of fertilization?
3. Try to trace the history of the problem.
   a. On what date were the symptoms first noticed?
   b. Which fertilizer and liming practices were used?
   c. Which pest-management practices were used to manage diseases, undesirable insects, and weeds — which chemicals (if any), were applied, at what application rates, and what was the previous use of equipment that was used for application?

d. What were the temperatures, soil moisture conditions, and level of sunlight?

e. What was the source of seed or planting stock?

f. Which crops were grown in the same area during the past 3 or 4 years?

4. Examine affected plants to determine whether the problem is related to insects, diseases, or cultural practices.

a. Do the symptoms point to **insect** problems? Insect problems are usually restricted to the crop. (A hand lens is usually essential to determine this.)

(1) Look for the presence of insects, webbing, and frass on foliage, stems, and roots.

(2) Look for feeding signs such as chewing, sucking, or boring injuries.

b. Do the symptoms suggest **disease** problems? These symptoms are usually not uniform; rather, they are specific for certain crops.

(1) Look for necrotic (dead) areas on the roots, stems, leaves, flowers, and fruit.

(2) Look for discoloration of the vascular tissue (plant veins).

(3) Look for fungal growth.

(4) Look for virus patterns; often these are similar to injury from 2,4-D or other hormones and nutritional problems.

(5) Examine roots for twisting or galling.

c. Do the symptoms point to **cultural** problems? Look for the following:

(1) Nutrient deficiencies. (A soil test from good areas and poor areas should be done as well as analysis of nutrient content of leaf tissue from the same areas.)

- Nitrogen—light green or yellow foliage. Nitrogen deficiencies are more acute on lower leaves.
- Phosphorus—purple coloration of leaves; plants are stunted.
- Potassium— yellow or brown leaf margins and leaf curling.
- Magnesium—interveinal chlorosis (yellowing between veins) of mid level or lower leaves.
- Boron—development of lateral growth; hollow, brownish stems; cracked petioles.
- Iron—light green or yellow foliage occurs first and is more acute on young leaves.
- Molybdenum—"whiptail" leaf symptoms on cauliflower and other crops in the cabbage family.

(2) Chemical toxicities.

- Toxicity of minor elements—boron, zinc, manganese.
- Soluble salt injury—wilting of the plant when wet; death, usually from excessive fertilizer application or accumulation of salts from irrigation water.

(3) Soil problems. (Take soil tests of good and poor areas.)

- Poor drainage.
- Poor soil structure, compaction, etc.
- Hard pans or plow pans.

(4) Pesticide injury. (Usually uniform in the area or shows definite patterns, and more than one plant species, such as weeds, are often symptomatic.)

- Insecticide burning or stunting.
- Weed-killer (herbicide) burning or abnormal growth.

(5) Climatic damage.

- High-temperature injury.
- Low-temperature (chilling) injury.
- Lack of water.
- Excessive moisture (lack of soil oxygen).
- Frost or freeze damage.

(6) Physiological damage.

- Air-pollution injury.
- Genetic mutations (this is rare).

In summary, when trying to solve a vegetable crop problem, take notes of problem areas, look for a pattern to the symptoms, trace the history of the problem, and examine the plants and soil closely. These notes can be used to avoid the problem in the future or to assist others in helping solve their problem. Publications and bulletins designed to help the grower identify specific vegetable problems are available from Extension.

AIR POLLUTION INJURY

The extent of plant damage by particular pollutants in any given year depends on meteorological factors leading to air stagnation, the presence of a pollution source, and the susceptibility of the plants.

Some pollutants that affect vegetable crops are sulfur dioxide (SO_2), ozone (O_3), peroxyacetyl nitrate (PAN), chlorine (Cl), and ammonia (NH_3).

Sulfur dioxide. SO_2 causes acute and chronic plant injury. Acute injury is characterized by clearly marked dead tissue between the veins or on leaf margins. The dead tissue may be bleached, ivory, tan, orange, red, reddish brown, or brown, depending on plant species, time of year, and weather conditions. Chronic injury is marked by brownish red, turgid, or bleached white areas on the leaf blade. Young leaves rarely display damage, whereas fully expanded leaves are very sensitive.

Some crops sensitive to sulfur dioxide are: squash, pumpkin, mustard, spinach, lettuce, endive, Swiss chard, broccoli, bean, carrot, and tomato.

Ozone. A common symptom of O_3 injury is small stipplelike or flecklike lesions visible only on the upper leaf surface. These very small, irregularly shaped spots may be dark brown to black (stipplelike) or light tan to white (flecklike). Very young leaves are normally resistant to ozone. Recently matured leaves are most susceptible. Leaves become more susceptible as they mature, and the lesions spread over a greater portion of the leaf with successive

ozone exposures. Injury is usually more pronounced at the leaf tip and along the margins. With severe damage, symptoms may extend to the lower leaf surface.

Pest feeding (red spider mite and certain leafhoppers) produces flecks on the upper surface of leaves much like ozone injury. Flecks from insect feeding, however, are usually spread uniformly over the leaf, whereas ozone flecks are concentrated in specific areas. Some older watermelon varieties and red varieties of Irish potatoes and beans are particularly sensitive to ozone.

Peroxyacetyl nitrate. PAN affects the under surfaces of newly matured leaves, and it causes bronzing, glazing, or silvering on the lower surface of sensitive leaf areas.

The leaf apex of broadleaved plants becomes sensitive to PAN about 5 days after leaf emergence. Since PAN toxicity is specific for tissue of a particular stage of development, only about four leaves on a shoot are sensitive at any one time. With PAN only successive exposures will cause the entire leaf to develop injury. Injury may consist of bronzing or glazing with little or no tissue collapse on the upper leaf surface. Pale green to white stipplelike areas may appear on upper and lower leaf surfaces. Complete tissue collapse in a diffuse band across the leaf is helpful in identifying PAN injury.

Glazing of lower leaf surfaces may be produced by the feeding of thrips or other insects or by insecticides and herbicides, but differences should be detectable by careful examination.

Sensitive crops are: Swiss chard, lettuce, beet, escarole, mustard, dill, pepper, Irish potato, spinach, tomato, and cantaloupe.

Chlorine. Injury from chlorine is usually of an acute type, and it is similar in pattern to sulfur dioxide injury. Foliar necrosis and bleaching are common. Necrosis is marginal in some species, but scattered in others either between or along veins. Lettuce plants exhibit necrotic injury on the margins of outer leaves, which often extends into solid areas toward the center and base of the leaf. Inner leaves remain unmarked. Crops sensitive to chlorine are: Chinese cabbage, lettuce, Swiss chard, beet, escarole, mustard, dill, pepper, Irish potato, spinach, tomato, cantaloupe, corn, onion, and radish.

Ammonia. Field injury from NH_3 has been primarily due to accidental spillage or use of ammoniated fertilizers under plastic mulch on light sandy soils. Slight amounts of the gas produce color changes in the pigments of vegetable skin. The dry outer scales of red onions may become greenish or black, whereas scales of yellow or brown onions may turn dark brown. In addition, chicken litter may be high in ammonia (NH_3) and ammonium (NH_4), and if sufficient time is not allowed between litter application and planting, substantial damage from ammonia toxicity may occur to seeds or seedlings.

WHAT ARE GOOD AGRICULTURAL PRACTICES (GAPS)?

Good agricultural practices (GAPs) are the basic environmental and operational conditions necessary for the production of safe, wholesome fruits and vegetables. The purpose of GAPs is to give logical guidance in implementing best management practices that will help to reduce the risks of microbial contamination of fruits and vegetables. Examples of GAPs include worker hygiene and health, manure use, and water quality throughout the production and harvesting process. While the United States has one of the safest food supplies in the world, recent media attention the past few years on food borne illness outbreaks underscores the importance of good agricultural practices.

Growers, packers, and shippers are urged to take a proactive role in minimizing food safety hazards potentially associated with fresh produce. Being aware of, and addressing, the common risk factors outlined in GAPs will result in a more effective, cohesive response to emerging concerns about the microbial safety of fresh fruits and vegetables. Furthermore, operators should encourage the adoption of safe practices by their partners along the farm-to-table food chain. This includes distributors, exporters, importers, retailers, producer transporters, food service operators, and consumers.

BASIC PRINCIPLES OF GOOD AGRICULTURAL PRACTICES (GAPS)

By identifying basic principles of microbial food safety within the realm of growing, harvesting, packing, and transporting fresh produce, growers will be better prepared to recognize and address the principal elements known to give rise to microbial food safety concerns.

1. *Prevention* of microbial contamination of fresh produce is favored over reliance on *corrective actions* once contamination has occurred.

2. To minimize microbial food safety hazards in fresh produce, growers, packers, and shippers should use good agricultural and management practices *in those areas over which they have control*.

3. Fresh produce can become microbiologically contaminated at any point along the farm-to-table food chain. The major source of microbial contamination with fresh produce is associated with *human or animal feces*.

4. Whenever *water* comes in contact with produce, its source and quality dictates the potential for contamination. Minimize the potential of microbial contamination from water used with fresh fruits and vegetables.

5. Practices using *animal manure or municipal biosolid wastes* should be managed closely to minimize the potential for microbial contamination of fresh produce.

6. *Worker hygiene and sanitation* practices during production, harvesting, sorting, packing, and transport play a critical role in minimizing the potential for microbial contamination of fresh produce.

7. Follow *all applicable local, state, and federal laws and regulations*, or corresponding or similar laws, regulations or standards for operators outside the U.S., for agricultural practices.

8. Accountability at all levels of the agricultural environment (farm, packing facility, distribution center, and transport operation) is important to a successful food safety program.

9. There must be *qualified personnel and effective monitoring* to ensure that all elements of the program function correctly and to help track produce back through the distribution channels to the producer.

More information and resources on Good Agricultural Practices can be found at: *http://www.ncfreshproducesafety.org* or by contacting your local Extension office.

POSTHARVEST HANDLING

Importance of Temperature Management

Once harvested, a vegetable continues life processes independent of the plant, and as a result, must utilize its own stored energy reserves. Within hours of harvest, crops held at ambient temperatures can suffer irreversible losses in quality, reducing postharvest life. Additionally, many vegetables, such as greens and lettuce, are cut at harvest, and this wound further increases stress on the tissue. The relative perishability of a crop is reflected in its respiration rate. Respiration is the process of life by which O_2 is combined with stored carbohydrates and other components to produce heat, chemical energy, water, CO_2, and other products. The respiration rate varies by commodity; those commodities with high respiration rates utilize the reserves faster and are more perishable than those with lower respiration rates. Therefore, vegetables with higher respiration rates, such as broccoli and sweet corn, must be rapidly cooled to the optimal storage temperature to slow metabolism and extend postharvest life during subsequent shipping and handling operations.

Since the introduction of hydrocooling for celery in the 1920s, rapid cooling (precooling) has allowed produce to be shipped to distant markets while maintaining high quality. Commercial cooling is defined as the rapid removal of field heat to temperatures approaching optimal storage temperature and it is the first line of defense in retarding the biological processes that reduce vegetable quality. Cooling, in conjunction with refrigeration during subsequent handling operations, provides a "cold chain" from packinghouse to supermarket to maximize postharvest life and control diseases and pests. (The term "postharvest life" is purposely used in this text, since "shelf life" has the connotation that the commodity "sits on the shelf", implying that the product requires no subsequent refrigeration.) Timeliness during handling is also essential in maintaining produce quality: timely and careful harvest and transport to the packinghouse, rapid packing and cooling, and rapid transport to the market or buyer. Everyone involved at each of the many steps during product handling (e.g., shippers, truckers, receivers) must take care to ensure that the refrigerated cold chain is not broken.

Many shippers are well equipped to rapidly cool their crops, and a growing number are incorporating cooling or improving their existing facilities. **Simple placement of packed vegetables in a refrigerated cooler is not sufficient to maintain quality for product destined for distant markets.** Neither should non-cooled vegetables be loaded directly into refrigerated trailers. In both of these situations, the product cools very slowly, at best. Refrigerated trailers are designed to maintain product temperature during transport, and they **do not** have the refrigeration capacity to quickly remove field heat. Therefore, only produce that has been properly cooled should be loaded, and only into trailers that have been cooled prior to loading.

STORAGE REQUIREMENTS

Horticultural crops may be grouped and stored into two broad categories based on sensitivity to storage temperatures. The degree of chilling sensitivity, and therefore the lowest safe storage temperature, is crop-specific. Those crops that are chilling sensitive should be held at temperatures generally above 50°F (10°C). Storage below this threshold will give rise to a physiological disorder known as **chilling injury**. Chilling injury symptoms are characterized by development of sunken lesions on the skin, increased susceptibility to decay, increased shriveling, and incomplete ripening (poor flavor, texture, aroma, and color). Vegetables most susceptible to chilling injury include cucumber, eggplant, melons, okra, peppers, Irish potatoes, summer squash, sweet potatoes, and tomatoes.The extent of chilling symptoms is also dependent on the length of exposure to low temperatures. Short exposure times will result in less injury than longer exposure to chilling temperatures. Those crops not as sensitive to chilling injury may be stored at temperatures as low as 32°F (0°C).

In addition to maintaining storage rooms at proper storage temperatures, the relative humidity should also be controlled to reduce water loss from the crop. Optimal storage recommendations and precooling methods are included for a wide range of vegetable commodities in Table 14.

OPTIMIZING COMMERCIAL COOLING

COOLING CONCEPTS

Cooling is a term that is often used quite loosely. In order to be effective and significantly benefit the shipping life of the product, an appropriate definition of commercial cooling for perishable crops is: *the rapid removal of at least 7/8 of the field heat from the crop by a compatible cooling method*. The time required to remove 7/8 of the field heat is known as the *7/8 Cooling Time*. Removal of 7/8 of the field heat during cooling is strongly recommended to provide adequate shipping life for shipment to distant markets; also, 7/8 of the heat can be removed in a fairly short amount of time. Removal of the remaining 1/8 of the field heat will occur during subsequent refrigerated storage and handling with little detriment to the product.

The rate of heat transfer, or the cooling rate, is critical for efficient removal of field heat in order to achieve cooling. As a form of energy, heat always seeks equilibrium. In the case of cooling, the sensible heat (or field heat) from the product is transferred to the cooling medium. The efficiency of cooling is dependent on time, temperature, and contact. In order to achieve maximum cooling, the product must remain in the precooler for sufficient time to remove heat. The cooling medium (air, water, crushed ice) must be maintained at constant temperature throughout the cooling period. The cooling medium also must have continuous, intimate contact with the surfaces of the individual vegetables. For reasonable cooling efficiency, the cooling medium temperature should be at least at the recommended storage temperature for the commodity found in Table 14. Inappropriately designed containers with insufficient vent or drain openings or incorrectly stacked pallets can markedly restrict the flow of the cooling medium, increasing cooling time.

TABLE 14. RECOMMENDED STORAGE CONDITIONS AND COOLING METHODS FOR MAXIMUM POSTHARVEST LIFE OF COMMERCIALLY GROWN VEGETABLES

Crop	Temperature °F	Temperature °C	% Relative Humidity	Approximate Storage Life	Cooling Method[1]
Asparagus	32-35	0-2	95-100	2-3 weeks	HY
Bean, green or snap	40-45	4-7	95	7-10 days	HY, FA
Bean, lima (butterbean)	37-41	3-5	95	5-7 days	HY
Bean, lima, shelled	32	0	95-100	2-3 days	ROOM, FA
Beet, topped	32	0	98-100	4-6 months	ROOM
Broccoli	32	0	95-100	10-14 days	HY,ICE
Cabbage, early	32	0	98-100	3-6 weeks	ROOM
Cabbage, Chinese	32	0	95-100	2-3 months	HY,VAC
Carrot, bunched	32	0	95-100	2 weeks	HY
Carrot, mature, topped	32	0	98-100	7-9 months	HY
Cauliflower	32	0	95-98	3-4 weeks	HY,VA
Collard	32	0	95-100	10-14 days	HY,ICE,VAC
Cucumber	50-55	10-13	95	10-14 days	HY
Eggplant	46-54	8-12	90-95	1 week	FA
Endive and escarole	32	0	95-100	2-3 weeks	HY,ICE,VAC
Garlic	32	0	65-70	6-7 months	ROOM
Greens, leafy	32	0	95-100	10-14 days	HY,ICE,VAC
Kale	32	0	95-100	2-3 weeks	HY,ICE,VAC
Kohlrabi	32	0	98-100	2-3 months	ROOM
Leek	32	0	95-100	2-3 months	HY,ICE,VAC
Lettuce	32	0	98-100	2-3 weeks	HY, VAC, ICE
Melon					
Cantaloupe, 3/4-slip	36-41	2-5	95	15 days	FA,HY
Mixed melons	45-50	6-10	90-95	2-3 weeks	FA,HY
Watermelon	50-60	10-15	90	2-3 weeks	ROOM, FA
Okra	45-50	7-10	90-95	7-10 days	FA
Onion, green	32	0	95-100	3-4 weeks	HY,ICE
Onion, dry[2]	32	0	65-70	1-8 months	ROOM
Parsley	32	0	95-100	2-2.5 months	HY,ICE
Parsnip	32	0	98-100	4-6 months	ROOM
Pea, green or English	32	0	95-98	1-2 weeks	HY,ICE
Southernpea	40-41	4-5	95	6-8 days	FA,HY
Pepper, sweet (bell)	45-55	7-13	90-95	2-3 weeks	FA, ROOM
Potato, Irish[2]	40	4	90-95	4-5 months	HY,ROOM,FA
Pumpkin	50-55	10-13	50-70	2-3 months	ROOM
Radish, spring	32	0	95-100	3-4 weeks	HY, FA
Radish, oriental	32	0	95-100	2-4 months	ROOM
Rutabaga	32	0	98-100	4-6 months	ROOM
Spinach	32	0	95-100	10-14 days	ICE,HY,VAC
Squash, summer	41-50	5-10	95	1-2 weeks	FA,HY
Sweet corn	32	0	95-98	5-8 days	HY,ICE,VAC
Squash, winter	50	10	50-70	Depending on type	ROOM
Sweetpotato[2]	55-60	13-16	85-90	4-7 months	ROOM
Tomato, mature-green	55-70	13-21	90-95	1-3 weeks	FA,ROOM
Tomato, firm-red	46-50	8-10	90-95	4-7 days	FA,ROOM
Turnip	32	0	95	4-5 months	FA,ROOM

[1] FA = Forced-air cooling; HY = Hydrocooling; ICE = Package ice, slush ice; ROOM = Room cooling; VAC = Vacuum cooling

[2] Curing required prior to long term storage. 'Curing' of dry onions actually involves drying the outer bulb scales, reducing the fresh weight by 5-6%.

COOLING METHODS

The cooling rate is not only dependent upon time, temperature, and contact with the commodity; it is also dependent upon the cooling method being employed. The various cooling media used to cool produce have different capacities to remove heat.

ROOM COOLING

The simplest, but slowest, cooling method is room cooling, in which the bulk or containerized commodity is placed in a refrigerated room for several days. Air is circulated by the existing fans past the evaporator coil to the room. Vented containers and proper stacking are critical to minimize obstructions to air flow and ensure maximum heat removal. Room cooling is not considered precooling and is satisfactory only for commodities with low respiration rates, such as mature potatoes, dried onions, and cured sweetpotatoes. Even these crops may require precooling, when harvested under high ambient temperatures.

FORCED-AIR COOLING

The cooling efficiency of refrigerated rooms can be greatly improved by increasing the airflow through the product. This principle led to the development of forced-air, or pressure cooling, in which refrigerated room air is drawn at a high flow rate through specially stacked containers or bins by means of a high capacity fan. This method can cool as much as four times faster than room cooling. Forced-Air cooling is an efficient method for precooling. In many cases, cold storage rooms can be retrofitted for forced-air cooling, which requires less capital investment than other cooling methods. However, in order to achieve such rapid heat removal, the refrigeration capacity of the room may need to be increased to be able to maintain the desired air temperature during cooling. Portable systems can be taken to the field.

With either room cooling or forced-air cooling, precautions must be taken to minimize water loss from the product. The refrigeration system actually dehumidifies the cold-room air as water vapor in the air condenses on the evaporator coil. This condensation lowers the relative humidity in the room. As a result, the product loses moisture to the air. To minimize water loss during cooling and storage, the ambient relative humidity should be maintained at the recommended level for the particular crop (commercial humidification systems are available) and the product should be promptly removed from the forced-air precooler upon achieving *7/8 Cooling*. Forced-air cooling is recommended for most of the fruit-type vegetables and is especially appropriate for vegetables such as peppers and tomatoes.

HYDROCOOLING

Hydrocooling removes heat at a faster rate than forced-air cooling. The heat capacity of refrigerated water is greater than that for air, which means that a given volume of water can remove more heat than the same volume of air at the same temperature. Hydrocooling is beneficial in that it does not remove water from the commodity. It is most efficient (and, therefore, most rapid) when individual vegetables are cooled by immersion in flumes or by overhead drench, since the water completely covers the product surfaces. Cooling becomes less efficient when the commodity is hydrocooled in closed containers, and even less efficient when containers are palletized and hydrocooled. It is important to continuously monitor the hydrocooler water and product temperatures and adjust the amount of time the product is in the hydrocooler accordingly in order to achieve thorough cooling.

Sanitation of the hydrocooling water is critical, since it is recirculated. Decay organisms present on the vegetables can accumulate in the water, inoculating subsequent product being hydrocooled. Cooling water should be changed frequently. Commodities that are hydrocooled must be sufficiently resistant to withstand the force of the water drench. The container must also have sufficient strength so as to resist the application of water. Crops recommended for hydrocooling include sweet corn, snap beans, cucumbers, and summer squash.

CONTACT ICING

Contact icing has been used for both cooling and temperature maintenance during shipping. Heat from the product is absorbed by the ice, causing it to melt. As long as the contact between the ice and produce is maintained, cooling is fairly rapid and the melted ice serves to maintain a very high humidity level in the package, which keeps the produce fresh and crisp. Non-uniform distribution of ice reduces the cooling efficiency. There are two types of contact icing: *top icing and package icing*.

Top icing involves placement of crushed ice over the top layer of product in a container prior to closure. Although relatively inexpensive, the cooling rate can be fairly slow since the ice only directly contacts the product on the top layer. For this reason, it is recommended that top icing be applied after precooling to crops with lower respiration rates such as leafy vegetables and celery but not for fruit of warm-season crops. Prior to shipping, ice is blown on top of containers loaded in truck trailers to aid in cooling and maintenance of higher relative humidity. However, care should be taken to avoid blockage of vent spaces in the load; this restricts airflow, which results in warming of product in the center of the load during shipment. Ice should also be "tempered" with water to bring the temperature to 32°F (0°C) to avoid freezing of the product.

Package Icing. Crushed ice distributed within the container is known as package icing. Cooling is faster and more uniform than for top icing, but it can be more labor intensive to apply.

A modified version of package icing utilizes a slurry of refrigerated water and finely chopped ice drenched over either bulk or containerized produce or injected into side hand holds. This "slush ice" method has been widely adopted for commodities tolerant to direct contact with water and requiring storage at 32°F (0°C). The water acts as a carrier for the ice so that the resulting slush, or slurry, can be pumped into a packed container. The rapidly flowing slush causes the product in the container to float momentarily until the water drains out the bottom. As the product settles in the container, the ice encases the individual vegetables by filling air voids, thus providing good contact for heat removal. Slush icing is somewhat slower than forced-air cooling, but it does reduce pulp temperatures to 32°F (0°C) within a reasonable amount of time and maintains an environment of high relative humidity. Container selection is critical. The container must be oversized to accommodate sufficient ice to provide cooling. Corrugated fiberboard cartons must be resistant to contact with water (usually impregnated with paraffin wax) and must be of sufficient strength so as not to deform. Shipping operations must also tolerate water dripping from the melting

ice during handling and storage. Package icing is successfully used for leafy crops, sweet corn, green onions, and cantaloupes.

VACUUM COOLING

Vacuum cooling is a very rapid method of cooling, and is most efficient for commodities with a high surface-to-volume ratio such as leafy crops. This method is based on the principle that, as the atmospheric pressure is reduced, the boiling point of water decreases. Containerized or bulk product is thoroughly wetted, placed in a vacuum chamber (tube) and sealed. The pressure in the chamber is reduced until the water on the product surface evaporates at the desired precooling temperature. As water on the product surface evaporates, it removes field heat; the resultant vapor is condensed on evaporator coils within the vacuum tube to increase cooling efficiency. Any water that evaporates from the vegetable tissue is removed uniformly throughout the product. Therefore, it does not tend to result in visible wilting in most cases.

Precautions must be taken so as not to cool the products below their chilling temperature threshold. Vacuum coolers are costly to purchase and operate and are normally used only in high volume operations or are shared among several growers. Commodities that can be cooled readily by vacuum cooling include leafy crops, such as spinach, lettuce, and collards.

SUMMARY

When selecting an appropriate cooling method, several factors must be considered, including: the maximum volume of product requiring precooling on a given day, the compatibility of the method with the commodities to be cooled, subsequent storage and shipping conditions, and fixed/variable costs of the system.

Specific Commodity Recommendations

For further information about Insect, Disease and Weed Control, see the appropriate control section after these specific commodity recommendations.

ASPARAGUS

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
ASPARAGUS								
Grande						N		
Guelph Millennium [2]	A					N		
Jersey Giant [2]	A	G	K	L	M	N	S	T
Jersey King [2]						N		
Jersey Knight [2]	A	G	K	L	M		S	T
Jersey Supreme [2]	A		K	L		N		T
Purple Passion	A		K	L	M			T
UC157 F_1	A	G	K	L				

[1] Abbreviations for state where recommended. [2] Male hybrid.

Soil Preparation. Be sure to soil test in order to determine liming and fertilizer requirements. The ideal pH for asparagus is between 6.7 and 7.0. Asparagus does not tolerate acidic soils and will not grow well at or below a pH of 6.0. Fungal diseases that contribute to asparagus decline (*Fusarium* Crown and Root rot) survive better at lower pH. Liming the soil 7.0 – 7.5 will reduce the survivability of *Fusarium*. Apply 100 lbs/acre of nitrogen. If no soil test is performed, supply sufficient phosphorus and potassium so that the soil contains 250 lbs/acre of available phosphorus and 300 lbs/acre of available potassium. Phosphorus does not move readily in the soil and cannot be incorporated into the soil after the asparagus is planted, so it must be incorporated prior to planting.

Asparagus grows and yields best in a deep, well-drained sandy loam soil, but will tolerate heavier soils as long as the soil has good internal drainage and the water table does not come within four feet of the soil surface as this would interfere with the extensive and deep root system.

Broadcast the fertilizer and plow it under when preparing the land for the planting furrows. Then, each year after harvest is complete, broadcast 100 lbs/acre nitrogen and other nutrients (if needed). Lime can also be added at this time. For the first four years, soil test yearly to determine if fertility and pH adjustments are necessary. Fertilizing in the spring before spears emerge will not benefit the developing crop since the buds on the crown were formed utilizing nutrients from the previous year. After four years, soil test every two years.

Planting. An optimal soil temperature of 50ºF is critical for rapid growth by crowns. See "Asparagus Planting Dates" table for suggested dates. Avoid planting crowns into cold soils. Prolonged exposure to cool, wet soils will make crowns more susceptible to *Fusarium* Crown and Root Rot. **If crowns are received before the field is ready to plant, crowns must be stored between 33 - 38ºF. Otherwise, the buds on the crowns will sprout, causing the fleshy crown roots to shrivel and die.**

Asparagus crowns and transplants are placed into furrows. Make furrows 6" deep. On a heavy soil, plant crowns no deeper than 5" and on a light textured soil, no more than 6". Apply fertilizer in the bottom of the furrow before planting crowns. Place crowns in the bottom of the furrow and cover with 1 to 2" of soil. The fertilizer will not burn the crowns. Although crown orientation is not important, crowns placed with their buds oriented upward will emerge faster. Research shows that pre-plant applications of phosphorus below the crown are an important factor in long-term asparagus production. Omitting the phosphorus placed in the bottom of the furrow will reduce yields in subsequent years as compared to not applying the additional phosphorus.

NOTE: Asparagus crowns are received in bulk or in bundles of 25 crowns per bundle. After receiving, separate the crowns by size into small, medium, or large. When ready to plant, plant all the smalls together in the same row, all the mediums together, and all the large crowns together. Do not plant a small crown next to a medium or large sized crown. This will cause the larger crown to shade the smaller one, which will then never attain its full growth potential.

Spacing. Crowns can be spaced 12" to 18" within the row. Research shows that there is no advantage of planting 9" between crowns in the row. Although a larger yield is obtained earlier with 9" spacing, after 4 or 5 years, the yield will be the same as with 18" in row spacing. Also, the closer the crowns are spaced in the row, the more crowns needed, increasing cost (for example, 18" in row x 5 feet between row = 5,808 crowns per acre; 12" crowns in row x 5 feet between row = 8,712 crowns per acre).

Asparagus crowns should not be planted in a solid block; rather, plant the field with drive rows spaced between a block of five rows. In order to obtain optimal spray coverage, an air-blast sprayer is needed to evenly apply insecticides and fungicides into the dense fern canopy from both sides of the five-row block. Boom sprayers usually cannot be set high enough to prevent the knocking over of ferns causing damage.

The furrows can be filled-in completely to soil level after planting without damaging the crowns. Do not drive on or compact the soil over the newly planted furrows, however; or emergence of the spears will be severely delayed or reduced. With good soil moisture, the new spears will break through the soil in 1-2 weeks.

ASPARAGUS PLANTING DATES

	Planting Dates		Planting Dates
AL North	2/15–4/15	NC East	2/15–3/31
AL South	1/15–3/15	NC West	4/1–5/31
GA North	2/15–4/15	SC East	2/1–3/15
GA South	3/15–4/30	SC West	3/1–4/15
MS	3/15–4/15	TN East	3/1–3/31
KY East	3/20–4/1	TN West	2/25–3/15
KY Central	3/15–3/25		
KY West	3/10–3/20		

SPECIAL NOTES FOR PEST MANAGEMENT

WEED MANAGEMENT

Weed control is critical in asparagus. If young plants compete with weeds, these young plants will become stressed preventing them from developing good fern growth. Cultivation is not recommended as there are effective herbicides labeled for use. Research shows that even the shallowest of cultivations between asparagus rows cuts and injures roots, predisposing them to *Fusarium* root rot fungus that eventually will kill the asparagus. Apply a pre-emergence and post-emergence herbicide over the entire field after planting crowns and again after the old fern growth is mowed each spring. Apply an herbicide three weeks prior to the emergence of new spears and ferns, so that these newly emerging spears and fern growth will not compete with weeds.

Although asparagus is highly salt tolerant and salt can be used to control weeds, salt will causes severe soil crusting; impeding water infiltration and percolation. Additionally, salts can leach horizontally through the soil killing other vegetables adjacent to the asparagus which are not as salt tolerant.

INSECTS AND DISEASES MANAGEMENT

Cutworms feed on the spear tips at night before emerging from the soil. They feed on one side of the spear, causing the tip to bend over. Cutworms can easily be managed with approved insecticides.

Asparagus Beetle adults chew on ferns reducing photosynthesis. Any reduction in leaf area causes a loss of stored food reserves in the crown which is needed for next year's crop. Asparagus beetles also lay eggs on the spears during harvest and will result in further damage. During this period, the best way to manage the beetle is to pick on a timely basis preventing any spear getting tall and spindly, or allowing them to fern out.

***Cercospora* Needle Blight** is a fungal disease that produces spores that are wind-blown during the summer when hot and humid. *Cercospora* Needle Blight turns the needles of the fern yellow, then brown, and then they fall off. This severely reduces the photosynthetic capability t the fern to manufacture carbohydrates which are critical for next year's spears. Spray an approved fungicide to manage *Cercospora* when reddish-brown, football-shaped lesions on the fern stalks are first noticed. Spray once every 7 to 10 days through September. Neglecting to spray might reduce spear yields up to 40% the following year. Burning the old ferns off instead of mowing them off and letting the residue remain on the ground will not prevent *Cercospora*. Be prepared to spray, regardless if the old ferns are burned or not.

***Fusarium* Crown and Root Rot** are the major destructive diseases of asparagus and the ones that usually take fields out of production. There are no controls once the plants succumb to these diseases. The main way to prevent infection is to prevent stresses from occurring to the plant. These stresses include: overharvesting; low soil pH; low soil fertility; frost damage to spears; waterlogged soil; and insect, disease, and weed pressures.

HARVESTING AND STORAGE

During the second year about 3 weeks before the spears emerge, mow off the dead ferns and spray a tank-mix of an approved pre-emergence and post-emergence herbicide. Mow the dead ferns off as close to the ground as possible. Do not cut ferns down in the fall because the dead ferns will capture moisture in the winter and will keep the soil temperature about 5 degrees colder than the temperature of bare soil. This colder soil temperature will delay spear emergence in the early spring when warm day temperatures force the growth of new spears in bare soil causing frost injury on spears.

With air temperatures (<70ºF), harvesting might be done once every 2 to 3 days, harvesting a 7" to 9" tall spear with tight tips. Air temperatures over 70ºF will cause the tips of the spears to open up or "fern out" at a shorter height causing fiber development in the spears making them tough. Fiber development is determined by the tightness of the spear tip but has no bearing on spear toughness. Harvesting under warm temperatures forces the grower to pick shorter, 5" to 7" tall spears before the spear tips fern out. Otherwise, the spears will lack tenderness and quality. This involves harvesting in the morning and evening of the same day as spears elongate rapidly under high temperatures.

Asparagus can be harvested safely for 2 weeks during the second year (the year following initial establishment of crowns), 4 weeks during the third year, 6 weeks during the fourth year, and 8 weeks during the fifth year. It is best to determine when to stop harvesting by looking at the spear diameter. When 3/4 of the spears are pencil-sized in diameter, stop harvesting. This will take some experience to determine.

Asparagus can be harvested with a knife, below the soil, but snapping is preferred. Using a knife results in a tough and fibrous butt being produced that has to be trimmed off. Cutting below the soil with a knife increases the chances of cutting into other buds on the crown that would normally produce more spears. Snapping involves using the thumb and index finger together to gently break the spear just above the soil line. Snapped asparagus contains no fibrous butt that needs to be removed. The harvested spear is all usable.

Do not allow any small spindly spears to grow into ferns while harvesting. These ferns can provide a site for asparagus beetles to lay their eggs, develop into larvae, then into adult beetles. The field should be free of any tall, spindly spears or fern growth during harvest, except for new spears coming up or ones ready to be harvested.

Harvest asparagus in the morning when the temperatures are cool. Asparagus has a very high respiration rate, just like a fresh cut flower. Place harvested spears into plastic containers that have holes in them to let water pass through. Plunge them into ice-cold water for about 5 minutes. This will remove the field heat out of the spears. Nest, allow containers to drain and put them into plastic bags. Place into refrigerated storage set at 36ºF with 95-100% RH. Storage life at 36ºF is about 2 weeks, but growers should try to sell the asparagus soon after it is picked, to let the consumer hold it for 2 weeks, if needed. See Table 14 for further postharvest information.

BASIL

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
BASIL								
Sweet								
Genovese [2]	A	G	K	L	M	N	S	T
Italian Large Leaf [3]	A	G	K	L	M	N	S	T
Nufar [2,3]	A	G	K	L	M	N	S	T
Aroma II [2,3]	A	G	K	L	M	N	S	T
Purple Ruffles	A	G	K	L	M	N	S	T
Specialty								
Lemon	A	G		L	M	N	S	T
Mrs. Burns	A	G		L	M	N	S	T
Sweet Thai (Horapha, Hun Que)	A	G	K	L	M	N	S	T
Cinnamon	A	G		L	M	N	S	

[1] Abbreviations for state where recommended. [2] *Fusarium* tolerance/resistance. [3] Suitable for High Tunnel production

Cultivation. Sow seed 1/8 inch deep. Basil is an easy to grow tender annual. Plant basil in *late spring after all danger of frost is past*. Grow in full sun in warm, well-drained soil, preferably in raised beds. A light sand to silt loam with a pH of 6.4 is best. Basil may be grown in the field from seed or transplants. Trim transplants to encourage branching and plant in the field when about six inches tall (4 to 6 weeks old).

Double-row plantings on 2 to 4 foot wide beds increase yields per acre and helps to shade out weeds. Planting dates may be staggered to provide a continuous supply of fresh leaves throughout the growing season. For fresh-cut basil production, the use of black plastic mulch is highly recommended. Basil will not tolerate moisture stress; provide a regular supply of water through drip or overhead irrigation.

Fertilization. Do not over fertilize basil. It is generally suggested that 100 pounds each of N, P_2O_5, and K_2O per acre be broadcast and incorporated at time of planting or follow guidelines for fertilization of salad greens. If more than one harvest is made, sidedress with 15 to 30 pounds N per acre shortly after the first or second cutting.

Pest Control. There are few agricultural chemicals registered for use on basil. To keep weed pressure down, use high plant populations, shallow cultivation, and/or mulch. BT products can be used to control various worms and caterpillars. Genovese, Italian Large Leaf, and lettuce leaf varieties are susceptible to Japanese beetles. Japanese beetle traps set about 20 feet away from the basil will help prevent damage. Reflective mulches, beneficial insects, insecticidal soaps, traps, and handpicking may give some level of control of other insect pests. Keep foliage as dry as possible by watering early in the day, or by using drip irrigation to reduce fungal disease. Rotate herbs to different parts of the field each year and remove and destroy all plant debris to reduce soil borne disease.

***Fusarium* Wilt –** Plants infected with this disease usually grow normally until they are 6 to 12 inches tall, then they become stunted and suddenly wilt. *Fusarium* wilt may persist in the soil for 8 to 12 years. Growers should use *Fusarium* wilt tested seed or resistant or tolerant varieties.

Basil Downy Mildew - Use clean seed and less susceptible varieties as they become available. Minimize leaf wetness as much as possible. Learn what the disease symptoms look like. Consider applying fungicides when the Cucurbit downy mildew forecasts indicate protection is needed.

Harvesting and Storage – Leaf yields range from 1 to 3 tons per acre dried or 6 to 10 tons per acre fresh. Foliage may be harvested whenever four sets of true leaves can be left after cutting to initiate growth, but when harvesting for fresh or dried leaves, always cut prior to bloom. Presence of blossoms in the harvested foliage reduces quality. Frequent trimming helps keep plants bushy. For small-scale production of fresh-market basil, the terminal 2- to 3-inch long whorls of leaves may be cut or pinched off once or twice a week. This provides a high-quality product with little stem tissue present. Basil can also be cut and bunched like fresh parsley. A sickle bar type mower with adjustable cutting height is commonly used for harvesting large plantings for fresh and dried production. The optimum storage temperature for fresh basil is 40° to 45° F with a high relative humidity.

BEANS: LIMA AND SNAP

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
BEANS - Lima								
Bush *(small seeded)*								
Bridgeton	A	G		L	M	N	S	T
Dixie Butterpea	A	G			M		S	
Early Thorogreen	A	G		L	M	N	S	
Henderson Bush	A	G		L	M	N	S	
Jackson Wonder	A			L	M		S	T
Nemagreen	A	G		L	M	N	S	
Bush (large seeded)								
Fordhook 242	A	G	K			N	S	T
Dixie Speckled Butterpea	A	G			M	N	S	T
Pole *(large seeded)*								
Christmas Pole				L				
Carolina Sieva	A	G		L	M	N	S	
Florida Speckled Butter		G		L	M		S	
King of the Garden	A	G		L		N	S	T
Willow Leaf	A			L				
BEANS - Snap								
Bush (Fresh Market)								
Ambra	A	G				N	S	T
Bowie	A							
Bronco	A	G	K	L		N	S	T
Bush Blue Lake 274	A	G	K	L		N		
Caprice	A	G	K			N		T
Carlo [2]	A	G						T
Charon		G				N		T
Clarke								T
Crockett								T
Dusky				L		N		T
Festina	A	G				N	S	T
Grenoble		G						
Hialeah	A		K	L		N	S	
Hickok		G						T
Inspiration								T
Jade	A		K			N		
Lewis	A		K					
Lynx				L		N	S	
Magnum	A	G	K		M	N		T
Nash		G						
Pike								T
Prevail								T
Renegade	A	G						
Roma II (flat pod)	A	G	K		M	N	S	
Storm	A	G		L		N	S	
Strike	A	G		L		N	S	
Tapia (flat pod)						N		
Tenderette	A					N		
Valentino		G		L		N		T
Wyett	A							
Pole								
Kentucky Blue			K	L	M	N		
Louisiana Purple Pole				L				
McCaslan	A	G		L				T

[1] Abbreviations for state where recommended.
[2] Spring production only in Georgia.
[3] Not for Coastal Plain areas.
[4] Yard long/Asparagus bean.

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
BEANS - Pole (cont'd)								
Rattle Snake				L	M			T
Red Noodle[4]	A				M			T
State Half Runner		G	K			N		T
Stringless Blue Lake	A	G		L		N	S	
Volunteer/Tennessee Half Runner[3]		G	K			N		T
White Seeded Kentucky Wonder 191	A	G	K	L	M	N	S	T

[1] Abbreviations for state where recommended.
[2] Spring production only in Georgia.
[3] Not for Coastal Plain areas.
[4] Yard long/Asparagus bean.

Seed Treatment. To protect against root rots and damping off, use treated seed or treat with an appropriate protectant at manufacturer's recommendation. Where bacterial blight is a concern, request that seed be treated with streptomycin. Rough handling of seed greatly reduces germination.

MARKET SNAPS PLANTING DATES

	Spring	Fall
AL North	4/1–7/15	NR
AL South	2/10–4/30	8/15–9/20
GA North	5/1–7/15	NR
GA South	2/15–4/30	7/15–9/15
KY East	5/1–7/15	NR
KY Central	4/25–7/25	NR
KY West	4/10–8/1	NR
LA North	4/1–5/15	8/15–9/15
LA South	3/1–5/31	8/15–9/15
MS North	3/30–5/10	8/15–9/1
MS South	2/10–5/1	8/15–9/20
NC East	3/20–6/15	8/1–9/15
NC West	5/1–8/15	NR
SC East	4/1–6/1	8/1–9/1
SC West	4/15–7/1	7/20–8/1
TN East	4/20–6/20	7/15–8/20
TN West	4/1–6/1	NR

PROCESSING SNAPS PLANTING DATES

	Spring	Fall
AL North	4/1–7/15	NR
AL South	2/10–4/30	8/15–9/20
GA North	5/1–7/15	NR
GA South	2/15–4/30	7/15–9/15
KY East	5/1–7/15	NR
KY Central	4/25–7/25	NR
KY West	4/10–8/1	NR
MS North	4/1–5/15	9/5–9/20
MS South	2/10–4/30	8/15–9/20
NC East	4/1–6/15	NR
NC West	5/15–7/31	NR
SC East	4/1–6/1	8/1–9/1
SC West	4/15–7/1	7/20–8/1
TN East	4/20–8/20	7/15–8/20
TN West	4/1–7/15	NR

LARGE & SMALL LIMAS PLANTING DATES

	Spring	Fall
AL North	4/1–7/1	NR
AL South	2/10–5/1	8/15–9/20
GA North	5/1–7/1	NR
GA South	3/1–5/1	7/15–9/1
KY East	5/10–7/10	NR
KY Central	5/1–7/20	NR
KY West	4/15–7/1	NR
MS North	4/1–7/25	NR
MS South	3/1–8/15	NR
NC East	4/10–6/15	7/15–8/1
NC West	6/1–7/15	NR
SC East	4/15–6/1	7/15–8/1
SC West	5/1–6/15	7/1–7/15
TN East	5/1–6/30	7/15–8/20
TN West	4/15–7/15	NR

SOIL AND FERTILITY

Snapbeans grow best on medium-textured, well drained soils, with a pH of 5.5 to 6.2. Commercial producers generally apply 65 lbs N/A by banding at planting 2 inches to each side and 3 inches below the seed. Direct contact with seed can cause injury or kill germinating seed.

SPACING

Snap Beans: With rows 30 to 36 inches apart, plant 5 to 7 seeds per foot. To increase yield plant in rows 18 to 24 inches apart with 4 to 6 seeds per foot. Calibrate planter according to seed size. Sow 1 to 1.5 inches deep in light sandy soil; shallower in heavier soil.

Lima Beans, Large Seeded: Plant in rows 30 to 36 inches apart, 2 seeds per foot, 1 to 1.5 inches deep.

Lima Beans, Small Seeded: Space rows 30 to 36 inches apart, 2 seeds per foot, 0.75 to 1.25 inches deep (deeper if soil is dry). For mechanically harvested irrigated fields: Rows 18 to 30 inches apart, 4 to 5 inches between plants.

Edamame: Edamame are green, immature soybeans sold as fresh vegetables with the seeds in the pods. Grown like bush beans, the pods are harvested when the seeds have reached full size but before the pods begin to yellow. Some commonly grown varieties include Midori Giant, Tohya, Lanco, and Envy.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Seed Maggot: See the preceding "Seed Treatment" section, or use approved soil systemic insecticides at planting time if probability of pest outbreak is high. Also see the "Maggots" section in Soil Pests—Their Detection and Control and following "Early Season Control" section.

Experience has shown that effective insect control with systemics usually lasts from 4 to 6 weeks after application. Frequent field inspections are necessary after this period to determine pest incidence and the need for additional spray controls.

Thrips: Treatments should be applied if thrips are present from cotyledon stage to when the first true leaves are established and/or when first blossoms form.

Mites: Spot treat areas along edges of fields when white stippling along veins on undersides of leaves is first noticed and 10 mites per trifoliate are present.

Aphids: Treat only if aphids are well-distributed throughout the field (50% or more of terminals with five or more aphids), when weather favors population increase, and if beneficial species are lacking.

Leafhoppers: Treat only if the number of adults plus nymphs exceeds 1 to 2 adults per sweep.

Tarnished Plant Bug (Lygus): Treat only if the number of adults and/or nymphs exceeds 15 per 50 sweeps from the pin pod stage until harvest.

Beet Armyworm (BAW), Cabbage Looper (CL): Treat if the number of worms (BAW and CL) averages 15 per 3 feet of row.

European Corn Borer (ECB)–Snap Beans Only: Treat when moth catches in local blacklight traps average five or more per night. The first application should be applied during the bud–early bloom stage and the second application during the late bloom–early pin stage. Additional sprays may be needed between the pin spray and harvest. Consult a pest management specialist for local black- light trap information and recommended spray intervals.

Corn Earworm (CEW), Fall Armyworm (FAW): In snap beans, treat every 5 to 7 days if CEW catches in local blacklight traps average 20 or more per night and most corn in the area is mature. The use of pheromone (insect sex attractants) and blacklight traps is very helpful in detecting population build-up of various insects.

For limas, treat when CEW populations exceed one per 6 feet of row from the late flat pod stage to harvest.

For both lima bean types, treatment should be timed when 50% or more of the CEW and/or FAW populations reach a length of 1/2 inch or longer. Treating too early for young CEW/FAW populations will eliminate natural control and may result in the need for additional sprays for reinfestations. See "How to Improve Pest Control" for insect sampling techniques. Consult a pest management specialist for more refined decision-making.

Whiteflies: Treat when whiteflies exceed five adults per fully expanded leaflet.

Nematode Management. Use nematicides listed n the "Nematode Control in Vegetate Crops" table in the Disease Control section.

Soybean cyst nematode, races I and III, are present in soybeans in some areas. Snap beans are susceptible, but small seeded lima beans are resistant to this nematode. Growers who rotate snap beans with soybeans should be alert to the possibility of problems in infested fields.

WEED CONTROL

Since beans are a quickly maturing crop, early weed control is essential. Weeds can reduce yield, quality and the efficiency of the mechanical harvester. Preparing a weed-free seedbed is the first step of a weed control program. A weed-free seed bed allows the bean plants to get off to a quick start without interference from weed growth. Carefully read herbicide labels to make sure that beans can tolerate the material. Be sure to avoid planting beans after other crops for which herbicides with a long residual have been used.

MINIMUM TILLAGE

When planning to use minimum tillage practices, give consideration to bean variety, date of planting, soil fertility practices, insect control, planting equipment, cover crop, and weed species in the field. Minimum tillage might not be suited to all growing areas around the SE US. Soil type and other environmental conductions might limit its success. Consult with your local Extension office for the latest recommendations.

HARVESTING AND STORAGE

See Table 14 for postharvest information.

BEETS

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
BEETS								
Bull's Blood (for greens)	A	G	K	L	M	N	S	T
Detroit Dark Red	A	G	K	L			S	T
Red Ace	A	G	K	L		N	S	T
Ruby Queen	A	G	K	L		N	S	T
Solo			K	L				T

[1] Abbreviations for state where recommended.

Light, well-drained soils are best for root development in beets. Beets are frost tolerant and produce the best commercial quality when grown during cool temperatures (50° to 65°F). Lighter color and wider zoning within the roots occur during periods of rapid growth in warm temperatures. If plants are exposed to 2 or 3 weeks of temperatures below 50°F after several true leaves have formed, seedstalks (undesirable because they will reduce root quality) will form. Cultivars vary in their sensitivity to this problem with newer cultivars generally being less sensitive to it.

Beets are susceptible to boron deficiency and will develop internal black spot if soil boron is not adequate. If boron is deficient, apply 2 to 3 lb. of boron per acre with broadcast fertilizer, or for smaller plantings, apply ½ oz. Borax per 100 square feet of row with initial fertilizer application.

Seeding and Spacing. Optimum germination temperature for beets ranges from 50° to 85°F, but early plantings can be made 4 to 6 weeks before the average last spring frost. Germination takes between 10-14 days, but can be hastened by soaking seed in warm water prior to planting. Sow seed ½ to 3/4 in deep at the rate of 15 to 18 seeds per foot of row. Space rows 15 to 20 inches apart; thin plants to 3 inches apart. Seeds remain viable for 2-3 years when stored properly.

BEET PLANTING DATES

	Spring	Fall
AL North	3/15–5/30	8/1–9/15
AL South	2/1–3/31	8/1–9/30
GA North	4/15–5/30	7/15–8/15
GA South	2/1–3/31	8/1–9/30
KY East	3/20–4/15	NR
KY Central	3/15–4/10	NR
KY West	3/10–4/1	NR
LA North	2/1–3/31	9/15–11/15
LA South	2/1–3/31	9/15–11/15
MS	NR	NR
NC East	3/1–4/15	8/1–9/15
NC West	4/1–5/31	7/15–8/15
SC East	2/15–3/31	8/15–9/30
SC West	3/15–5/31	7/15–8/31
TN East	3/15–4/15	9/1–9/30
TN West	3/1–4/1	9/15–10/1

SPECIAL NOTES FOR PEST MANAGMENT

DISEASE MANAGEMENT

Seed rot and damping-off may be a problem, especially in early spring plantings when soils are cool. Seeds should be treated with an appropriate fungicide to protect the seed.

Cercospora leaf spot is the most common disease that occurs on beets. Circular spots with reddish brown or purplish margins are the first signs. Spray every 2 to 3 weeks with an appropriate crop protectant.

INSECT MANAGEMENT

The most common insect pests of beets are aphids, leafminers, flea beetles, and webworms. Sanitation and crop rotation should be practiced to avoid pest build ups.

HARVESTING AND STORAGE

Market beets are hand-harvested when 1-3/4 to 2 inches in diameter, usually about 50-75 days after planting. Expected yield per 100 row feet is 100 lbs. See Table 14 for further postharvest information.

BROCCOLI, CABBAGE, CAULIFLOWER, COLLARDS, KALE, AND KOHLRABI

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
BROCCOLI								
Early								
Batavia[11]	A						S	
Castle Dome	A				M	N	S	T
Olympia				L				T
Packman	A	G	K	L	M	N	S	T
Windsor[10]			K					T
Mid-season								
Emerald Crown		G				N		
Emperor	A		K	L	M	N	S	
Ironman[5]						N	S	
Liberty							S	
Marathon[5, 6, 7, 10]	A		K	L	M	N		
Patron[2, 10]		G				N	S	
Premium Crop[10]	A		K	L	M	N		
Tlaloc	A	G				N		
Tradition						N		
Late-season								
Arcadia[6, 10]	A	G	K	L		N	S	T
Beumont							S	
Destiny[2, 5]							S	
Diplomat[10]		G		L		N	S	T
Emerald Pride	A	G		L		N	S	
Fiesta						N		
Greenbelt[5, 6, 8, 10]	A	G	K				S	
Heritage							S	
Patriot[5, 10]	A	G		L				
Pinnacle	A		K		M		S	
Triathlon[10]				L		N		
Full-season								
Bay Meadows[2]	A					N		
Belstar						N	S	T
Gypsy[10]	A	G	K	L	M	N	S	T
Green Magic[2, 11]		G	K	L		N	S	T
Lieutenant[5]	A					N	S	T
CABBAGE: green								
Bayou Dynasty	A	G	K		M	N	S	
Blue Dynasty[4, 6, 9]	A	G				N		T
Blue Thunder[4, 6, 8, 9]	A	G		L		N	S	T
Blue Vantage[4, 6, 8, 9]	A		K	L	M	N	S	T
Bravo[6, 9]	A	G	K	L	M	N	S	T
Bronco[4, 9]			K			N		T
Cheers[6, 8, 9]	A	G	K	L	M		S	T
Emblem[4, 6, 9]				L				
Hercules		G		L				
Lynx[4, 6, 9]				L				
Platinum Dynasty[4, 6, 9]	A	G			M	N	S	T
Royal Vantage[4, 6, 8, 9]		G		L				
Savoy Ace[4, 6, 8]		G	K			N	S	T
Silver Dynasty[4, 6, 9]		G				N	S	T
Solid Blue 780[6, 9]				L	M	N	S	
Thunderhead[4, 6, 9]	A	G				N		
Vantage Point[4, 6, 8, 9]				L				
CABBAGE: red								
Cardinal[9]	A	G		L		N	S	
Garnet[9]	A							
Red Dynasty[4, 6]	A	G	K			N	S	T
Red Rookie	A	G	K			N	S	T
Ruby Perfection[6]	A	G				N		

[1] Abbreviations for state where recommended.
[2] Bolting tolerant.
[3] Bolting susceptible.
[4] Tip burn tolerant.
[5] Hollow stem tolerance/resistance.
[6] Black rot tolerance/resistance.
[7] Bacterial leaf spot tolerance/resistance.
[8] Bacterial speck tolerance/resistance.
[9] Fusarium yellows tolerance/resistance.
[10] Downy mildew tolerance/resistance.
[11] Powdery mildew tolerance/resistance.

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
CAULIFLOWER								
Candid Charm	A	G	K	L				
Cumberland				L				
Early Snowball	A	G				N		
Freedom	A	G						
Fremont		G						T
Graffiti								T
Incline		G		L				
Majestic			K	L				
Minuteman		G						
Symphony		G		L				
Snow Crown	A	G	K	L	M	N	S	T
Super Snowball	A	G				N	S	
White Magic	A	G		L				
COLLARDS								
Blue Max[2]	A	G		L	M	N	S	
Champion			K	L		N		T
Flash	A	G	K	L	M	N	S	T
Georgia Southern[3]	A	G	K	L	M	N	S	T
Heavi-Crop	A	G		L	M	N	S	
Morris Heading						N	S	
Top Bunch[2]	A	G	K	L		N	S	T
Vates	A	G	K	L	M	N	S	T
KALE								
Premier						N	S	
Siberian	A	G	K	L	M	N	S	T
Squire						N	S	
Vates	A	G	K	L	M	N	S	T
Winterbor			K		M	N	S	T
KOHLRABI								
Early Purple Vienna	A	G	K	L	M	N	S	T
Grand Duke	A		K	L	M	N	S	T
Kossak					M			

[1] Abbreviations for state where recommended.
[2] Bolting tolerant.
[3] Bolting susceptible.
[4] Tip burn tolerant.
[5] Hollow stem tolerance/resistance.
[6] Black rot tolerance/resistance.
[7] Bacterial leaf spot tolerance/resistance.
[8] Bacterial speck tolerance/resistance.
[9] Fusarium yellows tolerance/resistance.
[10] Downy mildew tolerance/resistance.
[11] Powdery mildew tolerance/resistance.

Seed Treatment. Check with seed supplier to determine if seed is hot-water treated for black rot control. If not, soak seed at 122°F . Use a 20-minute soak for broccoli, cauliflower, collards, kale, and Chinese cabbage. Soak cabbage for 25 minutes. **Note**. Hot water seed treatment may reduce seed germination.

Following either treatment above, dry the seed, then dust with a labeled fungicide to prevent damping-off.

BROCCOLI PLANTING DATES

	Spring	Fall
AL North	3/1–7/1	NR
AL South	2/1–3/31	8/1–9/30
GA North	3/15–7/1	7/25-8/15
GA South	2/1–3/31	8/1–9/30
KY East	4/10–4/30	7/1–7/15
KY Central	4/5–4/20	7/15–8/1
KY West	3/30–4/10	8/1–8/15
LA North	1/15–3/15	8/1–10/31
LA South	1/15–3/15	8/1–10/31
MS North	2/15–3/15	7/25–8/15
MS South	1/15–3/10	8/5–9/15
NC East	2/15–4/15	8/1–9/15
NC West	4/1–8/15	NR
SC East	3/1–4/10	9/1–9/30
SC West	3/20–4/30	8/15–9/15
TN East	3/25–4/25	8/1–8/31
TN West	3/15–4/5	8/10–8/31

CABBAGE PLANTING DATES

	Spring	Fall
AL North	3/15–7/1	NR
AL South	2/1–3/31	8/1–10/31
GA North	3/15–7/1	7/25-8/15
GA South	2/1–3/31	8/1–10/31
KY East	4/1–4/15	6/20–7/1
KY Central	3/15–3/25	7/1–7/15
KY West	3/01–3/15	7/15–8/01
LA North	1/15–3/15	8/1–11/30
LA South	1/15–3/15	8/1–11/30
MS North	2/5–4/1	7/25–8/15
MS South	1/15–3/15	8/5–9/15
NC East	2/15–4/15	8/1–9/15
NC West	4/1–8/15	NR
SC East	2/1–3/31	8/15–9/30
SC West	3/15–4/30	7/15–8/30
TN East	3/25–4/25	7/25–8/15
TN West	3/15–4/15	8/25–9/15

CAULIFLOWER PLANTING DATES

	Spring	Fall
AL North	3/15–7/1	NR
AL South	2/1–3/31	8/1–9/30
GA North	3/15–7/1	7/25-8/15
GA South	2/1–3/31	8/1–9/30
KY East	4/10–4/30	7/1–7/15
KY Central	4/5–4/20	7/15–8/1
KY West	3/30–4/10	8/1–8/15
LA North	2/1–3/15	7/15–10/31
LA South	2/1–3/15	7/15–10/31
MS North	2/15–3/15	7/25–8/15
MS South	1/15–3/10	8/5–9/15
NC East	2/15–4/15	8/1–9/30
NC West	4/1–8/15	NR
SC East	3/1–4/10	8/15–8/30
SC West	3/20–4/30	7/15–8/30
TN East	3/25–4/25	7/15–8/15
TN West	3/15–4/15	8/1–8/20

COLLARDS PLANTING DATES

	Spring	Fall
AL North	2/15–6/30	7/15–10/15
AL South	1/15–5/31	7/15–10/31
GA North	3/15–7/31	7/25-8/15
GA South	2/1–3/31	8/1–10/31
KY East	3/15–4/30	7/1–7/15
KY Central	3/10–4/25	7/15–8/1
KY West	3/1–4/15	8/1–8/15
LA North	1/15–3/15	7/15–10/31
LA South	1/15–3/15	7/15–10/31
MS North	1/20–4/1	7/25–8/20
MS South	1/15–3/1	8/10–9/15
NC East	2/15–6/30	8/1–9/15
NC West	4/1–8/15	NR
SC East	2/1–6/15	8/1–10/30
SC West	3/15–6/30	8/1–9/30
TN East	3/15–5/1	7/15–8/15
TN West	2/15–4/15	8/1–8/20

KALE PLANTING DATES

	Spring	Fall
AL North	3/15–4/30	8/1–9/15
AL South	2/1–3/31	8/1–10/31
GA North	3/15–4/30	NR
GA South	2/1–3/31	8/1–10/31
KY East	4/1–4/30	7/1–7/15
KY Central	3/20–4/15	7/15–8/1
KY West	3/10–4/10	8/1–8/15
LA North	2/1–3/15	7/15–10/31
LA South	2/1–3/15	7/15–10/31
MS North	1/20–4/1	7/25–8/20
MS South	1/15–3/1	8/10–9/15
NC East	2/15–6/30	8/1–9/15
NC West	4/1–8/15	NR
SC East	2/1–6/15	8/1–10/30
SC West	3/15–6/30	8/1–9/30
TN East	3/15–5/1	8/1–9/1
TN West	2/15–4/15	8/15–9/15

KOHLRABI PLANTING DATES

	Spring	Fall
AL North	3/15–7/1	NR
AL South	2/1–3/31	8/1–9/30
GA North	3/15–7/1	NR
GA South	2/1–3/31	8/1–9/30
KY East	4/10–4/30	NR
KY Central	4/5–4/20	NR
KY West	3/30–4/10	NR
LA North	2/1–3/15	7/15–10/31
LA South	2/1–3/15	7/15–10/31
MS	2/1–3/31	8/1–9/30
NC East	2/15–6/30	8/1–9/15
NC West	4/1–8/15	NR
SC East	2/1–6/15	8/1–9/30
SC West	3/15–6/30	8/1–9/15
TN East	3/25–4/25	8/1–8/15
TN West	3/15–4/15	8/15–8/30

PLASTIC MULCH

Early spring cabbage, cauliflower, and broccoli are frequently grown using plastic mulch, with black mulch used in the spring and white on black or black mulch painted white used in the fall.

Broccoli. *Field seeding*: Space rows 36 inches apart; plants 12 to 18 inches apart in row; seed 1/2 to 1 pound per acre.

Transplants: Sow 10 seeds per foot of row in rows 12 to 18 inches apart. Set transplants 12 to 18 inches apart in rows 36 inches apart (14,520 plants per acre). *High population for bunched broccoli:* 2 to 4 rows per bed, rows 18 to 20 inches apart, plants 9 to 10 inches in row (27,000 to 32,000 plants per acre). This requires a more intensive disease managment system.

Cabbage. The early cabbage crop is grown from transplants seeded at the rate of 1 ounce for 3,000 plants. Transplants are ready for field planting 4 to 6 weeks after seeding. Storage of pulled, field-grown cabbage transplants should not exceed 9 days at 32°F or 5 days at 66°F prior to planting in the field. Precision seeders can be used for direct seeding. However, seed should be sown 15 to 20

days in advance of the normal transplant date for the same maturity date. Early varieties require 85 to 90 days from seeding to harvest, and main-season crops require 110 to 115 days. Set transplants in rows 2 to 3 feet apart and 9 to 15 inches apart in the row for early plantings and 9 to 18 inches apart for late plantings, depending on variety, fertility, and market use.

Cauliflower. Start seed in greenhouse or protected frames 4 to 6 weeks before planting. Use 1 ounce of seed for 3,000 plants. Set transplants in rows 3 to 4 feet apart, and plants are set 18 to 24 inches apart in the row. Make successive plantings in the field at dates indicated in preceding table.

Collards and Kale. Seed at the rate of 2 pounds per acre and thin to desired spacing. For precision, air-assist planters use 1/3 to ½ pound per acre for twin rows on 3 foot centers, or use half of this rate for single rows on 3 foot centers. When using transplants, set plants in rows 16 to 24 inches apart and 6 to 18 inches apart within the row.

Kohlrabi. Transplants may be used for a spring crop. Seed 6 weeks before expected transplant date. Use precision seeder for hybrid varieties. Space rows 18 to 24 inches apart and 6 to 8 between plants.

Bolting. Bolting in cabbage, collards and kale, and buttoning in cauliflower, can occur if the early-planted crop is subjected to 10 or more continuous days of temperatures between 35° to 50°F. However, sensitivity to bolting depends upon the variety.

SPECIAL NOTES FOR PEST MANAGMENT

Note: The use of a **spreader-sticker** is recommended for cole crops in any case; the heavy wax coating on the leaves reduces deposition of spray materials. These adjuvants allow the spray to spread out and stick to the leaves. Multiple nozzles per row or bed will provide the under leaf coverage and high coverage rates necessary to manage caterpillar pests of cole crops.

INSECT MANAGEMENT

Aphids: The cabbage aphid can be a serious problem on these crops and should be treated immediately if noticed. Other aphid species are found on these crops and should be treated if the crop is near harvest or their level of infestation is increasing. Often parasitic wasps take out these species if broad-spectrum insecticides use is avoided.

Cabbage Root Maggot: Root maggots and other similar insects such as the seed corn maggot can be a problem in heavier soils in the Southeast especially during cool, damp times of the year. Avoid planting into soils with freshly plowed down crop residue or high levels of organic matter.

Caterpillars: A number of moth and butterfly larvae feed on cole crops. The major ones are the cabbage looper (CL), the imported cabbageworm (ICW), and the diamondback moth (DBM) referred to as the cabbageworm complex. Other caterpillars found on cole crops are the cross-striped cabbageworm, corn earworm, armyworms, and webworms. Webworms often damage the bud of the young plants and should be treated immediately; very young larvae are much more easily managed than older ones.

Scouting and using a threshold for spray applications is a cost effective method of managing these pests. Broad-spectrum insecticides that reduce the natural enemies in the field should be avoided if at all possible. If the cabbageworm complex is the major group of pests, a threshold of 1 cabbage looper equivalent (CLE) per 10 plants can be used. A cabbage looper equivalent relates the feeding amounts of the three caterpillars. One cabbage looper is equivalent to 1.5 imported cabbageworms or 5 diamondback moth larvae. (**Example**: 10 DBM larvae per 10 plants would be like 2 CLEs per 10 plants; this level would require treatment.) In other areas of the South where armyworms are common pests of cole crops, a threshold of 1 caterpillar (regardless of the kind) per 3 plants has been effectively used as a threshold. The use of a threshold to determine the need for treatment usually reduces the number of sprays per crop without loss of crop quality and improves the profit margin.

Note: *Bacillus thuringiensis* (BT) preparations are effective against most of these pests but must be eaten by the larvae. Thorough coverage of the plant particularly the undersurface of the leaf is essential, and the use of a **spreader-sticker** is strongly recommended.

Note: Several of these insects are prone to develop resistance to insecticides. Growers must rotate among classes of insecticides for each pest generation. See the section on resistance management.

Nematode Management. Use nematicides listed in the "Nematode Control in Vegetate Crops" table in the Disease Control section.

HARVESTING AND STORAGE

Fresh market cabbage should be harvested when heads are firm and weigh 2.5 to 3.0 pounds. Most markets require one to three wrapper leaves to remain. The heads should be dense and free of insect damage. Cabbage for slaw or kraut usually has much larger heads and weighs 3 to 12 pounds.

Broccoli should be harvested when the beads (flower buds) are still tight, but a few outer beads have begun to loosen. The stalks should be 7 inches long from top of the crown to the butt. Broccoli is usually bunched in 1.5 pound bunches with 2 to 3 heads per bunch. Secure bunches with a rubber band or twist tie.

Kohlrabi should be harvested when the bulbs are 2 to 3 inches in diameter and before internal fibers begin to harden.

Cauliflower is harvested while the heads are pure white and before the curds become loose and ricey. Heads are blanched by tying outer leaves over the heads when heads are 3 to 4 inches in diameter. Blanching takes about 1 week in hot weather and 2 weeks in cooler weather.

Kale is harvested by cutting off the entire plant near ground level, or lower leaves may be stripped from plant. Collards may be harvested at any stage of growth. See Table 14 for further postharvest information on these crops.

CARROTS

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
CARROTS								
Apache [3]	A	G		L	M	N	S	
Bolero [4]								T
Danvers 126 [5]	A			L		N	S	
Maverick [6]		G		L				
Narbonne [4]						N		
Purple Haze [2, 3]	A	G		L	M	N	S	T
Sugar Snax 54	A	G	K	L		N		T
Tastypeel [3]				L				

[1] Abbreviations for state where recommended.

[2] Purple.

[3] Imperator type: 7-8 inches long w/ long conical shape and narrow shoulders.

[4] Nantes type: Smooth, cylindrical over entire length w/ a blunt end.

[5] Danvers type: Tapering root w/ a semi-blunt tip.

[6] Nantes x Imperator type.

Seeding Dates. Small carrot seedlings up to six leaves cannot withstand hard freezes but are somewhat frost tolerant. Optimum temperatures are in the range of 60-70°F, with daytime highs of 75°F and nighttime lows of 55°F ideal. Although the crop can be grown outside this range with little or no effect on tops, temperatures differing drastically from the above can adversely affect root color, texture, flavor, and shape. Lower temperatures in this range may induce slow growth and make roots longer, more slender and lighter in color. Carrots with a root less than one inch in diameter are more susceptible to cold injury than larger roots. Soil temperatures should be above 40°F and below 85°F for best stand establishment.

CARROT PLANTING DATES

	Spring	Fall
AL North	3/1–4/15	NR
AL South	NR	8/1–11/30
GA North	3/1–4/15	NR
GA South	NR	8/1–11/30
KY East	4/1-4/30	NR
KY Central	3/20-4/15	NR
KY West	3/10-4/10	NR
LA North	1/15–2/28	9/15–10/15
LA South	1/15–2/28	9/15–10/15
MS North	2/15–4/1	NR
MS South	1/15–3/15	NR
NC East	2/15–3/31	6/15–8/15
NC West	4/1–6/15	7/21-8/15
SC East	2/1–3/15	9/1–9/15
SC West	2/15–3/31	8/1–9/15
TN East	3/15-5/1	NR
TN West	3/1-4/30	NR

SPACING

Spatial arrangements for planting can differ markedly. Carrots can be planted with vacuum, belt, or plate seeders. Often a special attachment called a scatter plate or spreader shoe is added to the plate planters to scatter the seed in a narrow band. Carrots should be spaced 1½ to 2 inches apart within the row. Carrot seed should be planted no deeper than ¼-½ inch. A final stand of 14 to 18 plants per foot of twin row is ideal. Ideal patterns are twin rows that are 2½ -3½ inches apart. Three or four of these twin rows are situated on one bed, depending on the width of the bed. One arrangement is to plant three twin rows on beds that are on 72-inch centers. Another arrangement is to plant four twin rows on a 92-inch bed (center to center). The sets of twin rows are 14 to 18 inches apart. Beds on 72-inch centers will have approximately 48 inches of formed bed. Row spacing wider than 18 inches will reduce total plant stand per acre and thus, will reduce total yield. Ideal plant populations should be in the range of 400,000 for fresh market carrots and 250,000 for processing carrots.

PLANTING AND LAND PREPARATION

Beds that are **slightly** raised are advantageous because they allow for good drainage. Beds should be firmed and not freshly tilled before planting and soil should be firmed over the seed at planting. A basket or roller attachment is often used to firm the soil over the seed as they are planted. Light irrigation will be required frequently during warm, dry periods for adequate germination.

Windbreaks are almost essential in areas with primarily sandy soils. Sand particles moved by wind can severely damage young carrot plants, reducing stands. Small grain strips planted between beds or at least planted between every few beds can help reduce this sandblasting injury.

Begin by deep turning soils to bury any litter and debris and breaking soils to a depth of 12-14 inches. Compacted soils or those with tillage pans should be subsoiled to break the compacted areas. If uncorrected, compact soil or tillage pans can result in restriction of root expansion. It is best to apply lime after deep turning to prevent turning up acid soil after lime application. Prepare a good seedbed using bed-shaping equipment. Do not use disks or rototiller to avoid soil compaction. Carrots should be planted on a slightly raised bed (2-3 inches) to improve drainage. After beds are tilled and prepared for seeding, it is best to allow the beds to settle slightly before planting. Avoid other tillage practices that can increase soil compaction. **Following in the same tracks for all field operations will help reduce compaction in planting areas.**

SPECIAL NOTES FOR PEST MANAGEMENT

DISEASE MANAGEMENT

Root-Knot Nematode: By far, the most destructive problem in carrots is root-knot nematodes. Root-knot nematodes are small eel-like worms that live in the soil and feed on plant roots. Since the root of the carrot is the harvested portion of the plant, no root-knot damage can be allowed. Root-knot causes poor growth and distorted or deformed root systems which results in a non marketable root. Root-knot damage also allows entry for other diseases such as *Fusarium, Pythium,* and *Erwinia*.

If any root-knot nematodes are found in a soil assay, treatment is recommended. Good success has been obtained using field soil fumigation to eradicate root-knot nematodes in the root zone of carrots. Use nematicides or fumigants listed in the "Nematode Control in Vegetate Crops" table in the Disease Control section.

SOIL-BORNE ROOT DISEASES

Depending on the cropping history of the field, *Pythium,* Southern Blight, and *Sclerotinia* may cause problems. It is advisable to avoid fields where these diseases have been identified in the previous crop. Deep turning is also necessary to help prevent root diseases.

***Pythium* Blight** is usually characterized by flagging of the foliage indicating some root damage is occurring. Under wet conditions, *Pythium* may cause serious problems to the root causing a white mycelium mat to grow on the infected area which rapidly turns to a watery soft rot. Forking of the root system is also a common symptom associated with *Pythium* infection. Rotation is considered a major factor in reducing *Pythium* along with the use of fungicides.

Southern Blight: Southern blight causes serious damage to carrots. This disease is usually associated with carrots remaining in the field after the soil begins to warm in the spring. This disease causes a yellow top to develop with a cottony white fungal growth associated with the upper part of the carrot root. The top of the root and the surrounding soil may be covered with a white mycelium with tan sclerotia developing as the disease progresses. Southern Blight is best controlled by using rotation and deep turning.

***Sclerotinia* Blight:** *Sclerotinia* blight causes serious damage to the roots of carrots. This disease is usually worse under wet soil conditions. White mycelium forms around the infected area and later, dark sclerotia develop on the white mycelium which is a good indicator of *Sclerotinia* rot. This disease causes a progressive watery soft rot of the carrot root tissue and is considered a potential problem in the production of carrots. Rotation and deep turning of the soil are recommended to reduce losses to this disease.

***Rhizoctonia*:** *Rhizoctonia* rot causes brown to black lesions to develop on the sides of the carrot root. The disease is much worse under cool, wet conditions. Saturated soil conditions often enhance all soil-borne diseases which are potential problems in carrot production. *Rhizoctonia* damage can be minimized by using rotation and good cultural practices. Soil fumigation will prevent damage with any of the soil inhabiting fungi.

FOLIAR DISEASES

Bacterial Blight: Bacterial blight causes irregular brown spots on the leaves and dark brown streaks on the petioles and stems. The lesions on the foliage begin as small yellow areas with the centers becoming dry and brittle, with an irregular halo. The bacterium affects the leaflets, stems and petioles as the disease progresses. Some of these lesions may crack open and ooze the bacteria. These bacteria may be washed down to the crown of the plant causing brown lesions on the top of the root. The earlier the infection occurs the greater the damage to the root. The bacterium is spread by splashing water and takes about 10-12 days before symptoms appear after inoculation. Disease development progresses rapidly between 77˚ and 86˚ F. Crop rotation is a major factor in controlling Bacterial blight.

***Alternaria* Blight:** *Alternaria* blight causes small dark brown to black spots with yellow edges forming mostly on the leaf margins. The spot increases as the disease progresses and in some cases entire leaflets may be killed. In moist weather, the disease can move so rapidly it resembles frost injury. Such conditions can reduce the efficiency of mechanical harvesters which require strong healthy tops to remove the carrot from the soil. *Alternaria* may also cause damping off of seedlings and a black decay of roots. The spores and mycelium are spread by splashing rains, contaminated soil, or on cultivation tools. The disease can manifest itself in about 10 days after infection. The optimum temperature for *Alternaria* blight is 82˚ F.

***Cercospora* Leaf Blight:** *Cercospora* blight causes lesions to form on the leaves, petioles and stems of the carrot plant. The symptoms appear to mimic that of *Alternaria* blight but can be separated using a compound microscope. *Cercosproa* blight progresses in warm, wet weather and spots appear in about 10 days after infection. The youngest leaves are usually more susceptible to *Cercosproa* infection.

INSECT MANAGEMENT

Soil Insects: Wireworms, white grubs, and the granulate cutworm may be partially controlled with good cultural practices. Soil should be deep turned in sufficient time prior to planting to allow destruction of previous crop residue that may harbor soil insects. When possible, avoid planting just after crops that are slow to decompose such as tobacco and corn. Avoid planting behind peanuts and root crops such as sweet potatoes and turnips. If a field has a history of soil insect problems, either avoid these or, broadcast incorporate a soil insecticide prior to planting. Plantings in fields that were recently in permanent pasture should be avoided as should fields recently planted to sod/turf, although these are not as critical. Fields with a history of whitefringed beetle larvae should not be planted to carrots because there are no currently registered insecticides effective on this pest.

Flea beetle larvae can damage roots by feeding from the surface into the cortex. The damage will take on the appearance of narrow "s" shaped canals on the surface. Flea beetle larvae can be prevented easily with soil insecticides.

The seedcorn maggot is an opportunistic pest that takes advantage of crops that are under stress or where there is decaying organic matter. At-planting soil insecticides will prevent the de-

velopment of maggot infestations for several weeks after planting. Seedcorn maggots cannot be effectively controlled after the infestation begins. If plants become stressed during the period of high root maggot potential, preventive applications of insecticides should be sprayed every seven days until the stress is minimized.

FOLIAR INSECTS

Foliar insect pests may be monitored and insecticides applied as needed. Carrots should be scouted at least once per week for developing populations of foliage pests.

Aphids: Several species of aphids may develop on carrots. The most common aphids to inhabit carrots are the green peach aphid and the cotton or melon aphid. Often parasitic wasps and fungal diseases will control these aphids. If populations persist and colonize plants rapidly over several weeks and honeydew or sooty mold is observed readily, then foliar insecticides are justified.

Flea Beetles: Fleas beetle adults may cause severe damage to the foliage on occasion. If carrots are attacked during the seedling stage and infestations persist over time, an insecticide application may be necessary. If plants are in the cotyledon to first true leaf stage, treatments should be made if damage or flea beetles are observed on more than 5% of the plants. After plants are well established, flea beetles should be controlled only if foliage losses are projected to be moderate to high, e.g., 15% or more.

Vegetable Weevil: The adult and larvae of the vegetable weevil may attack carrots. The adult and larvae feed on the foliage. Vegetable weevil larvae often will feed near the crown of plants and, if shoulders are exposed at the soil surface, larvae will feed on tender carrots. Treatments are justified if adults or larvae and damage are easily found in several locations.

Armyworms: The armyworm can cause damage in carrots. Armyworms may move from grain crops or weeds into carrots or adults may lay eggs directly on carrot plants. Armyworms are easily managed with foliar insecticides.

Beet Armyworm: The beet armyworm infests carrots in the late spring. Usually natural predators and especially parasites regulate beet armyworm populations below economically damaging levels.

Whiteflies: The silverleaf whitefly can be a problem during the early seedling stage of fall plantings. Silverleaf whitefly migrates from agronomic crops and other vegetables during the late summer. Infestation may become severe on carrots grown in these production areas. Often whiteflies may be controlled by several natural enemies and diseases by early fall so, treatments may not be justified. However, if whiteflies develop generally heavy populations, treatment of young plantings is justified.

HARVESTING AND STORAGE

Topped: 4 to 5 months at 32°F and 90% to 95% relative humidity. See Table 14 for further post harvest information.

CUCUMBERS

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
CUCUMBERS								
Slicer / Fresh Market								
Dasher II [2, 3, 4, 5, 6, 10]	A	G	K	L	M	N	S	T
Daytona [2, 3, 5, 6, 7, 8, 9, 10]	A	G	K	L		N	S	T
General Lee [4, 5, 6, 10]	A	G	K	L	M	N	S	
Indy [2, 3, 4, 5, 7, 8, 9, 10]	A		K	L		N	S	T
Intimidator [2, 3, 4, 6, 10]		G	K	L		N	S	T
Poinsett 76 [2, 3, 5, 10]	A	G				N	S	
Rockingham [2, 3, 5, 6, 10]	A	G	K		M	N	S	
Slice More [2, 4, 5, 6, 10]		G		L		N	S	
Speedway [2, 3, 5, 6, 10]	A	G	K	L		N	S	T
StoneWall [2, 3, 4, 5, 6, 10]		G	K	L		N	S	
Talladega [2, 3, 5, 9, 10]	A	G	K	L	M	N	S	T
Thunder [3, 4, 5, 6, 8, 10]	A	G	K	L	M	N	S	T
Pickling Types - Multiple Harvest								
Calypso [2, 3, 4, 5, 6, 10]	A	G	K	L	M		S	T
Colt	A					N	S	
Fancipak [2, 3, 4, 5, 6, 10]	A	G					S	T
Pickling Types - Multiple or Once-over Harvest								
Excursion [2, 3, 4, 5, 6, 10]	A					N	S	T
Expedition [2, 3, 5, 6, 10]	A					N	S	
Fiesty	A					N	S	
Lafayette	A					N	S	
Sassy [2, 3, 5, 6, 7, 8, 9, 10]	A					N		T

[1] Abbreviations for state where recommended.
[2] Anthracnose tolerance/resistance.
[3] Angular Leaf Spot tolerance/resistance.
[4] Downy Mildew tolerance/resistance.
[5] Powdery Mildew tolerance/resistance.
[6] Cucumber Mosaic Virus tolerance/resistance.
[7] Papaya Ring Spot Virus tolerance/resistance.
[8] Zucchini Yellows Mosaic Virus tolerance/resistance.
[9] Watermelon Mosaic Virus tolerance/resistance.
[10] Scab tolerance/resistance.

For earlier cucumber production and higher, more concentrated yields, use gynoecious varieties. A gynoecious plant produces only female flowers. Upon pollination female flowers will develop into fruit. To produce pollen, 10% to 15% pollinizer plants must be planted; seed suppliers add this seed to the gynoecious variety. Both pickling and slicing gynoecious varieties are available. For machine harvest of pickling cucumbers, high plant populations (55,000 per acre or more) concentrate fruit maturity for increased yields.

Planting Dates. For earliness container-grown transplants are planted when daily mean soil temperatures have reached 60°F but most cucumbers are direct seeded. Consult the following table for planting dates for transplants in your area. Early plantings should be protected from winds with hot caps or row covers. Growing on plastic mulch can also enhance earliness.

CUCUMBER *SLICERS* PLANTING DATES

	Spring	Fall
AL North	4/1–7/15	8/1–8/30
AL South	3/1–4/30	8/1–9/15
GA North	4/15–7/15	8/1–8/30
GA South	3/1–4/30	8/1–9/15
KY East	5/10-6/1	6/1-6/15
KY Central	5/5-6/1	6/1-7/1
KY West	4/25-5/15	5/15-7/15
LA North	3/15–5/15	7/15–8/31
LA South	3/1–5/15	8/1–9/15

CUCUMBER *SLICERS* PLANTING DATES (cont'd)

	Spring	Fall
MS North	4/1–5/15	7/25–8/21
MS South	3/15–5/1	8/14–9/14
NC East	4/15–5/15	7/15–8/15
NC West	5/15–7/31	NR
SC East	3/15–5/15	8/1–8/30
SC West	4/15–6/5	8/1–8/30
TN East	5/5-6/15	7/1-8/10
TN West	5/1-6/1	7/25-8/25

CUCUMBER *PICKLING* PLANTING DATES

	Spring	Fall
AL North	4/15–7/15	8/1–8/30
AL South	3/1–4/30	8/1–9/15
GA North	4/15–7/15	NR
GA South	3/1–4/30	8/1–9/15
KY East	5/10-6/1	6/1-6/15
KY Central	5/5-6/1	6/1-7/1
KY West	4/25-5/15	5/15-7/15
LA North	4/1–5/15	7/15–8/31
LA South	3/15–5/15	8/1–9/15
MS South	4/1–4/15	NR
NC East	4/20–5/20	7/15–8/15
NC West	5/25–7/31	NR
SC East	3/15-5/15	8/1–8/30
SC West	4/15–6/15	8/1–8/30
TN East	5/5-6/15	7/1-8/10
TN West	5/1-6/1	7/25-8/25

Spacing. *Slicers:* Space rows 3 to 4 feet apart with plants 9 to 12 inches apart. *Pickles*: For hand harvest, space 3 to 4 feet apart; for machine harvest, space three rows 24–28 inches apart on a bed. Plants for hand harvest should be 6 to 8 inches apart in the row; 2 to 4 inches apart for machine harvest. Close spacing increases yields, provides more uniform maturity and reduces weed problems, but require slightly higher fertilizer rates. *Seeding for slicers*: 1.5 pounds per acre. *Seeding for pickles*: 2 to 5 pounds per acre.

Mulching. Fumigated soil aids in the control of weeds and soilborne diseases. Black plastic mulch laid before field planting conserves moisture, increases soil temperature, and increases early and total yield. Plastic and fumigant should be applied on well-prepared planting beds 2 to 4 weeks before field planting. Plastic should be placed immediately over the fumigated soil. The soil must be moist when laying the plastic. Fumigation alone may not provide satisfactory weed control under clear plastic. Herbicides labeled and recommended for use on cucumbers may not provide satisfactory weed control when used under clear plastic mulch on nonfumigated soil. Black plastic can be used without a herbicide. Fertilizer must be applied during bed preparation. At least 50% of the nitrogen (N) should be in the nitrate (NO_3) form.

Foil and other reflective mulches can be used to repel aphids that transmit viruses in fall-planted (after July 1) cucumbers. Direct seeding through the mulch is recommended for maximum virus protection. Fumigation will be necessary when there is a history of soilborne diseases in the field. Growers should consider drip irrigation with plastic mulch. For more information, see the section on "Irrigation".

SUGGESTED FERTIGATION SCHEDULE FOR CUCUMBER* (N:K,1:2)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			25.0	45.0
0-14	0.9	1.8	37.6	75.2
15-63	1.5	3.0	110.3	196.6
64-77	0.7	1.4	120.1	216.6

ALTERNATIVE FERTIGATION SCHEDULE FOR CUCUMBER* (N:K,1:1)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			24.0	24.0
0-7	1.0	1.0	31.0	31.0
8-21	1.5	1.5	52.0	52.0
22-63	2.0	2.0	136.0	136.0
64-70	1.5	1.5	150.0	150.0

*Adjust based on tissue analysis.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Cucumber Beetle: Cucumber beetles can transmit bacterial wilt; however, losses from this disease vary greatly from field to field and among different varieties. Pickling cucumbers grown in high-density rows for once-over harvesting can compensate for at least 10% stand losses. On farms with a history of bacterial wilt infections and where susceptible cultivars are used, foliar insecticides should be used to control adult beetles before they feed extensively on the cotyledons and first true leaves. Begin spraying shortly after plant emergence and repeat applications at weekly intervals if new beetles continue to invade fields. Treatments may be required until stems begin vining (usually about 3 weeks after plant emergence), at which time plants are less susceptible to wilt infections.

An alternative control option for cucumber beetles is the use of Admire at planting. **Note:** Use of Admire at planting can lead to spider mite outbreaks later in the season.

Pickleworm, Melonworm: Make one treatment prior to fruit set, and then treat weekly.

Aphids: Aphids transmit several viruses (CMV, WMV, PRSV, etc.) and can delay plant maturity. Thorough spray coverage beneath leaves is important. For further information on aphid controls, see the preceding "Mulching" section. Treat seedlings every 5 to 7 days or as needed.

Mites: Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow or maintain these areas after midsummer because this forces mites into the crop. Localized infestations can be spot-treated. Begin treatment when 50% of the terminal leaves show infestation. ***Note:*** Continuous use of Sevin or the pyrethroids may result in mite outbreaks.

DISEASE MANAGEMENT

***Phytophthora* Blight:** To minimize the occurrence of this disease, fields should be adequately drained to ensure that soil water does not accumulate around the base of the plants. Just before plants begin vining, subsoil between rows to allow for faster drainage following rainfall.

Belly Rot: Belly rot is a soil-borne disease. Application of appropriate crop protectant at last cultivation may be helpful.

Weed Management: See the previous "Mulching" section for futher information on weed control under clear plastic mulch.

Nematode Management. Use nematicides listed in the "Nematode Control in Vegetate Crops" table in the Disease Control section.

POLLINATION

Bees are critical for insuring that pollination and cucumber fruit set occurs. Supplementing a field with bee hives can be especially helpful when native bee populations are low or lacking. Having sufficient bees provides the opportunity to maximize cucumber yields and quality. Lack of sufficient pollination can result in a variety of misshapen fruits; dogbone, crooks, nubs, etc.

Rented honeybee hives are often placed in cucumber fields as plants begins to flower. The timing of hive placement is important because cucumber flowers are not that attractive to honeybees. If the honeybee hives are placed by cucumber fields prematurely before the crop flowers, the honeybees may forage to wild flowers nearby which are more attractive due to their higher nectar and pollen supply. If this occurs, the honeybees may be predisposed to visit these wild flowers even though cucumber flowers are in full bloom a few days later. Assuming that the honeybee hive is a

healthy hive, one hive per acre is recommended for hand-harvested pickling and slicing cucumbers with recommended plant populations of approximately 25,000 to 30,000 plants per acre. For mechanical or once-over harvested pickling cucumbers, the recommended plant populations are generally 55,000 to 60,000 plants per acre. Therefore, two honeybee hives should be placed per acre to account for the increased number of flowers from the increased plant population used for mechanically harvested cucumbers. When hybrid cucumbers are grown at high plant populations for machine harvest, flowers require 15 to 20 visits for maximum fruit set. Generally, as the number of visits increase, there will be an increase in the numbers of fruit set and an increase in number of seed per fruit, as well as improved fruit shape and fruit weight.

Bumblebees are an effective pollinator alternative to honeybees in cucumber production. Bumblebees have some advantages compared to honeybees; flying under more adverse weather conditions in which it is cool, rainy or windy. They will also visit flowers earlier in the morning than honeybees, and fly later in the afternoon and early evening when the temperatures cool. Because bumblebees have a larger body size than honeybees, fewer flower visits are required by bumblebees in order to achieve good pollination and fruit set.

As with honeybees, bumblebees should be placed in the cucumber field shortly after the crop begins to flower. Bumblebees will typically last for 6 to 12 weeks and will meet the pollination needs of 2 to 3 sequentially planted cucumber crops.

Bumblebee hives are sold as a quad or four hives per quad. A quad is the minimum order that can be purchased from a supplier. Generally one bumblebee hive contains 200 to 250 bees and is equivalent to one honeybee hive. Thus, one quad of bumblebees (minimum order, contains 4 bumblebee hives) would provide good pollination for four acres of hand-harvested cucumbers. For machine-harvest pickling cucumbers, one quad would provide good pollination for every two acres. Bumblebee hives should not be placed in direct sunlight so that the bees work more efficiently. No more than two bumblebee quads should be placed in one location so that pollination is more uniform in the field. As with honeybees, one must carefully plan when to spray insecticides so that the bumblebees are not killed. Because bumblebees are most active from dawn until late morning and from about 4 PM to sunset, the hives need to be closed around 11 AM so that the bees in the hive remain protected during a late evening spray application. Bumblebee quads should be located a minimum of 650 to 700 feet away from the other quads in order to maximize pollinator efficiency.

See the section on “Pollination” in the General Production Recommendations for additional information.

HARVESTING AND STORAGE

See Table 14 for postharvest information.

EGGPLANT

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
EGGPLANT								
Black Bell				L	M			T
Black Shine					M			
Calliope [2]	A	G		L	M	N	S	T
Casper [3]	A	G			M		S	T
Classic	A	G	K	L	M	N	S	T
Dusky	A		K	L	M	N	S	T
Epic	A	G	K	L	M	N	S	T
Fairy Tale [4]	A	G	K	L	M	N	S	T
Ghostbuster [3]	A	G	K		M			T
Green Giant [5]	A	G		L				
Gretel [3, 6]	A	G	K		M		S	T
Hansel [6]	A	G	K			N	S	T
Ichiban [6]	A	G	K	L	M	N	S	T
Little Fingers [6]	A		K		M	N	S	T
Kermit [6, 7]	A	G		L		N	S	T
Night Shadow	A	G					S	T
Pingtung Long [6]	A	G				N		
Rosalita	A	G	K		M	N		
Rosita	A	G	K		M	N		
Santana	A	G	K	L		N	S	T

[1] Abbreviations for state where recommended.
[2] White exterior with purple streaks.
[3] White exterior.
[4] Purple exterior with white stripes.
[5] Green exterior.
[6] Small diameter fruit.
[7] Green and white exterior.

Eggplant is a warm-season crop that makes its best growth at temperatures between 70° to 85°F. Temperatures below 65°F result in poor growth and fruit set.

Seed Treatment. Soak seed in hot water at 122°F for 25 minutes. Dry seed, then treat with an appropriate fungicide to prevent damping-off.

EGGPLANT PLANTING DATES

	SPRING	FALL
AL North	4/1–7/15	NR
AL South	3/1–4/30	7/15–8/31
GA North	4/15–7/15	NR
GA South	3/1–4/30	7/15–8/31
KY East	5/15-6/1	NR
KY Central	5/10-6/15	NR
KY West	5/1-7/1	NR
LA North	4/15–5/15	7/1–8/15
LA South	3/15–5/15	7/1–8/30
MS North	4/15-6/15	NR
MS South	3/1-4/30	8/1-8/31
NC East	4/15–5/10	8/1–8/15
NC West	5/15–7/15	NR
SC East	4/1–4/30	8/1–8/31
SC West	5/1–6/30	NR
TN East	4/25-7/15	NR
TN West	4/15-6/15	NR

Spacing. *Rows:* 4 to 5 feet apart; plants: 2 to 3 feet apart in the row.

Staking. Staking eggplant improves quality and yield, while reducing decay. Use a 5 foot tomato stake between every other plant and place string along each side of the plants as they grow. This is described in detail in the tomato section of this guide. Side branches of eggplant should be pruned up to the first fruit and 2 main stems should be used. If additional stems grow too large remove them. The first fruit should be pruned off until the flower is at least 8 inches above the ground, this will allow for straight fruit to form.

Transplant Production. Sow seed in the greenhouse 8 to 10 weeks before field planting. Three to 4 ounces of seed are necessary to produce plants for 1 acre. Optimum temperatures for germination and growth are 70° to 75°F. Seedlings should be transplanted to 2-inch or larger pots or containers anytime after the first true leaves appear, or seed can be sown directly into the pots and thinned to a single plant per pot. Control aphids on seedlings in greenhouse before transplanting to field.

Transplanting Dates. Harden plants for a few days at 60° to 65°F and set in field after danger of frost and when average daily temperatures have reached 65° to 70°F.

Drip Irrigation and Fertilization. Before mulching, adjust soil pH to 6.5 and in the absence of a soil test, apply fertilizer to supply 50 pounds per acre of N,P_2O_5 and K_2O, (some soils will require 100 pounds per acre of K_20). Thoroughly incorporate into the soil.

After mulching and installing the drip irrigation system, the soluble fertilizer program should be initiated using the following table. On low to low-medium boron soils, also include 0.5 pound per acre of actual boron.

The first soluble fertilizer application should be applied through the drip irrigation system within a week after field-transplanting the eggplant. Continue fertigating until the last harvest.

SUGGESTED FERTIGATION SCHEDULE FOR EGGPLANT* (high soil potassium)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			50.0	100.0
0-22	0.5	0.5	60.5	110.5
22-49	0.7	0.7	80.1	130.1
50-70	1.0	1.0	101.1	151.1
71-91	1.1	1.1	124.2	174.2
92-112	1.0	2.0	145.2	195.2

ALTERNATIVE FERTIGATION SCHEDULE FOR EGGPLANT* (low soil potassium)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
0-22	0.5	0.5	60.5	111.0
22-49	0.7	1.4	80.1	150.2
50-70	1.0	2.0	101.1	192.5
71-91	1.1	2.2	124.2	238.7
92-112	1.0	2.0	145.2	280.7

*Adjust based on tissue analysis.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Colorado Potato Beetle (CPB), Flea Beetles (FB): CPB has the ability to rapidly develop resistance to insecticides. Refer to "Eggplant" insecticide section for management options. Control of many early season pests including CPB, FB, whiteflies, and aphids can be accomplished through the use of Admire at planting. The use of row covers can be highly effective for flea beetle management early in the season.

Silverleaf Whitefly: Treat when an average of 5 or more adults are found per leaf.

Weed Management. See "Mulching" section for further information on weed control under clear plastic mulch.

RATOONING EGGPLANT: PRODUCING A FALL CROP FROM A SPRING PLANTED CROP

Ratooning eggplants can be done after the first crop is complete to allow a second crop to develop. Depending on the location, the first crop may be completed by June or July. Plants at this point will appear "topped out," not producing any more flowers and any subsequent fruits. Mow plants 6 to 8 inches above the soil line, being sure to leave two to three leaf axils. Next, fertilize with 50 to 60 pounds of nitrogen per acre and 80 to 100 pounds of potash per acre (K_2O). This combination will produce vigorous re-growth and stimulate flowering. Plants will begin producing fruit 4 to 6 weeks after ratooning and should produce eggplants until frost.

HARVESTING AND STORAGE

Eggplant may be harvested once the fruit has reached one-half to full size for a given variety. However, harvesting prior to full size may reduce potential yields.

Harvest-ready fruit have a glossy appearance and are firm, without wrinkles. Harvest eggplant fruit before they become over mature. When over mature, the fruit is dull in color, seeds are hard and dark, and the flesh is characteristically spongy. Although the fruit can often be "snapped" from the plant, they should be clipped with a sharp knife or scissors to prevent damage. When harvesting, cut the stem approximately 1/4 inch from the fruit. Eggplant skin is tender and easily bruised, so handle with care. See Table 14 for further postharvest information.

GARLIC AND ELEPHANT GARLIC

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
GARLIC								
California Early[2]		G						
Chesnok Red[4]						N		
Creole				L				
Elephant (also called Tahiti)[3]	A	G	K	L	M	N	S	T
German Extra Hardy[4]	A		K			N	S	T
Italian[2]				L				
Music[4]						N		
New York White Neck[2]	A					N	S	T
Spanish Roja[4]						N		

[1] Abbreviations for state where recommended.
[2] Softneck.
[3] *Allium ampeloprasum* (Broadleaf Wild Leek)
[4] Hardneck.

Most garlic that is available from retail markets tends to be softneck types. When selecting softneck garlic for planting be sure to secure a strain of softneck garlic from a local grower who has had success with fall-planted garlic. Unlike many strains sold commercially, such a strain should be well adapted to your area to overwinter. Avoid planting the Creole types of softneck garlic in the northern range (also called Early, Louisiana, White Mexican, etc.), because they are not very winter-hardy and do not keep well. Both the Italian and Creole types have a white outer skin covering the bulb, but the Italian type has a pink skin around each clove, whereas the skin around each Creole clove is white. Elephant-type garlic (milder than regular garlic and up to four times larger) may not yield very well when fall-planted in areas with severe cold or extensive freezing and thawing cycles, which cause heaving. Elephant garlic has performed well, however, in western North Carolina when it is well-hilled with soil or mulched with straw. The Italian and Elephant types take about 220 days to mature.

Many of the most productive Italian garlic strains produce seed heads prior to harvest. Whether removed as they form or left intact, they have produced satisfactory yields.

Research in Kentucky and North Carolina has shown that hardneck types of garlic produce superior yields and are more winter-hardy than softneck types. Unlike softneck types, which will produce large numbers of small cloves per bulb; hardneck garlic will produce bulbs with 7-10 large cloves. Hardneck types have a hard "seedstalk" (called a "scape") that is typically removed prior to harvest. Scapes are sometimes sold at farmers markets as a specialty item.

Seed pieces for hardneck garlic are often more expensive and harder to find than softneck types, but improved winter hardiness and bulb quality in the spring in Kentucky suggests that these are preferred for production at more northern latitudes. Results from these states might not translate to all areas of the southeastern US. Consult with your local Extension office to find appropriate cultural information for your area.

Soil Fertility. Maintain a soil pH of 6.2 to 6.8. Fertilize according to soil test recommendations for garlic. In moderately fertile soils, apply about 75 pounds nitrogen (N) per acre, 150 pounds phosphate (P_2O_5) per acre and 150 pounds potash (K_2O) per acre and disk about 6 inches deep before planting. When plants are about 6 inches tall (about March 15), topdress with 25 pounds per acre nitrogen and repeat the top dressing about May 1. Apply all top dressings to dry plants at midday to reduce chance of fertilizer burn.

Because sulfur may be partially associated with the extent of pungency, you may wish to use ammonium sulfate for the last top dressing (May 1). If ammonium sulfate is used, make sure pH is 6.5 to 6.8.

Garlic is commonly grown on muck, sandy, or fine textured soils as long as they are loose and friable. Use of organic matter or cover cropping is important.

Planting. Garlic cloves should be planted during the fall because a chilling requirement must be met for good bulb development. Plant according to the times listed in the following table to ensure that good root systems are established prior to winter. Final bulb size is directly related to the size of the cloves that are planted. Avoid planting the long, slender cloves from the center of the bulb and cloves weighing less than 1 gram.

GARLIC PLANTING DATES

	Planting Dates		Planting Dates
AL North	9/15–11/10	MS	9/15–10/30
AL South	10/1–11/30	NC East	9/15–11/10
GA North	9/15–11/10	NC West	8/15–10/15
GA South	10/1–11/30	SC East	10/1–11/30
KY East	9/1-10/1	SC West	8/15–10/15
KY Central	9/10-10/15	TN East	9/1-11/1
KY West	9/15-11/1	TN West	9/15-11/1
LA North	9/1–11/30		
LA South	9/1–11/30		

Spacing. Garlic should be planted 4 by 4 inches apart in triple rows or multiple beds 16 to 18 inches apart. Between-row spacing depends on the equipment available. Clove tops should be covered with 1 to 1.5 inches of soil. The cloves must not be so deep that the soil will interfere with the swelling of the bulbs, nor so shallow that rain, heaving from alternate freezing and thawing, and birds will dislodge them. Vertical placement of cloves by hand gives optimal results. Cloves dropped into furrows are likely to lie in all positions and may produce plants with crooked necks. Garlic has also been grown successfully in Kentucky using plastic mulch as this helps reduce weed pressure during the long growing season.

INSECT MANAGEMENT

Thrips: During hot, dry weather, the population of thrips increases following harvest of adjacent alfalfa or grain. Thrips could therefore present the most serious insect problem on garlic. (See "Onions" in the Insect Control section of this publication). Read and follow specific label directions for use on garlic; if not listed, do not use. Treat if thrips counts exceed an average of 5 thrips per plant.

HARVESTING AND STORAGE

Garlic is ready for harvest in mid-May to mid-June—it must be harvested when around 30% of foliage is starting to yellow or the bulbs will split and be more susceptible to disease. When a few tops fall over, push all of them down and pull a sample. There are only about 10 days to 2 weeks for optimal garlic harvest. Before then, the garlic is unsegmented; much after that period the cloves can separate so widely that the outer sheath often splits and exposes part of the naked clove. Picked at the proper time, each clove should be fully segmented and yet fully covered by a tight outer skin.

Run a cutter bar under the bulbs to cut the extensive root system and partially lift them. The bulbs are usually pulled and gathered into windrows. Tops are placed uppermost in the windrow to protect bulbs from the sun, and the garlic is left in the field for a week or more to dry or cure thoroughly. Curing can also be accomplished in a well-ventilated shed or barn. The bulbs must be thoroughly dried before being shipped or stored. Outdoor curing is not recommended where morning dew can keep it too damp. Bring in for drying immediately from field. Emphasize gentle handling. Cure for about 6 weeks.

After curing garlic, discard diseased and damaged bulbs. Clean the remaining bulbs to remove the outer loose portions of the sheath, and trim the roots close to the bulb. Do not tap or bang bulbs together to remove soil. Braid or bunch together by the tops of the bulbs, or cut off the tops and roots and bag the bulbs like dry onions.

When properly cured, garlic keeps well under a wide range of temperatures. Storage in open-mesh sacks in a dry, well-ventilated storage room at 60° to 90°F is satisfactory. However, garlic is best stored under temperature and humidity conditions required for onions [32°to 35°F and 65% relative humidity]. Garlic cloves sprout quickly after bulbs have been stored at temperatures near 40°F, so avoid prolonged storage at this temperature. Garlic stored at above 70% relative humidity at any temperature will mold and begins to develop roots.

Marketing. New growers should develop a local retail market (roadside stands, night markets, gourmet restaurants), wholesale shipper, or processing market before planting. The demand for garlic is increasing due to recent reports about the health and medical benefits of garlic. The main markets are New York, Philadelphia, Pittsburgh, Washington, D.C., Chicago, and St. Louis.

The markets of the northern and eastern United States will take the bulbs trimmed like dry onions and known as "loose garlic." Frequently, 30 to 50 bulbs are tied in bunches. Bulbs should be graded into three sizes—large, medium, and small. Each string or bunch should contain bulbs of uniform size and of the same variety.

First-class garlic bulbs must be clean and have unbroken outer sheaths. Many of the larger vegetable markets, such as the large chain stores, could retail garlic in the form of clean, uniform cloves, two dozen to a mesh bag. Processors are not particular about having the cloves enclosed in a neat sheath and occasionally accept sprouted bulbs.

Garlic-growing can be very profitable when freshness is stressed and if the tops are braided, tied together, or placed into long, narrow, plastic mesh bags so they can be effectively displayed at roadside or night-market stands

GREENS: MUSTARD & TURNIP

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
MUSTARD								
Florida Broadleaf	A	G	K	L	M	N	S	T
Green Way	A		K	L				T
Red Giant					M			
Savannah	A	G	K	L	M		S	T
Southern Giant	A	G	K	L	M	N	S	T
Tendergreen[2]	A	G	K	L	M	N	S	T
TURNIP GREENS								
Alamo	A	G	K	L	M		S	T
All Top	A	G	K	L		N	S	T
Just Right	A				M	N	S	
Purple Top White Globe	A	G	K	L	M	N	S	T
Seven Top	A	G	K	L		N	S	T
Shogoin	A			L		N	S	
Southern Green	A	G	K		M	N	S	
Top Star	A	G						T
Topper			K	L	M		S	T
Tokyo Cross		G		L			S	T

[1] Abbreviations for state where recommended. [2] Spinach-mustard.

Seeding. Greens can be succession seeded throughout the indicated times liated in the table below. The next seeding date should be made when the previous crop is 50% emerged. Seeds emerge in 3-12 days: emergence is temperature dependent, with rapid emergence in warm weather (fall planting) and slower in cool temps (spring planting). Rows should be 12-24 inches apart and in-row spacing should be 1-2 inches.

Soils. Loamy soils will produce greatest yields, but many soil types are suitable. Sandy soils are preferred for cool season and overwintering production. Greens grown in sandy soils are easier to pull from the soil, and easier to clean off soil residue, than those grown in clay soils. Soil pH of 6.0 to 6.5 is desirable.

Fertilizers. Quality greens require quick, continuous growth. A continual supply of nitrogen is essential for good color and tenderness. Applications of nitrogen at planting followed by additional sidedress applications during the growing season, are essential to produce consistent, high quality greens.

Cultivation. In addition to adequate nutrition, consistent irrigation is necessary for good leaf formation. Overhead irrigation should be avoided as it causes favorable conditions for the development of several diseases.

MUSTARD AND TURNIP PLANTING DATES

	Spring	Fall
AL North	2/1–4/30	8/1–9/15
AL South	2/1–5/15	8/1–10/31
GA North	3/15–4/30	8/1–9/15
GA South	2/1–5/15	8/1–10/31
KY East	3/15-4/30	7/1-7/15
KY Central	3/10-4/25	7/15-8/1
KY West	3/1-4/15	8/1-8/15
LA North	2/1–3/15	7/15–10/31
LA South	2/1–3/15	7/15–10/31
MS North	1/20–4/1	7/25–8/20
MS South	1/15–3/1	8/10–9/15

MUSTARD AND TURNIP PLANTING DATES (cont'd)

	Spring	Fall
NC East	2/15–6/30	8/1–9/15
NC West	4/1–8/15	NR
SC East	2/1–6/15	8/1–10/15
SC West	3/15–9/15	NR
TN East	4/1-5/30	7/1-7/30
TN West	2/15-4/15	8/1-8/31

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Aphids: These insects can be serious pests of greens crops. Frequent examinations of the crops are necessary to avoid undetected infestations. Broad-spectrum insecticides used for caterpillar management can lead to aphid infestations.

Caterpillars: Many of the same caterpillars that feed on the large Cole crops (cabbage, collard, etc.) will feed on greens. Action thresholds for greens crops are currently lacking, but low levels of caterpillars can be tolerated during the early stages of growth. The use of BTs and other soft materials are encouraged in order to maintain natural enemy populations in the crops.

Flea Beetles: These small insects can be serious pests of greens crops. They are often associated with heavier soils and weedy areas. BTs are ineffective against beetle pests. These materials are generally ineffective against these insects although the new neonictinoid insecticides work well with little effect on natural enemies. Treatment should begin when the infestation is first noticed. Frequent use of broad-spectrum insecticides for flea beetle management often leads to resurgence of other pests. Reflective mulches have been found to be effective in repelling flea beetles.

HARVESTING AND STORAGE

See Table 14 for postharvest information.

LEEKS

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
LEEKS								
Alcazar	A					N	S	
Alora		G						
Firena	A					N	S	
Lancelot	A					N	S	
Tadorna	A					N	S	

[1] Abbreviations for state where recommended.

Transplants. Transplants are used for early spring plantings. For summer planting, sow in seed beds as indicated in following table. About 2 pounds of seed are required to provide enough plants to set an acre. Seed should be planted 1/3 to 1/2 inch deep 8 to 12 weeks before field setting. Plants will be ready to set in early August. Plug cells have worked well.

LEEK PLANTING DATES

	Spring	Fall
AL North	3/15–4/30	9/15-10/31
AL South	2/1–3/31	NR
GA North	3/15–4/30	9/15–10/31
GA South	2/1–3/31	NR
KY East	4/1-6/15	NR
KY Central	3/25-7/1	NR
KY West	3/15-7/15	NR
MS	NR	NR
NC East	2/15–6/30	NR
NC West	4/1–8/15	NR
SC East	2/1–6/15	NR
SC West	3/15–6/30	NR
TN East	4/1-6/30	NR
TN West	3/15-8/1	NR

Field Spacing. *Rows:* 20 to 30 inches apart; *plants:* 4 inches apart in the row. Set plants in trenches 3 to 4 inches deep.

Culture. Leeks grow slowly for the first 2 or 3 months. To develop a long white stem, start to gradually fill in trenches and then hill soil around stems to 3 or 4 inches.

There has been limited success growing leeks in Kentucky and Tennessee. They can be grown for direct market sales, but wholesale production is not currently recommended. At this time there are no varieties recommended for these states.

HARVESTING AND STORAGE

Spring-transplanted leeks are ready for harvest in July. Fall-transplanted leeks are ready to harvest by July. Fall-planted leeks are ready by November and can be overwinterted. See Table 14 for postharvest information.

LETTUCE, ENDIVE, AND ESCAROLE

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
LETTUCE								
Head								
Crispino				L				
Great Lakes				L			S	
Ithaca	A	G		L		N	S	T
Mighty Joe	A					N	S	
Maverick				L		N		
Raider				L				
Green Leaf								
Grand Rapids		G	K			N	S	
Green Star	A							T
Nevada	A			L		N		
Salad Bowl	A	G	K	L	M	N		T
Sierra	A			L				
Slobolt	A					N	S	T
Tango	A		K	L		N		T
Tehama[3]				L		N	S	
Tiara							S	T
Two Star	A			L		N	S	
Red Leaf								
New Red Fire[4]	A	G	K	L	M	N	S	T
Red Express[4]						N	S	
Red Sails[4]	A		K	L		N		T
Ruby[4]				L		N		T
Cos or Romaine								
Coastal Star	A							T
Green Forest	A		K	L		N	S	T
Green Towers	A	G	K	L		N	S	T
Ideal Cos			K	L		N	S	T
Musena[3]						N	S	
Parris Island Cos	A		K	L			S	T
Red Eyes Cos[4]	A			L				
Ridgeline				L				
Sunbelt[2]	A	G				N	S	
Valley Heart[2]	A					N	S	
Butterhead								
Adriana	A					N		T
Bennett						N	S	
Buttercrunch	A	G	K	L		N		T
Caliente				L				
Ermosa	A		K	L		N	S	
Esmeralda	A	G	K			N	S	T
Harmony				L				
Nancy	A		K			N		T
ENDIVE								
Galia Frisse	A					N	S	
Salad King	A		K	L		N	S	T
ESCAROLE								
Florida Deep Heart				L				
Full Heart Batavian	A		K	L		N	S	T
Full Heart 65	A					N	S	

[1] Abbreviations for state where recommended.
[2] Recommended for fall production only (bolting susceptible).
[3] Bolting resistant.
[4] Red.

Lettuce and endive are cool-season crops. Properly hardened lettuce transplants can tolerate temperatures as low as 20° to 25°F. Temperatures above 85°F for several days will cause seed stalk formation and bolting in lettuce. Temperatures below 70°F during the seedling stage promote premature stalk formation in endive and escarole.

Seeding and Transplanting. *Spring crop*. Lettuce transplants are started in frames or greenhouses. Seed for the lettuce crop is sown in heated greenhouses in November to February at the rate of 4 to 6 ounces of seed for 1 acre of plants.

Direct-seeded lettuce is sown in prepared beds as early in the spring as the ground can be worked. Seed should be sown shal-

low—some of the seed will actually be uncovered and visible. Pelleted seed should be watered at night during high-temperature periods (soil temperatures above 80°F) until germination occurs.

LETTUCE *HEAD* PLANTING DATES

	Spring	Fall
AL North	4/15–5/30	8/1–9/15
AL South	2/1–3/31	8/1–9/30
GA North	4/15–5/30	NR
GA South	2/1–3/31	8/1–9/30
KY East	4/1-4/30	NR
KY Central	3/25-4/15	NR
KY West	3/15-4/1	NR
LA North	1/15–3/15	9/15–10/30
LA South	1/15–3/15	9/15–10/30
MS	NR	NR
NC East	2/1–4/10	8/25–9/25
NC West	3/1-8/10	NR
SC East	2/1-4/15	NR
SC West	3/15-5/15	NR
TN East	3/15-4/30	8/1-9/1
TN West	3/1-4/15	8/15-9/15

LETTUCE *LEAF AND BUTTERHEAD* PLANTING DATES

	Spring	Fall
AL North	4/15–5/30	8/1–9/30
AL South	2/1–4/15	8/1–10/15
GA North	4/15–5/30	8/1–8/30
GA South	2/1–4/15	8/1–10/15
KY East	4/1-4/30	NR
KY Central	3/25-4/15	NR
KY West	3/15-4/1	NR
LA North	1/15–3/15	9/15–10/30
LA South	1/15–3/15	9/15–10/30
MS North	3/15-4/30	8/1-9/30
MS South	2/1-4/15	8/1-10/15
NC East	2/1–4/20	8/25–10/1
NC West	3/1-8/25	NR
SC East	2/1–4/15	9/15–11/1
SC West	3/1–5/15	NR
TN East	3/15-4/30	8/1-9/1
TN West	3/1-4/15	8/15-9/15

LETTUCE *COS OR ROMAINE* PLANTING DATES

	Spring	Fall
AL North	4/15–5/30	8/1–9/15
AL South	2/1–3/31	8/1–9/30
GA North	4/15–5/30	NR
GA South	2/1–3/31	8/1–9/30
KY East	4/1-4/30	NR
KY Central	3/25-4/15	NR
KY West	3/15-4/1	NR
LA North	1/15–3/15	9/15–10/30
LA South	1/15–3/15	9/15–10/30
MS	NR	NR
NC East	2/1-4/10	8/25-9/15
NC West	3/15-8/1	NR
SC East	2/1-4/15	9/15-11/1
SC West	3/1-5/15	NR
TN East	3/15-4/30	8/1-9/1
TN West	3/1-4/15	8/15-9/15

ENDIVE/ESCAROLE PLANTING DATES

	Spring	Fall
AL North	4/15-5/30	8/1-9/15
AL South	2/1-3/31	8/1-9/30
GA North	4/15-5/30	NR
GA South	2/1-3/31	8/1-9/30
KY East	4/1-4/30	NR
KY Central	3/25-4/15	NR
KY West	3/15-4/1	NR
LA North	1/15–3/15	9/15–10/30
LA South	1/15–3/15	9/15–10/30
MS	NR	NR
NC East	3/20-6/15	8/1-9/15
NC West	5/1-8/15	NR
SC East	2/1-4/15	9/15-11/1
SC West	3/1-5/15	NR
TN East	3/15-4/30	8/1-9/1
TN West	3/1-4/15	8/15-9/15

Mulching. Using polyethylene mulch can be very beneficial for all types of lettuce and endive, in that the plastic reduces the amount of soil that gets inside the leaves. Use white plastic when air temperature exceeds 85°F. Most leaf lettuce varieties can be planted in 3 or 4 rows to the 30 inch bed top. In row spacing should be 9 to 12 inches and between row spacing should be 9 to 12 inches. Romaine types do best with 2 or 3 rows per bed and 12 to 15 inches in row spacing.

SPACING

Lettuce: Head lettuce is planted in rows 2 feet apart with plants 12 to 15 inches apart in the row. Leaf and Butterhead type lettuce are planted 3 to 4 rows per bed with beds spaced 66 to 72 inches on centers. Space plants 9 to 12 inches apart in the row. Use black plastic in spring and white plastic when mean daily temperature at planting is >85°F.

Endive/Escarole: Plant three to four rows per bed and space beds 66 to 72 inches on centers. Space plants 9 to 15 inches apart in the row.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Keep lettuce fields isolated from endive and escarole for spray purposes.

Thrips: Scout for thrips and begin treatments when observed. Do not produce vegetable transplants with bedding plants in the same greenhouse.

Leafhopper: Control of leafhoppers will prevent spread of lettuce yellows. In the spring, spray when plants are one-half inch tall; repeat as needed. In the fall, spray seedlings 4-5 times at 5-day intervals.

Corn Earworm (CEW): **Note.** Head lettuce seedlings, in the 7 to 18 leaf stage, are vulnerable to CEW attack in August to September. Control must be achieved before center leaves start to form a head (15 to 18 leaf stage).

Tarnished Plant Bug: This insect can cause serious damage to the fall crop; it is usually numerous where weeds abound.

HARVESTING AND STORAGE

See Table 14 for postharvest information.

MELONS

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
CANTALOUPES and MIXED MELONS								
Eastern								
Avatar [4, 5, 7, 8, 9]	A						S	T
Ambrosia [2, 3, 6]	A				L	M	N	S	T
Ariel	A						N	S	
Aphrodite [4, 5, 7, 8, 9, 11]		G	K	L	M	N		T
Atlantis	A		K			N	S	T
Athena [4, 5, 7, 8, 9, 11]	A	G	K	L	M	N	S	T
Grand Slam	A					N	S	
Jaipur [7, 8, 9, 12]			K			N		T
Magenta						N		
Odyssey [2, 5, 8, 9]	A							T
Proteo	A					N		
Western								
Carribean Gold [12]	A					N	S	T
Magellan [6, 9]						N		
Magnum 45 [6]	A	G		L	M			T
Mission [6]	A				M			
Origami [4, 5, 7, 8, 9, 12]	A	G				N	S	T
Samoa [4, 5, 7, 8, 9, 12]	A	G				N	S	T
XLT 9000 [6, 7, 8, 9, 12]	A					N	S	T
Yuma Grande [6, 7, 9]							S	
Honey Dew								
Honey Max	A	G				N	S	T
Rocio [3, 6, 10]	A	G				N	S	
Santa Fe						N	S	
Saturno [6, 7, 9]	A					N	S	
Silver Express [4, 5, 7, 9]						N	S	
Summer Dew [4, 5, 8, 9, 10]		G	K			N	S	T
Temptation [13]			K					T
Galia								
Elario						N	S	
Esmeralda						N		
Galia [4]	A	G				N	S	T
Golan 329						N	S	
Solar Ace	A	G				N	S	
Juan Canary								
Golden Beauty 229 [6]	A	G	K			N		T
Golden Lady	A	G				N		
Sonora [6, 9]	A	G				N		
Sugar Nut			K			N		T
Sunbeam [4, 5, 7, 8, 9]	A	G				N	S	
Oriental (Asian type)								
Sprite (Crisp flesh type)	A	G	K			N	S	T
Yellow Star [2]	A	G				N		
Ananas								
Duke [6]	A	G				N		

[1] Abbreviations for state where recommended.
[2] Local markets only.
[3] Downy Mildew tolerance/resistance (DM).
[4, 5] Powdery Mildew race 1 or 2 tolerance/resistance (PM).
[6] Powdery Mildew tolerance/resistance (non-race specific).
[7, 8, 9] Fusarium Wilt race 0,1, or 2 tolerance/resistance (FW).
[10] Fusarium Wilt tolerance/resistance (non-race specific).
[11] Tolerant to sulphur.
[12] Extended shelf-life type.
[13] Orange-fleshed honeydew.

Melon Types. Most growers and consumers are familiar with cantaloupes and honey dew melons. Cantaloupes turn beige and slip from the vine when ripe and have an orange, sweet flesh. Cantaloupes are typically separated into two categories; eastern and western. Eastern types are sutured, larger and generally have a shorter shelf life (a few days) than western types. Many eastern types are only suited for local markets, while improved eastern varieties such as 'Athena' have a longer shelf life and can be shipped to more distant markets. Western types typically are not sutured, are round with a corky beige netting, and usually have a two-week shelf life.

Honeydew melons generally have smooth rinds with some corky striations becoming obvious as the fruit nears or becomes ripe. These fruit do not slip like cantaloupe. Rind color can vary among varieties. Most are an off-white or beige but some have a yellow rind. Flesh color is typically light green, firm, and honey dews are sweeter than cantaloupes. Honey dew melons are typically grown in the southwestern United States in arid, dry climates. In the southeastern United States, honey dew fruit are more susceptible to cracking or splitting open. This is due to the uneven, high moisture conditions often encountered in the southeastern United States.

Other specialty melons include Galia, Juan Canary, and oriental crisp-flesh types. The Galia type melon rind normally turns from green to golden yellow and will slip from the vine when ripe. The flesh is soft and white to light green, and the fruit produces a strong odor. The Juan Canary melons have a bright yellow rind when ripe but will not slip from the vine. Flesh color is white to very pale green. The oriental crisp-flesh melons have a crispy white flesh and have white and/or yellow rinds. Some types are more bland, while others are more sweet like the variety Sprite.

Plant Production. Transplants should be grown in pots or cells that provide a space of *at least* 1.5 inches by 1.5 inches for each plant.

Smaller pots or cells will restrict root growth and provide less protection to the newly set transplant. If the seed is of good quality with a high germination test, one seed per pot is sufficient. One ounce of melon seed contains 950 to 1,250 seeds.

The required amount of seed can then be estimated using Table 6 and 7 and knowing how many seeds make up an ounce of the desired variety.

Planting and Spacing. Transplant or seed when daily mean temperatures have reached 60°F. Temperatures below 45°F can stunt plant growth. Consult the following table for planting dates in your area. Early plantings should be protected from wind with row covers or rye strips. Plantings can continue until about 100 days before first frost.

Normal in-row spacing for melons is 1.5 to 2 feet on plastic mulch and 2 to 4 feet on bare ground. Typically, an average of 7.5 to 15 ft^2 should be allocated per plant on plastic mulch. On bare ground, 20 to 25 ft^2 should suffice per plant.

MELON PLANTING DATES

	Spring	Fall*
AL North	4/15–6/15	8/1–8/30
AL South	3/1–6/30	8/1–9/15
GA North	4/15–6/15	NR
GA South	3/1–4/30	8/1–9/15
KY East	5/15-6/15	NR
KY Central	5/10-7/1	NR
KY West	4/25-7/15	NR
LA North	4/1–6/30	7/1–7/31
LA South	3/15–6/30	7/1–8/15
MS North	4/1–4/10	NR
MS South	3/1–3/15	NR
NC East	4/15–5/15	7/1–7/15
NC West	5/15–7/31	NR
SC East	3/15–5/15	7/1–7/30
SC West	4/15–6/5	NR
TN East	5/5-6/15	NR
TN West	4/15-6/1	NR

*Use transplants for later season plantings.

Drip Fertilization. Before mulching, adjust soil pH to 6.5 and in the absence of a soil test apply fertilizer to supply 25 pounds per acre of N, P_2O_5 and K_2O, (some soils will require 50 pounds per acre of K_2O), then thoroughly incorporate into the soil. After mulching and installing the drip irrigation system, the soluble fertilizer program should then be initiated according to that described in the table below. On low to low-medium boron soils, also include 0.5 pound per acre of actual boron. The first soluble fertilizer application should be applied through the drip irrigation system within a week after field transplanting or direct seeding the muskmelon. Continue fertigating until the last harvest.

SUGGESTED FERTIGATION SCHEDULE FOR MELON* (low potassium soil)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			25.0	50.0
0-28	0.9	1.8	50.2	100.4
29-49	1.3	2.6	77.5	155.0
50-77	1.5	3.0	119.5	239.0
78-91	0.7	1.4	129.3	258.6

SUGGESTED FERTIGATION SCHEDULE FOR MELON* (high potassium soil)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			25.0	50.0
0-28	0.9	0.9	50.2	75.2
29-49	1.3	1.3	77.5	102.5
50-77	1.5	1.5	119.5	144.5
78-91	0.7	0.7	129.3	154.5

*Adjust based on tissue analysis.

Plastic Mulch. The use of plastic mulch is especially beneficial when growing melons. It substantially reduces the amount of fruit rots and often results in a 100% increase in yields than if the crop is grown on bare ground. Black embossed plastic mulch is generally used to increase soil temperatures in the spring as well as pro-

vide weed control, and fertilization and irrigation efficiency. Fruit maturation is usually quickened with the use of plastic. White plastic can be used instead of black plastic mulch when air temperatures exceed 85°F to reduce excessive heat that can occur under black plastic at the later planting dates. Spacing on plastic mulch is typically 5 to 6 feet between rows and 18 to 30 inches in-row. Marketable yields will generally range between 7,000 to 10,000 fruit per acre when grown on black plastic mulch.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Seed Corn Maggot (SCM): Use insecticide treated seed or at-planting soil-insecticide treatments to avoid SCM in the early season. SCM problems subside with later plantings.

Cucumber Beetle: Cucumber beetles transmit bacterial wilt, and most cultivars of muskmelons are highly susceptible to this disease. Also adult beetles can cause direct feeding injury to young plants. Foliar insecticides should be used to control adult beetles before they feed extensively on the cotyledons and first true leaves. Begin spraying shortly after plant emergence and repeat applications at weekly intervals if new beetles continue to invade fields. Treatments may be required until vining, at which time plants are less susceptible to wilt infections. An alternative control option for cucumber beetles is the use of Admire at planting. **Note:** Use of Admire at planting can lead to spider mite outbreaks later in the season.

Pickleworm, Melonworm: Make one treatment prior to fruit set, and then treat weekly.

Aphids: Aphids can delay plant maturity. Thorough spray coverage beneath leaves is important. For further information on aphid controls, see the preceding section on "Mulches and Row Covers." Treat seedlings every 5 to 7 days or as needed.

Squash Bug: Begin treatments shortly after vining. Treat every 7 to 10 days or as needed.

Leafhoppers: High numbers of potato leafhoppers cause leaf yellowing (chlorosis) known as hopper burn, which will result in yield loss.

POLLINATION

Honeybees are important for pollination, high yields, and quality fruit. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until blooms have closed before application. See section on "Pollination" in the General Production Recommendations.

HARVESTING AND STORAGE

Cantaloupes should be harvested at quarter-to half-slip for shipping. Healthy vines and leaves must be maintained until melons are mature to obtain high-quality melons. Harvest daily or twice daily in hot weather. See Table 14 for further postharvest information. Many other types of melons do not slip and judging maturity can be difficult. Many melons will change their water not color. It is critical to be familiar with the unique character of each melon.

OKRA

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
OKRA								
Annie Oakley II[2]	A	G	K	L	M	N	S	T
Cajun Delight	A	G	K	L	M	N	S	T
Clemson Spineless 80	A	G	K	L	M	N	S	T
Emerald	A	G		L		N	S	
Gold Coast				L				
Lee	A					N	S	
North and South	A				M			T

[1] Abbreviations for state where recommended. [2] Dwarf cultivar.

Okra is a tropical annual which is widely adapted, however, it is very sensitive to frost and cold temperatures and should not be planted until soil has warmed in the spring.

Seeding and Spacing. Generally only one planting is made. For cooler areas, seed in the greenhouse in cells and transplant to the field through black plastic mulch.

For dwarf varieties, space the rows about 3.5 feet apart; for medium and tall varieties, 4 to 4.5 feet apart. Drill seeds 1 to1.5 inch deep, with 3 or 4 seed per foot of row (5 to 7 pounds per acre). Thin plants when they are 5 inches high. Dwarf varieties should be spaced 12 to 15 inches apart in the row; plants of tall varieties should be spaced 18 to 24 inches apart.

OKRA PLANTING DATES

	Spring	Fall
AL North	4/15–6/15	7/15–8/15
AL South	3/1–4/30	8/1–8/30
GA North	5/1–7/15	7/15–8/15
GA South	3/15–4/30	8/1–8/30
KY East	5/15-7/1	NR
KY Central	5/10-7/15	NR
KY West	4/20-8/1	NR
LA North	4/15–5/31	7/1–7/31
LA South	3/15–5/31	8/1–7/31
MS	4/15–6/1	8/1–9/1
NC East	5/1–5/30	8/1–8/30
NC West	5/25–7/31	NR
SC East	5/1-6/30	NR
SC West	5/15–7/15	NR
TN East	5/15-6/15	7/1-7/31
TN West	4/15-6/15	7/25-8/25

Ratooning Okra: Producing a Fall Crop from a Spring Planting. Market price for okra typically declines sharply as the summer progresses. After the market price drops, consider ratooning or cutting back your okra. Ratooning okra will allow the plants to rejuvenate and produce a crop in the fall, when okra prices are generally higher. Cut plants back using a mower, leaving 6 to 12 inches of each plant above the ground. Re-fertilize with 15-0-14, 8-0-24, or 13-0-44 to encourage re-growth and the development of side branches. Fall yields of cutback okra will often exceed that of spring crops or the yields of a crop that is not cut back.

Drip Fertilization. Before mulching, adjust soil pH to 6.5 and in the absence of a soil test apply fertilizer to supply 25 pounds per acre of N, P_2O_5 and K_2O, (some soils will require 50 pounds per acre of K_2O), then thoroughly incorporate into the soil. Apply 1 to 2 pound per acre of actual boron. After mulching and installing the drip irrigation system, the soluble fertilizer program should then be initiated according to that described in the tables below. The first soluble fertilizer application should be applied through the drip irrigation system within a week after field transplanting or direct seeding the okra. Continue fertigating until the last harvest.

SUGGESTED FERTIGATION SCHEDULE FOR OKRA* (low potassium soil)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			25.0	50.0
0-14	0.9	1.8	50.2	100.4
15-28	1.3	2.6	77.5	155.0
29-84	1.5	3.0	119.5	239.0
85-91	0.7	1.4	129.3	258.6

SUGGESTED FERTIGATION SCHEDULE FOR OKRA* (high potassium soil)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			25.0	50.0
0-14	0.9	0.9	50.2	75.2
15-28	1.3	1.3	77.5	102.5
29-84	1.5	1.5	119.5	144.5
85-91	0.7	0.7	129.3	154.5

*Adjust based on tissue analysis.

Plastic Mulching. Polyethylene (black plastic) mulch can offer growers several advantages. Drip irrigation systems must be used with plastic mulch. On plastic mulch, transplant at the three-to four-leaf stage into staggered double rows spaced 15 to 18 inches apart between the double rows. Place plants 12 inches apart.

HARVESTING AND STORAGE

An okra pod usually reaches harvesting maturity 4 to 6 days after the flower opens. The pods are 3 to 3.5 inches long at this stage and are tender and free of fiber.

Pick pods at least every second day to avoid the development of large, undesireable pods. Okra should be kept at temperatures between 50° to 55°F and of 85% to 90% relative humidity. Okra pods are subject to chilling injury below 50°F.

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
GREEN ONIONS								
Beltsville Bunching [2]	A				M	N	S	
Crystal White Wax				L				
Evergreen Bunching [2]			K	L			S	
Ishikura Improved	A		K		M	N	S	
Parade							S	
Southport [2]							S	
White Spear				L			S	
ONIONS (Short Day)								
Amelia (WI-129)		G**						
Candy Ann (SS 2005)		G**						
Caramelo		G**						T
Century		G**		L				
Georgia Boy		G**		L				
Goldeneye		G**						
Granex 33	A	G**		L		N	S	T
Honeybee		G**						
Mata Hari [4]		G**						
Miss Megan		G**		L				
Mr. Buck		G**		L				
Nirvana		G**		L				
Ohoopee Sweet		G**		L				
Red Hunter	A	G**					S	
Savannah Sweet	A	G**					S	
Sweet Caroline		G**		L				
Sweet Harvest		G**						
Sweet Jasper		G**						
Sweet Vidalia				L	M			
Texas Early Grano 502				L		N	S	
Texas Grano 1015Y	A			L	M	N	S	
Yellow Granex [3]				L				
ONIONS (Intermediate Day)								
Candy			K	L	M			T
Expression								T
Hi Ball						N		
Superstar (white)			K	L		N		
Tough Ball						N		

[1] Abbreviations for state where recommended.

[2] Bulbing type.

[3] Also designates a "type" of onion and performance may vary.

[4] Red

** **Georgia Growers note:** To be marketed as "Vidalia," varieties must be on the Georgia Department of Agriculture's "Recommended Vidalia Onion List" and grown in the Vidalia area. All of these varieties can be used for green onions.

Planting and Seeding Dates. In the northern range of the Southeast for dry bulb onions, sets and seed can be planted as soon as soil conditions are favorable in the spring. Plant transplants for bulb onions as indicated in the following table.

Seed for bunching onions can be planted as soon as soil conditions are favorable in the spring and successive plantings can be made throughout the summer in the cooler parts of the Southeast.

On-farm transplant production can be performed in most conditions for dry bulb onion production. In the northern range of the Southeast it may be preferable to purchase transplants. Transplant production should begin by seeding plantbeds from late August to the end of September. A common method of producing transplants is to seed in high density plantings with 30-70 seed per linear foot. Four to five rows are planted 12-14 in. apart on beds prepared on six-foot centers.

For dry bulb onion production from transplants follow planting dates recommended in the following table. Onion production from sets has not worked as well because it is difficult to mechanically orient the sets with the growing point up. Hand planting sets, however, works well for smaller operations.

Direct seeding dry bulb onions can save money on labor and materials. See seeding dates in table below. It is recommended that coated or encrusted seed be used with a vacuum planter to insure good seed singulation. It is critical that the beds be properly prepared without any previous plant debris. Preplant fertilizer application of 1/5 to 1/4 of required amount with proper bed moisture is

recommended. Care should be taken so that the seed is singulating properly, soil is not clogging the seeder, and planting depth is correct (~ 0.25 in.). Watering is required to insure germination and emergence. It may be necessary to apply water more than once a day during periods of hot, dry weather.

Seeding dates for green onions are listed in the table below. Green onions during winter production will require 12-14 weeks. Spring production may be shorter. Green onions can also be produced from transplants.

ONION *DIRECT SEED* PLANTING DATES

	Green Onions	Onions (dry)
AL North	NR	NR
AL South	8/15-10/15	10/5-10/25
GA North	NR	NR
GA South	8/15–10/15	10/5–10/25
LA North	9/15–10/31	9/15–10/31
LA South	10/1–10/31	10/1–10/31
MS North	2/15-3/30	9/15-10/15
MS South	10/15–2/15	9/15-10/30
NC East	8/1–6/15	9/15–10/31
NC West	4/1–8/15	9/1–9/30
SC East	2/15–10/15	9/15–11/15
SC West	3/15–7/30	NR
TN East	9/1-9/30	NR
TN West	NR	NR

ONION *TRANSPLANT* PLANTING DATES

	Onions (dry)		Onions (dry)
AL North	11/1-12/31	MS North	12/15–3/1
AL South	11/1–1/31	MS South	10/1–2/15
GA North	11/1-12/31	NC East	10/1–3/1
GA South	11/1–1/31	NC West	9/15–10/15
KY East	4/1-6/15	SC East	10/1–11/15
KY Central	3/25-7/1	SC West	9/15–10/15
KY West	3/15-7/15	TN East	9/15/10/15
LA North	12/15–1/31	TN West	3/1-3/30
LA South	12/15–1/31		

Spacing. A typical planting arrangement for dry bulb onions is to plant four rows, 12-14 in. apart on beds prepared on six-foot centers. In-row spacing should be 4-6 inches. Row spacing up to 24 in. can be used. For direct seeded onions, set the planter to sow seed with a 3-4 in. in-row spacing.

For green onions, space rows 12 to 16 in. apart and space seed 0.75 to 1.5 inches apart (2-6 pounds per acre). A vacuum planter with a double row planter or a scatter shoe will work well. Seed depth should be 0.25-0.5 inches. Place transplants or sets 1.5 to 2.5 inches deep.

Cultivation. For bunching onions, hill with 1 to 2 inches of soil to ensure white base.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Soilborne pests are often controlled with a preplant application of a soil insecticide.

Seedcorn Maggot: An early season problem that is common following winter injury to plants or in fields where planting occurs soon after a cover crop has been plowed under.

Cutworms: See cutworm section in Soil Pests-Their Detection and Control.

Thrips: Use a threshold of 5 thrips per plant.

HARVESTING AND STORAGE

See Table 14 for postharvest information

PARSLEY AND CILANTRO

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
PARSLEY								
Curly Leaf								
Banquet	A	G	K	L	M	N	S	T
Forest Green	A			L		N	S	T
Moss Curled	A					N	S	
Starke	A					N	S	
Flat Leaf								
Dark Green Italian	A			L			S	
Giant of Italy	A			L		N		
Plain Italian Green	A	G	K	L	M	N	S	T
CILANTRO								
Jantar Longstanding	A	G		L	M	N	S	T
Santo	A		K	L		N	S	T

[1] Abbreviations for state where recommended.

Parsley is a biennial grown as an annual. There are two varietal types of parsley: flat-leaf and curled leaf. Flat leaf parsley tends to be more aromatic than the curled leaf and is used for flavoring in cooking. Curled leaf parsley is more attractive and is primarily used as a garnish. Cilantro is a fast growing annual that is cultivated for its fresh leaves. The seeds of the cilantro plant are referred to as the spice coriander. Parsley and cilantro are best cultivated as cool season crops in the southeast.

Seeding and Spacing. Neither parsley nor cilantro transplant well due to their taproots which are typical of plants in the Apiaceae. Direct seeding is recommended and is best achieved when using a precision seeder. Multiple plantings every 1-3 weeks are necessary for a season-long supply. Parsley seed is slow to germinate (12-25 days, temperature dependent). Seed is viable for 3-5 years but its percentage germination reduces quickly after 1 year.

Seed is sown 1/3 to ½ inches deep in a well-prepared seed bed. Seeding rates are from 16 to 24 pounds per acre (1/4 oz. per 100 row feet) for parsley and 15 to 50 pounds per acre (1-2 oz. per 100 row feet) for cilantro. Spacing between single rows is 15 to 18 inches. Parsley and cilantro can be precision seeded into raised beds with 3 to 4 rows per bed. Final in-row spacing should be 6 to 8 inches for parsley and 2 to 5 inches for cilantro. Research has shown that maximum yields can be achieved with more closely spaced plants.

PARSLEY/CILANTRO PLANTING DATES

	Spring	Fall
AL North	3/15–5/30	NR
AL South	2/1–3/31	8/1–9/30
GA North	3/15–5/30	NR
GA South	2/1–3/31	8/1–9/30
KY East	5/10-7/10	NR
KY Central	5/1-7/20	NR
KY West	4/15-7/1	NR
LA North	2/15–4/15	9/15–10/31
LA South	2/1–4/15	9/15–10/31
MS	NR	8/1–9/30
NC East	2/15–4/15	8/1–9/30
NC West	4/1–8/15	NR

PARSLEY/CILANTRO PLANTING DATES (cont'd)

	Spring	Fall
SC East	NR	9/1–11/15
SC West	NR	8/15–9/30
TN East	4/1-8/1	NR
TN West	4/1-5/30	8/1-9/1

Cultivation. Parsley and cilantro grow best in a well-drained, organic loam soil with soil pH between 6.5 and 7.5. Overhead irrigation is essential for stand establishment. Irrigation during the germination period and the 2-3 weeks following emergence are critical. Too little water at any point will result in diminished leaf yield. Long, warm periods with too little water results in bolting which is undesirable since the plants are grown for their leaves. In addition, bolting reduces the amount, quality, and flavor of the leaves.

Cilantro cultivars are divided into "temperature sensitive" and "slow-bolt" groups. When high temperatures and daylight greater than twelve hours occur, temperature sensitive cultivars tend to set flowers in as little as three weeks following germination. Cilantro responds well to growth stimulators (gibberellic acid, folcyteine, extracts of marine algae) to maximize leaf production. Premature bloom can be delayed through the use of these foliar sprays.

Both parsley and cilantro are weak competitors with other plants. Weed control is critical throughout the season and will also make harvest more efficient.

SPECIAL NOTES FOR PEST MANAGEMENT

There are few agricultural chemicals cleared for use on parsley and cilantro. Weed control is important and can best be obtained by using black plastic mulch and cultivation. Parsley and cilantro are prone to leaf blights, leaf spots, and mildews. Any approved fungicides should be sprayed as soon as symptoms appear. Cultural controls include the use of drip irrigation, crop rotation, and limited movement through the fields during wet conditions.

Root and crown rot of parsley is best controlled by a two-year crop rotation with non-susceptible plants. Swallowtail caterpillars feed on parsley and are present in large numbers in late summer months. Row covers while swallowtail butterflies are present may

reduce damage by blocking butterfly access to plants for egg laying.

Harvesting and Storage. Parsley and cilantro are usually harvested by hand and bunched with rubber bands or twist ties in the field. Cutting entire plants 1.25 to 3 inches above the crown may result in secondary growth sufficient to allow for another harvest. Average yield for both parsley and cilantro is 30-40 pounds per 100 row feet of row. Maximum biomass usually occurs at 40-45 days after germination for cilantro and at 75-90 days for parsley. Multiple harvests are more likely with parsley than cilantro. Store parsley and cilantro at 32° F with high humidity. See Table 14 for further postharvest information.

PARSNIP

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
PARSNIP								
All American	A	G				N	S	
Harris Model	A		K			N	S	
Javelin						N	S	

[1] Abbreviations for state where recommended.

Seeding and Spacing. Seed as indicated in the following table. Seeds germinate very slowly (taking up to 18 days). Seed more than one-year-old will not germinate. Parsnips need 120 to 180 days to mature and need to mature during cool weather.

Seed 3 to 5 pounds per acre at a depth of ¼ to 3/8 inch in rows 18 to 30 inches apart. Adjust seeder to sow 8 to 10 seeds per foot of row. Thin seedlings to 2-4 inches apart in the row. This will result in parsnips of similar shape and size to a plump carrot. To produce the huge roots popular in some areas, provide a much greater spacing of up to 12" between plants. Do not transplant parsnips.

Cultivation. Cultivate parsnips in a similar manner as to carrots. Do not let the roots dry out too much, as this will lead to cracked, unmarketable roots and bitter flavor.

Yield. Expected yield is 50-75 pounds per 100 row feet or 4 to 4.5 tons per acre.

Harvesting and Storage. Roots are ready for harvest when tops start to die back in autumn. Parsnips may be dug, topped, and then stored at 32°F at 90 to 95% relative humidity. Roots can be stored up to 6 months. Parsnips left in the ground over winter should be removed before growth starts in the spring. See Table 14 for further postharvest information.

Note: Many people develop a rash after contact with the juice that parsnip leaves exude when crushed or torn, especially when handling leaves in the sun. Consider wearing gloves during harvest and handling; do not display parsnips with leaves still attached as is common for fresh market carrots.

PARSNIP PLANTING DATES

	Spring	Fall
AL North	3/15–4/30	8/1–9/15
AL South	2/1–5/15	8/1–9/30
GA North	3/15–4/30	8/1–9/15
GA South	2/1–5/15	8/1–9/30
KY East	4/1–6/1	NR
KY Central	3/20–6/15	NR
KY West	3/10–7/1	NR
LA	NR	NR
MS	NR	NR
NC East	2/15–4/15	8/1–9/30
NC West	4/1–8/15	NR
SC East	2/1–3/31	8/15–10/15
SC West	3/15–4/30	7/15–9/30
TN East	NR	NR
TN West	NR	NR

Harvesting and Storage. Parsnips may be dug, topped, and stored at 32°F at 90% to 95% relative humidity. Storage can be up to 6 months. Parsnips left in the ground over winter should be removed before growth starts in the spring. See Table 14 for further postharvest information.

ENGLISH/GARDEN PEAS

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
ENGLISH/GARDEN PEAS								
Dual		G						
Green Arrow	A	G	K	L		N	S	T
Knight		G		L			S	T
Novella					M	N		
Oregon Sugar Pod II [2, 3]	A	G	K	L	M	N	S	T
Sugar Ann [3]		G	K	L		N	S	T
Sugar Bon [3]	A			L		N		
Sugar Snap [3]	A	G	K	L		N	S	T
Tall Telephone (Alderman)				L	M	N		

[1] Abbreviations for state where recommended. [2] Flat podded - snow pea. [3] Edible pod type.

Garden peas thrive in cool weather and are frost tolerate . Early plantings can be made as soon as soil can be tilled in the spring. Inoculation of seed can enhance early nodule formation and improve plant development.

Seed Treatment. Use seed already treated with an approved seed treatment, or treat seed with a slurry or dust that contains an approved fungicide.

Seeding and Spacing. For Garden peas and processing peas, plant 3-4 seeds per foot in rows 6-8 inches apart, requiring seed 80-120 pounds per acre in 30 inch rows. Seed at a depth of no more than one inch unless soil is dry. Use press wheel drill or seeder to firm seed into soil.

Seedlings will emerge in 6 to 14 days, weather dependent. Harvesting usually begins 50-75 days after emergence. Average yield of Garden peas is approximately 20 pounds per 100 row feet.

Cultivation. Avoid overfertilization. Too much nitrogen will reduce yields. Garden peas need some type of support structure for best performance and speedier picking. Garden peas should not follow beans or another Legume crop.

Harvesting and Storage. Harvest often. Picking is labor intensive and may need to happen almost daily during peak production periods. Allowing Garden peas to get too large on the vines will greatly reduce production. Larger acreages of Garden peas require mechanical harvesting to be profitable. Leafless type Garden peas, with more tendrils than true leaves, are easier to harvest. Cool Garden peas as soon as possible after picking as their sugars convert to starch at higher temperatures. See Table 14 for further postharvest information.

ENGLISH/GARDEN PEAS PLANTING DATES

	Spring	Fall
AL North	3/15–4/30	8/1–8/31
AL South	2/1–3/31	8/1–9/30
GA North	3/15–4/30	8/1–8/31
GA South	2/1–3/31	8/1–9/30
KY East	3/15-4/15	NR
KY Central	3/1-4/1	NR
KY West	2/20-3/20	NR
LA North	11/15–2/1	NR
LA South	11/15–2/1	NR
MS North	2/10-4/25	NR
MS South	1/25-4/5	NR
NC East	2/15–4/15	8/1–9/30
NC West	4/1–6/15	NR
SC East	2/1–3/15	8/15–11/30
SC West	3/1–4/15	8/15–10/30
TN East	3/15-4/30	NR
TN West	2/15-3/30	NR

PEAS, SOUTHERN

NOTE ON SEED AVAILABILTY: Seed supply has been limited in recent years and this will likely continue for the next few years.

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
PEAS, SOUTHERN								
Blackeyes								
Bettergro Blackeye [2, 4]	A	G					S	
California Blackeye #5 [2, 5]	A	G				N	S	
Magnolia Blackeye [5]	A			L	M			
Queen Anne [2, 5]	A	G	K	L	M	N		T
Pinkeyes								
Coronet [2, 5]	A							
Pinkeye Purple Hull [4]		G		L		N	S	T
Pinkeye Purple Hull - BVR [4]	A	G		L	M	N		T
QuickPick Pinkeye [2, 5]	A	G		L	M	N	S	T
Texas Pinkeye	A			L				
Top Pick Pinkeye [2]	A	G		L				
Creams								
Big Boy (cream/browneye) [5]							S	
Elite [2, 5]				L				T
Mississippi Cream [2, 5]				L	M			T
Tender Cream [2, 5]							S	
Texas Cream 8		G			M		S	T
Texas Cream 12	A	G						
Top Pick Cream	A	G		L				T
White Acre-BVR	A	G						
Crowders								
Clemson Purple						N	S	
Colossus 80 [2, 5]						N	S	
Dixie Lee				L		N		T
Hercules	A	G				N	S	T
Knuckle Purple Hull		G				N	S	
Mississippi Purple [3]	A	G	K	L	M	N	S	T
Mississippi Shipper [2, 3]	A	G		L	M	N	S	T
Mississippi Silver [3]	A	G	K	L	M	N	S	T
Purple Tip Crowder							S	T
Top Pick Crowder	A	G		L		N		
Zipper Cream [4]	A	G		L	M	N	S	T

[1] Abbreviations for state where recommended. [3] Semi-vining. [5] Bush.
[2] Suitable for mechanical harvest. [4] Vining

Southern peas originated in India in prehistoric times and moved to Africa, then to America. In India, Southern peas are known by 50 common names and in the United States are called "Field peas", "Crowder peas", "Cowpeas" and "blackeyes", but Southern peas is the preferred name. Southern peas require relatively warms soils for good germination.

Seeding and Spacing. Sow when soil temperature reaches 60°F and continue sowing until 80 days before fall frost. Seeding too early causes poor stands and you may need to replant. Bush types should be seeded 4 to 6 per foot or 30 to 50 pounds of seed per acre. Vining types should be seeded 1 to 2 per foot or 20 to 30 pounds of seed per acre. Plant seeds 3/4 to 1 1/4 inch deep in rows spaced 20 to 42 inches apart depending on cultivation requirements.

Fertility. Most soils will produce a good crop, but medium fertility with pH of 5.8 to 6.5 is desirable. High fertility produces excessive vine growth and poor yields. Inoculants of specific N fixing bacteria may increase yield especially in soils where Southern peas have not been grown. Crop rotation or fumigation is important for nematode control.

PEAS, SOUTHERN PLANTING DATES

	Spring	Fall
AL North	4/15–7/31	NR
AL South	3/15–6/15	7/15–8/30
GA North	5/15–7/15	NR
GA South	3/15–5/15	7/15–8/30
KY East	5/10-6/15	NR
KY Central	5/5-7/1	NR
KY West	4/20-7/15	NR
LA North	4/15–7/31	7/1–7/31
LA South	4/1–5/31	7/15–8/15
MS North	4/15–7/15	NR
MS South	3/15–6/15	8/1–8/30

PEAS, SOUTHERN PLANTING DATES (cont'd)

	Spring	Fall
NC East	3/25–6/15	8/1–8/30
NC West	4/15–7/15	NR
SC East	4/1–6/15	7/15–8/1
SC West	4/15-7/15	NR
TN East	5/10-7/15	NR
TN West	4/15-7/31	NR

Insect Management. Cowpea Curculio: At first bloom, make three insecticides applications at five-day intervals for curculio control.

Harvesting and Storage. Depending on variety and weather, harvest will begin 65 to 80 days after seeding and continue for 3 to 5 weeks. Begin harvest when a few pods are beginning to change color and harvest only pods with well formed peas. This is the best stage for shelling and eating.

Southern peas are sold in bushel hampers or mesh bags. Do not use burlap sacks because they are not properly ventilated. Southern peas weigh 22 to 30 pounds per bushel. One person can harvest 12 to 20 bushels per day if yields are average. Average production is 60 to 200 bushels per acre. See Table 14 for further postharvest information.

PEPPERS

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
PEPPER (open pollinated)								
Bell								
Capistrano	A			L	M	N	S	
Jupiter	A			L	M	N	S	T
Purple Beauty [9]	A				M	N		
Frying type								
Cubanelle	A	G	K			N	S	T
Sweet Banana	A	G	K	L			S	T
HOT/PUNGENT TYPES (open pollinated)								
New Mexican/Anaheim type								
Anaheim	A	G	K	L		N		T
Cayenne type								
Carolina Cayenne [10]						N	S	
Charleston Hot [10]				L	M	N	S	
Large Red Thick				L				
Long Slim Cayenne	A	G			M	N	S	
Habenero / Scotch Bonnet type								
Habañero	A	G	K	L		N	S	T
Wax type								
Long Hungarian Wax	A	G	K	L		N	S	T
Surefire						N	S	
Jalapeño type								
Jalapeño M	A	G		L	M	N	S	T
Tula [4]	A	G		L		N	S	T
PEPPER (Hybrid)								
Bell								
Alliance [4, 8bcdf, 11, 13, 14, 15]	A		K			N		T
Aristotle [4, 8bcd]	A	G	K	L		N	S	T
Camelot X3R [8bcd]	A	G	K	L	M	N	S	T
Declaration [2, 3, 8bcdf, 11]	A	G	K	L		N		T
Enterprise [8bcd]	A	G					S	
Excursion II [4, 8bcd, 13]	A		K	L		N		T
Flamingo [12, 13]	A					N		
Flavorburst [7]	A		K			N		
King Arthur [4, 6, 8c, 13]	A	G	K	L	M	N	S	T
Mecate [4, 7, 8bcd, 13, 15]	A					N		
Orobelle [4, 7, 13]	A				M	N		
Paladin [2, 13]	A	G	K	L		N		
Patriot [4, 8bcdf]		G	K			N	S	T
Plato [3, 4, 8bcd]	A	G		L		N	S	
Polaris [8bcd]			K			N		T
PS 09942815 [3, 8b-k]	A	G						
Red Knight [4, 8bcd]		G	K			N	S	
Red Lion	A					N		
Revolution [2, 8bcdf, 11]	A	G	K	L	M	N		T
Sirius [3, 7, 8bc]	A							
Tequila [9, 13]	A				M	N		T
Valencia [7, 13]					M	N	S	
Vanguard [2, 8bcdef, 11]	A					N	S	
Wizard [4, 8 bcd]	A	G	K			N	S	T

[1] Abbreviations for state where recommended.

[2] Phytophthora Root Rot tolerance/resistance.

[3] Tomato Spotted Wilt Virus tolerance/resistance (TSWV).

[4] Potato Virus Y tolerance/resistance (PVY).

[5] Tomato Mosaic Virus tolerance/resistance (ToMV).

[6] Tobacco Etch Virus tolerance/resistance (TEV).

[7] Mature Yellow fruit or Mature Orange fruit.

[8a, b, c, d, e, f, g, h, i, j, k] Bacterial Leaf Spot resistance for races 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, respectively.

[9] Mature Purple fruit.

[10] Nematode resistance (N).

[11] Cucumber Mosaic Virus tolerance/resistance (CMV).

[12] Fruit mature from White to Red.

[13] Tobacco Mosaic Virus (TMV) tolerance/resistanace.

[14] Pepper Yellow Mosaic virus tolerance/resistance (PYMV).

[15] Pepper Mottle Virus tolerance/resistance (PMV).

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
Frying type								
Aruba	A	G						
Banana Supreme	A	G	K	L		N	S	T
Biscayne	A	G			M	N	S	
Gypsy	A	G	K	L	M	N		
Key Largo	A	G			M	N	S	
Ancho/Poblano								
Ancho 101	A							
San Juan	A					N		
San Martin	A		K			N		T
Tiburon	A	G			M			T
HOT/PUNGENT TYPES (Hybrid)								
Serrano type								
Nazas[5]	A					N		
Cayenne type								
Mesilla[4, 6]								T
Super Cayenne[8c, 13]	A					N	S	
Jalapeño type								
Compadre[5, 8cf]	A	G						
Delicias[4, 6]				L				
El Rey[8bcd]	A	G	K	L	M	N		T
Grande[4, 6]		G	K	L	M			T
Inferno	A	G		L		N		
Ixtapa[4, 8bcd]	A	G	K		M			T
Mitla[4]	A	G		L	M	N	S	T
Tormenta[4, 6, 8bcd]	A			L				T

[1] Abbreviations for state where recommended.
[2] Phytophthora Root Rot tolerance/resistance.
[3] Tomato Spotted Wilt Virus tolerance/resistance (TSWV).
[4] Potato Virus Y tolerance/resistance (PVY).
[5] Tomato Mosaic Virus tolerance/resistance (ToMV).
[6] Tobacco Etch Virus tolerance/resistance (TEV).
[7] Mature Yellow fruit or Mature Orange fruit.
[8a, b, c, d, e, f, g, h, i, j, k] Bacterial Leaf Spot resistance for races 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, respectively.
[9] Mature Purple fruit.
[10] Nematode resistance (N).
[11] Cucumber Mosaic Virus tolerance/resistance (CMV).
[12] Fruit mature from White to Red.
[13] Tobacco Mosaic Virus (TMV) tolerance/resistanace.
[14] Pepper Yellow Mosaic virus tolerance/resistance (PYMV).
[15] Pepper Mottle Virus tolerance/resistance (PMV).

Peppers are a warm-season crop that grow best at temperatures of 70° to 75°F. This crop is sensitive to temperature extremes. Poor fruit set and blossom drop can be expected when night temperatures drop below 60° or day temperatures rise above 85°F.

Seed Treatment. If seed is not treated in order to minimize the occurrence of bacterial leaf spot, dip seed in a solution containing 1 quart of household bleach and 4 quarts of water plus 1 teaspoon of surfactant for 15 minutes. Provide constant agitation. Use at the rate of 1 gallon of solution per pound of seed. Prepare a fresh solution for each batch of seed. Wash seed in running water for 5 minutes and dry seed thoroughly. Plant seed soon after treatment.

Planting and Spacing. Space rows 4 to 5 feet apart. Set plants 12 to 18 inches apart in double rows. Select fields with good drainage. Plant on raised, dome-shaped beds to aid in disease control.

To minimize sunscald when growing pepper on sandy soils and on plastic mulch without drip irrigation, plant varieties that have excellent foliage.

PEPPER PLANTING DATES

	Spring	Fall
AL North	5/15–6/30	7/1-8/1
AL South	3/1–4/30	7/15–8/30
GA North	5/15–6/30	7/1-8/1
GA South	3/1–4/30	7/15–8/30
KY East	5/20-6/15	NR
KY Central	5/10-7/1	NR
KY West	5/1-7/15	NR
LA North	4/1–5/15	6/15–7/31
LA South	3/1–5/15	6/15–7/31
MS North	4/20–6/30	NR
MS South	3/1–4/30	8/1–8/15
NC East	4/15–5/10	8/1–8/15
NC West	5/15–7/15	NR
SC East	4/1–5/15	7/10–8/1
SC West	5/1–6/30	NR
TN East	5/15-7/1	NR
TN West	4/20-6/30	NR

Drip Fertilization. Before mulching, adjust soil pH to 6.5, and in the absence of a soil test, apply enough fertilizer to supply 50 pounds per acre of N, P_2O_5 and K_2O, (some soils will require 100 pounds per acre of K_2O) then thoroughly incorpotrate into the soil. After transplanting the soluble fertilizer program should then be initiated following that described in the following table. On soils

testing low-medium for boron, also include 0.5 pound per acre of actual boron. The first soluble fertilizer application should be applied through the drip irrigation system within a week after transplanting the peppers. Continue fertigating until the last harvest.

SUGGESTED FERTIGATION SCHEDULE FOR PEPPER* (low soil potassium)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			50.0	100.0
0–14	0.5	0.5	57.0	107.0
15–28	0.7	1.4	66.8	126.6
29–42	1.0	2.0	80.8	154.6
43–56	1.5	3.0	101.8	196.6
57–98	1.8	3.6	177.4	347.8

SUGGESTED FERTIGATION SCHEDULE FOR PEPPER* (high soil potassium)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			50.0	100.0
0–14	0.5	0.5	57.0	107.0
15–28	0.7	0.7	66.8	116.8
29–42	1.0	1.0	80.8	130.8
43–56	1.5	1.5	101.8	151.8
57–98	1.8	1.8	177.4	227.4

*Adjust based on tissue analysis.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Green Peach and Melon Aphid: For best green peach aphid control during periods of drought, apply insecticide 2 to 3 days after irrigation. Thorough spray coverage beneath leaves is critical.

Pepper Maggot: Pepper maggot flies are active from June 1 to mid-August.

Pepper Weevil (PW): PW is a pest occasionally imported on older transplants or transplants with flowers or fruit.

European Corn Borer (ECB): European Corn Borer (ECB). The use of pheromone insect traps is recommended, treat when more than ten moths per trap per week are found. Follow table in Insect Control section of this publication.

Nematode Management. Use nematicides listed in the "Nematode Control in Vegetate Crops" table in the Disease Control section.

VIRUSES

Aphid-transmitted Viruses (TMV, PVX, CMV, TEV, PVY): Use tolerant or resistant varieties to control these viruses when available and provided that the fruit quality is consistent with market demands. Use these varieties in areas where these viruses have been prevalent or when high aphid pressure is expected. Generally, these viruses cannot be adequately controlled with insecticide applications, but symptom expression can be delayed through their use combined with the use of reflective mulches.. Because aphids transmit these virus, growers may wish to use yellow trap pans containing water to determine when mass flights of winged aphids occur.

Thrips-transmitted Virus (Tomato Spotted Wilt Virus, TSWV): Use tolerant or resistant varieties. TSWV can be severe on peppers during both greenhouse production of transplants and during field production of the crop. The virus is spread to peppers by thrips. During transplant production, thrips transmit the virus from infected ornamental plants (flowers). Be sure not to grow any ornamental bedding plants in the same greenhouse as pepper transplants. Monitor greenhouses and scout fields for thrips. Begin an insecticide program BEFORE a problem is observed.

HARVESTING AND STORAGE

See Table 14 for postharvest information.

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
POTATOES								
Atlantic [4, 5, 9]	A	G	K	L	M	N	S	T
Coastal Chip [5, 9]						N	S	
Dark Red Norland [4, 7]	A		K	L		N	S	T
Harley Blackwell [4, 8]						N		
Katahdin [5]						N	S	
Kennebec [6, 8]		G	K	L		N	S	T
La Chipper [5, 6, 7]				L				
La Rouge [4]	A			L		N		T
Mountain Rose [3]						N	S	
Norchip [4]			K			N	S	T
Purple Majesty [2]						N	S	
Red LaSoda [5]	A	G	K	L	M	N	S	T
Red Pontiac [5]		G	K			N	S	T
Superior [4, 8]		G	K			N		
Vivaldi [5]						N		
Yukon Gold [5, 7, 9]	A	G	K		M	N	S	T
Fingerling Types								
French Fingerling		G	K			N	S	T
Russian Banana [4]		G	K			N	S	T

[1] Abbreviations for state where recommended.
[2] Purple flesh when mature.
[3] Red flesh when mature.
[4] Tolerant/resistant to scab.
[5] Susceptible to scab.
[6] Late blight tolerance/resistance.
[7] Ozone sensitive.
[8] Tolerant to heat necrosis.
[9] Susceptible to heat necrosis.

Planting and Spacing. The recommended planting dates for potatoes are in the following table.

IRISH POTATO PLANTING DATES

	Spring	Fall
AL North	2/15–4/30	NR
AL South	1/15–3/31	NR
GA North	3/15–4/30	NR
GA South	2/1–3/31	NR
KY East	3/20-6/15	NR
KY Central	3/15-7/1	NR
KY West	3/15-7/15	NR
LA North	1/15–2/28	7/15-9/1
LA South	1/15–2/28	7/1-9/15
MS North	1/20–3/15	NR
MS South	1/20–3/1	NR
NC East	2/15–3/31	NR
NC West	4/1–6/15	NR
SC East	2/1–3/31	NR
SC West	3/15–4/30	NR
TN East	3/20-4/30	NR
TN West	2/15-3/31	NR

Space seed 7 to 12 inches apart in 34- or 36- inch rows. Use closer spacing for large, cut seed pieces and wider spacing for whole (B-size) seed. Use close spacing for potatoes being marketed in 5- and 10-pound consumer packs and for Katahdin and Kennebec, which tend to set few tubers and produce oversize tubers.

Seed-Piece Treatment. Use certified seed. Warm potato seed 65°F to 70°F for a period of 2 to 3 weeks before planting to encourage rapid emergence. Do not use seed pieces that weigh less than 1.5 oz each. Plant seed pieces immediately after cutting or store under conditions suitable for rapid healing of the cut surfaces (60° to 70°F plus high humidity). Dust seed pieces immediately after cutting with fungicide. Some fungicide seed-piece treatments are formulated with fir or alder bark. Bark formulations have been effective treatments to reduce seed piece decay.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Colorado Potato Beetle (CPB): Rotation to non-solanaceous crops (crops other than potato, tomato, eggplant, and pepper) is extremely important in reducing CPB problems.

The further fields can be planted from last year's solanaceous crop, the more beneficial it will be in reducing CPB problems. Avoid the application of late-season sprays to prevent the buildup of insecticide-resistant beetles.

Beginning at plant emergence, sample fields weekly for CPB to determine the need to spray. Select at least 10 sites per field along a V- or W-shaped path throughout the field. At each site, select one stem from each of five adjacent plants and count and record all adults, large larvae (more than half-grown), and small larvae (less than half-grown). As a general guideline, if more than 25 adults or 75 large larvae or 200 small larvae are counted per 50 stems, a treatment is recommended. The amount of yield loss as a result of CPB feeding depends on the age of the potato plant. The Superior variety (short season) cannot compensate for early season defoliation by overwintered beetles, but, during the last 30 days of the season, Superior can withstand up to 50% defoliation without yield loss.

Note: Several insecticides may no longer be effective in certain areas due to CPB resistance. Alternate insecticide classes from one year to the next to avoid resistance. Check with the county Extension agent in your area for the most effective control.

Flea Beetles and Leafhoppers: Treatment is suggested if leafhopper counts exceed three adults per sweep or one nymph per 10 leaves. Use of Admire or Platinum at planting will also control flea beetles, leafhoppers, aphids and whiteflies.

European Corn Borer (ECB): Continued treatment for ECB may significantly increase CPB insecticide resistance. However, for proper timing of ECB sprays, consult your local county Extension office for further information.

Potato Aphid and Green Peach Aphid: Insecticide treatments are recommended when aphid counts exceed two per leaf prior to bloom, four aphids per leaf during bloom, and 10 aphids per leaf within two weeks of vine kill.

Potato Tuberworm: Treat when foliage injury is first noted. Potato tuberworms are primarily a problem with late potatoes, in cull piles, or potatoes in storage. Sanitation is very important.

Cutworms: See "Cutworms" section in Soil Pests-Their Detection and Control. Cutworms are especially troublesome to tubers where soil cracking occurs. Variegated cutworms feed on lower leaves and petioles.

HARVESTING AND STORAGE

See Table 14 for postharvest information.

PUMPKINS AND WINTER SQUASH

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
PUMPKIN								
Miniature <2 lbs								
Apprentice [B, H, R]	A	G				N		T
Baby Boo [H, V, W, FL]	A	G	K					T
Bumpkin [H, S, FL, PM]	A	G				N	S	T
Crunchkin [B, H, FL]	A							
Gold Dust [H, SB, FL, PM]	A					N		T
Gooligan [H, V, W, FL]	A	G	K					T
Jack-Be-Little [V, H, FL]	A	G	K	L		N		T
Lil Pump-ke-mon [H, B, FL, W w/ orange stripes]	A	G	K			N		T
Lil Ironsides [B, H, R]	A	G	K			N	S	T
Munchkin [V, H, FL]	A	G		L	M	N	S	T
WeeeeOne [B, R, PM] (carvable)	A							T
Small 2-6 lbs								
Cannon Ball [V, P, PM]	A	G	K			N		T
Field Trip [SV, W, FL-R, PM]	A		K			N		T
Gargoyle [B, WA, R, PM]	A					N		T
Iron Man [V, H, R, PM]	A	G	K			N	S	T
Little Giant [S, H, R]	A							
Prankster [S, H, R, PM]	A	G						
Small Sugar [V, O]	A	G		L		N		
Spookie [V, H, R]				L		N		
Trickster [SV, H, R]						N		
Medium 6-12 lbs								
Autumn Gold [S, R]	A				M	N		
Cotton Candy [V, W, R]	A	G	K			N		T
Goosebumps II [V, WA, R]	A		K			N		T
Hybrid Pam [B, H, R]			K			N		T
Jamboree [V, BL, FL-O, CMV, PRSV]	A					N		T
Jarrahdale [V, BL, FL]	A	G	K			N		T
Long Island Cheese [V, BU, FL]	A		K			N		T
Lumina [V, W, FL-R]	A	G	K			N		T
Mystic Plus [V, FL-R, PM]	A	G				N		T
Neon [SB, R]	A	G			M	N		
Orange Bulldog [V, H, O-R, PM]	A	G						
Rouge Vif D' Etampes [V, RS, FL]	A		K			N		T
Large 12-20 lbs								
Appalachian [SB, R-O]	A	G	K	L		N		T
Aspen [SB, R-O]	A	G		L		N		T
Big Autumn [SB, O]		G	K	L	M			
Cinderella [V, RS, FL]	A	G		L		N		T
Dependable [V, R-O, PM]	A	G				N		T
Fairy Tale [V, BU, FL]	A	G				N		T
Gold Medal [S, W, R]	A	G		L				T
Knuckle Head [S, WA, R-O]			K			N		T
Magic Lantern [S, R, PM]	A	G	K			N	S	T
Magic Wand [S, R-FL, PM]	A	G	K			N		T
Magician [S, R, PM, ZYMV]	A	G	K			N	S	T
Merlin [S, R, PM]	A	G	K			N		
Pro Gold 510 [V, R-O]		G	K	L	M	N		T
Sorcerer [S, R]	A	G		L		N	S	T
20 Karat Gold [SB, R]			K			N		T

[1] Abbreviations for state where recommended.

Growth habit:
- [B] Bush growth habit.
- [SB] Semi-bush growth habit.
- [S] Semi-vining growth habit.
- [V] Vining growth habit.

Skin features:
- [BL] Blue skin.
- [BU] Buff skin.
- [G] Green skin.
- [H] Hardshell.
- [W] White skin.
- [WA] Warts.
- [RS] Red Skin.

Shape:
- [FL] Flat (Cinderella, pancake).
- [O] Oblong.
- [R] Round.

Disease Tolerance/Resistance:
- [F] *Fusarium* tolerance.
- [PH] *Phytophthora* tolerance.
- [PM] Powdery mildew tolerance.
- [VT] Virus tolerance (non-specific).
- [CMV] Cucumber Mosaic Virus.
- [WMV] Watermelon Mosaic Virus (Strain 2).
- [ZYMV] Zucchini Yellows Mosaic Virus.
- [PRSV] Papaya Ringspot Virus.

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
PUMPKIN (cont'd)								
Extra Large 20-50 lbs								
Aladdin [SV, R-O, PM]	A	G	K	L		N	S	T
Apollo [S, O, PH]	A					N		T
Big Max [V, R-O]	A	G		L	M	N		T
Camaro [V, R, PM]	A		K		M	N	S	T
Gold Medallion [V, R-O]	A	G			M	N		T
Gold Rush [V, R]	A	G			M			T
Howden Biggie [V, O]	A	G	K		M	N		T
Gladiator [S, R, PM]	A	G	K			N		
Mammoth Gold [V, R]	A					N		
Mustang [S, R, PM]	A		K			N	S	
Phantom [V, R-O]		G				N		
Super Herc [V, R-O, PM]	A	G	K			N		T
Warlock [V, H, R-O, PM]		G	K			N		T
Giant >50 lbs +								
Atlantic Giant [V, R-O]	A		K	L		N		T
First Prize [V, O-R]		G				N		
Full Moon [V, W, R]	A	G	K			N		T
New Moon [V, O-R]	A	G				N		T
PrizeWinner [V, RS (red-orange skin), FL-R]	A	G	K	L		N		T
HARDSHELL SQUASH								
Acorn								
Celebration [B, PM]	A					N	S	T
Table Ace [SB]		G	K	L		N	S	T
Table Queen [V]	A	G	K	L	M	N	S	T
Taybell PM [SB, PM]	A	G	K	L	M	N	S	T
Buttercup								
Buttercup [V]	A	G				N	S	T
Butternut								
Avalon [V]	A							T
Butternut Supreme [S]	A	G	K			N	S	T
Early Butternut [SB]	A			L			S	
Ultra [V]	A					N		
Waltham Butternut [V]	A	G	K	L	M	N	S	T
Hubbard								
Golden Hubbard [V]	A	G				N		T
True Green Improved Hubbard [V]	A	G						
Spaghetti								
Pasta Hybrid [S]								T
Vegetable Spaghetti [V]	A	G	K		M	N	S	T
Miscellaneous Types								
Bush Delicata [B, PM]	A		K			N		
Cushaw Green Striped [V]	A		K	L		N		T
Cushaw Orange Striped [V]						N		T
Gold Nugget [B]						N		
Golden Delicious [V]	A							
Kabocha								
Sweet Mama [S]	A	G	K		M	N	S	T
Calabaza								
El Dorado [V]	A	G	K		M	N	S	T
La Estrella [V]	A	G	K		M	N	S	T

[1] Abbreviations for state where recommended.

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- [H] Hardshell.
- [W] White skin.
- [WA] Warts.
- [RS] Red Skin.

Shape:
- [FL] Flat (Cinderella, pancake).
- [O] Oblong.
- [R] Round.

Disease Tolerance/Resistance:
- [F] *Fusarium* tolerance.
- [PH] *Phytophthora* tolerance.
- [PM] Powdery mildew tolerance.
- [VT] Virus tolerance (non-specific).
- [CMV] Cucumber Mosaic Virus.
- [WMV] Watermelon Mosaic Virus (Strain 2).
- [ZYMV] Zucchini Yellows Mosaic Virus.
- [PRSV] Papaya Ringspot Virus.

Seeding and Spacing. Seed in the field as indicated in the following table:

Bush types: Rows–5 to 6 feet apart; plants–2 to 3 feet apart in row; seed–4 to 6 pounds per acre.

Semi-vine types: Rows- 6 to 8 feet apart; plants–2 to 4 feet apart in row; seed–2 to 4 pounds per acre.

Vine types: Rows–8 to 10 feet apart; plants–4 to 5 feet apart in row; seed–2 to 4 pounds per acre.

PUMPKIN/HARDSHELL SQUASH PLANTING DATES

	Halloween	Hardshell Squash
AL North	6/15–7/15	4/15–6/15
AL South	6/15–7/15	3/15–5/15
GA North	5/1–6/15	4/15–6/15
GA South	6/15–7/15	3/15–5/15
KY East	5/10-6/1	5/15-6/15
KY Central	5/5-6/15	5/10-7/10
LA North	6/15-7/15	4/15–5/15
LA South	6/15-7/15	3/15–5/15
MS North	6/20–7/5	4/15-6/15
MS South	6/20–7/5	3/15-5/15
NC East	6/15–7/10	4/15–5/20
NC West	5/25–6/30	5/25–6/30
SC East	NR	3/20–5/1
SC West	NR	4/15–6/15
TN East	6/1-7/15	5/15-6/30
TN West	5/15-6/15	4/25–6/30

For Soil Strips between Rows of Plastic Mulch. Use the following land preparation, treatment, planting sequences, and herbicides labeled for pumpkins or squash or crop injury may result.

1. Complete soil preparation and lay plastic and drip irrigation (optional) before herbicide application. In some cases, overhead irrigation can be used if small holes are punched into the plastic.
2. Spray preemergence herbicides on the soil and the shoulders of the plastic strips in bands before weeds germinate. DO NOT APPLY HERBICIDE TO THE SURFACE OF THE PLASTIC. Herbicides may wash from a large area of plastic into the plant hole and result in crop injury.
3. Incorporate preemergence herbicide into the soil with 0.5 to 1 inch of rainfall or overhead irrigation within 48 hours of application and BEFORE PLANTING OR TRANSPLANTING.
4. Apply selective postemergence herbicides broadcast or in bands to the soil strips between mulch to control susceptible weeds.

Minimum Tillage. No-tillage is the most commonly used minimum tillage practice with pumpkins. No-till planters currently in use with row crop production will plant pumpkin seed but seed plates or feed cups need to match up with seed size. Improper seed plates or cups will break pumpkin seed. Type of winter cover crop residue can affect pumpkin seed depth. Inspect seed placement and adjust for correct depth. Early spring planting with no-tillage in pumpkin may delay growth and days to harvest. Planting after soils warm in the spring will improve vigor (pumpkins are normally planted after soil warms so this may not be a management problem). Use of small grain cover residue may require additional nitrogen fertilizer (20 to 30 lbs N/acre in addition to the normal recommendation) if cover crop is fairly mature when killed. Normal pumpkin nitrogen fertilizer recommendations can be used if a legume cover crop (hairy vetch, winter peas, or crimson clover) is used as residue.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Cucumber Beetle: Cucumber beetles cause direct feeding damage to the foliage. Young plants need to be protected with insecticide as soon as they emerge or are transplanted. Cucumber beetles also cause direct damage to pumpkin and winter squash rinds. Fall treatments with foliar insecticides to prevent feeding damage may also reduce incidence of bacterial wilt. While Hubbard squash, butternut squash and processing pumpkins are susceptible to bacterial wilt, Jack-o-lantern pumpkins and most other varieties of squash are rarely susceptible to bacterial wilt.

Squash Vine Borer: Pheromone baited sticky traps can be used soon after planting to monitor the activity of the adult moths. Start inspecting plants closely for squash vine borer eggs (1mm [1/25 inch] diameter oval, flattened, dull-red to brownish) as soon as moths are caught in the traps. The first application of insecticide should occur when eggs begin to hatch or just prior to hatching. Applications should be made in afternoons or evenings after flowers close to reduce the spraying of valuable pollinators, especially bees. If pheromone traps are not used, a preventive treatment should be applied when vines begin to run. Re-apply insecticide every seven days for four weeks. Continue monitoring the pheromone traps into August to detect the emergence of the new moths. When moths are caught, inspect plants for second-generation eggs, and begin the insecticide applications when eggs first begin to hatch or just prior to hatching.

Aphids: Aphid feeding can delay plant maturity. Thorough spray coverage, especially on the underside of the leaves is important. Treat seedlings every five to seven days, or as needed. The transmission of plant viruses by aphids has the potential to be the most damaging to the crop. Unfortunately, insecticide use for aphids does not reduce the spread of virus. A better approach is the application of Stylet Oil to fill tiny grooves between the leaf cells. When the aphid probes the leaf surface, its stylet must pass through a layer of oil. This reduces the infectivity of the virus resulting in less disease in the squash plant. The application of Stylet Oil can delay virus infection, but requires application every other day, thorough coverage and high pressure sprays. Also, refer to the preceding "Mulches" section for information on metallized reflective mulch used to repel or disorient aphids that can spread viruses.

Squash Bug: Begin scouting shortly after plant emergence. Treat every 7 to 10 days when adults or nymphs appear. The control of squash bugs is particularly important where yellow vine disease occurs since squash bugs vector the pathogen responsible for this disease.

Spider Mites: Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow these areas after midsummer because this forces mites into the crop. Localized infestations can be spot-treated. **Note:** Continuous use of Sevin or pyrethroid sprays may result in mite outbreaks.

POLLINATION

Honey bees are important for pollination, high fruit yields, fruit size, and quality. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Use one hive per acre to get good pollination. Apply insecticides only in the evening hours or wait until blooms have closed before application. See section on "Pollination" in the General Production Recommendations.

HARVESTING AND STORAGE

Use clean storage bins and sanitize. Be sure to thoughly clean and santize bins prior to usage and subsequent storage.

Harvest as soon as fruits are mature and prior to frost. Use care in handling fruit to prevent wounds. Cure after harvest at temperatures between 80° to 85°F with a relative humidity of 75% to 80% for 10 days.

Temperatures below 50°F cause chilling injury. The hard-shelled varieties, such as Butternut, Delicious, and the Hubbard strains, can be stored for several months. Store at 55°F and 55% relative humidity. See Table 14 for further postharvest information.

RADISHES, RUTABAGAS, AND TURNIPS

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
RADISH: Salad, Daikon, and Icicle Types								
Cherriette [2]	A	G				N	S	T
Cherry Belle [2]	A		K	L	M	N	S	T
Cherry Beauty	A					N		
Champion [2]	A	G			M	N		
Crunchy Royal [2]						N	S	T
Easter Egg [2] (mixture of 5 - 6 root colors)			K			N		T
Early Scarlet Globe [2]	A		K		M	N		T
Fireball							S	
Red Boy	A					N		
Red Jewel [2, 7, 8]	A							
Red Pearl [2, 7, 8]	A							
Red Silk							S	
Ricardo [2]						N	S	
Sparkler [2] (half red, half white root)	A				M	N		
White Icicle [4]	A	G	K		M	N		T
RADISH: Storage Types								
April Cross [3]	A	G	K			N		
Everest [3]	A		K			N		
Omny [3]	A				M	N		
Long Black Spanish [5]	A				M	N		T
Round Black Spanish [5]	A				M	N		T
RUTABAGAS								
American Purple Top	A	G				N	S	
Laurentian	A	G				N	S	
TURNIPS								
Hakurei [6]			K					T
Purple Top White Globe	A	G	K	L	M	N	S	T
Royal Crown		G		L				T
Scarlet Queen Red Stems [6]	A		K	L				T
Shogoin	A				M	N	S	
Tokyo Cross	A		K	L	M	N	S	T
White Egg						N	S	
White Lady				L	M		S	T

[1] Abbreviations for state where recommended.
[2] Garden radish.
[3] Daikon radish.
[4] Icicle radish.
[5] Spanish radish.
[6] Small root type; best when harvested at 2" to 3" diameter.
[7] Downy mildew tolerance/resistance.
[8] *Fusarium* wilt tolerance/resistance.

Seed Treatment. Soak seed in hot water at 122°F. Soak rutabagas for 20 minutes and turnips for 25 minutes. Dry the seed, then dust with a labeled fungicide to prevent damping-off.

SPACING AND SEEDING

Radishes: *Salad or garden radish* roots are normally red skinned, round, less than two inches in diameter and grow rapidly, generally taking less than one month from seeding to harvest. *Icicle* types are elongated root forms of garden radishes. *Daikon radishes* are Asian storage radishes that produce large, white cylindrical roots which can exceed twelve inches in length and can weigh over one pound. *Spanish radishes* have round or elongated large storage roots with black skin. *Storage radishes* can take up to ninety days from seeding to harvest.

Radishes are a quick-growing, cool-season crop producing its best quality when grown at temperatures of 50° to 65°F. Many radish types are ready for harvest 23 to 28 days after sowing. Radishes must be grown with an adequate moisture supply; otherwise, when growth is checked radishes become hot, tough, and pithy. Warm temperature and longer day-lengths induce seedstalk formation.

Seed radish as early in the spring as soil can be worked, then in order to maintain a continual supply make additional plantings at 8- to 10-day intervals. Space rows 8 to 15 inches apart and sow 12 to 15 seed per foot within a row. This will require 10 to 15 pounds of seed per acre.

RADISH PLANTING DATES

	Spring	Fall
AL North	2/15–5/15	8/1–10/15
AL South	1/15–3/31	8/1–10/31
GA North	3/15–5/15	8/1–9/15
GA South	2/1–3/31	8/1–10/15
KY East	3/15-5/15	8/1-9/1
KY Central	3/10-5/10	8/15-9/15
KY West	3/10-4/1	9/15-10/1

RADISH PLANTING DATES (cont'd)

	Spring	Fall
LA North	2/1–3/15	8/1–10/30
LA South	1/15–3/15	8/1–10/30
MS North	3/5-4/30	8/1-9/15
MS South	2/1-3/31	8/1-9/30
NC East	2/15–6/30	8/1–9/15
NC West	4/1–8/15	NR
SC East	2/1–6/15	8/1–9/30
SC West	3/15–6/30	8/1–9/15
TN East	4/1-5/30	8/1-9/15
TN West	3/1-5/1	8/1-9/30

Rutabagas: A cool-season crop that develops best at temperatures of 60° to 65°F. Usually considered a fall crop, it can be grown in the spring. Seed at least 90 days before the early freeze date in the fall. Sow 1.5 to 2 pounds of seed per acre at a depth of 1 inch in rows 30 to 36 inches apart. Thin to 4 to 8 inches in the row when plants are 2 to 3 inches tall.

RUTABAGA PLANTING DATES

	Spring	Fall
AL North	2/15–5/15	8/1–9/15
AL South	1/15–3/31	8/1–10/15
GA North	3/15–5/15	8/1–9/15
GA South	2/1–3/31	8/1–10/15
KY East	3/15-5/15	NR
KY Central	3/10-5/10	NR
KY West	3/10-4/1	NR
LA North	2/1–3/15	7/15–10/30
LA South	1/15–3/15	7/15–10/30
MS	NR	NR
NC East	2/15–4/15	8/1–9/30
NC West	4/1–8/15	NR
SC East	2/1–3/31	8/15–10/15
SC West	3/15–4/30	7/15–9/30
TN East	3/15-5/15	NR
TN West	3/10-4/1	NR

Turnips: Seed as early in the spring as soil can be worked or at least 70 days before the early freeze date in the fall. Seed in rows 1 to 2 pounds per acre, 0.25 to 0.5 inch deep, in rows 14 to 18 inches apart. Plants should be 2 to 3 inches apart in the row. Seed can also be broadcast at the rate of 2.5 pounds per acre.

TURNIP (ROOTS) PLANTING DATES

	Spring	Fall
AL North	2/15–5/15	8/1–10/15
AL South	1/15–3/31	8/1–10/30
GA North	3/15–5/15	8/1–9/15
GA South	2/1–3/31	8/1–10/15
KY East	3/15-4/15	7/1-7/15
KY Central	3/10-4/10	7/15-8/1
KY West	3/1-4/1	8/1-8/15
LA North	2/1–3/15	7/15–10/31
LA South	1/15–3/15	7/15–10/31
MS North	1/20–4/1	7/25–8/20
MS South	1/15–3/1	8/10–9/15
NC East	2/15–6/30	8/1–9/15
NC West	4/1–8/15	NR
SC East	2/1–4/1	8/1–9/30
SC West	3/15–4/30	8/1–9/15
TN East	3/15-5/30	7/15-8/10
TN West	3/1-5/1	8/1-8/25

HARVESTING AND STORAGE

Rutabagas: Pull and trim tops in field. Bruised, damaged, or diseased rutabagas will not store well. Wash rutabagas in clean water, spray-rinse with clean water, then dry as rapidly as possible before waxing and shipping. Rutabagas can be stored 2 to 4 months at 32°F and at 90% to 95% relative humidity.

Turnips: The crop is dug mechanically and either bunched or topped. Turnips can be stored at 32° to 35°F and at 90% to 95% relative humidity.

For further postharvest information on radish, rutabaga, and turnip, see Table 14.

SPINACH

VARIETIES[1]	AL	GA	KY	LA	MS	NC	OK	SC	TN
SPINACH									
Baker [5]							O		
Bloomsdale Long Standing [2, 5]	A	G	K			N			T
Bolero [5]							O		
Chesapeake Hybrid [3, 4, 6]	A					N			
Crescent [7]							O		
Early Hybrid #7 [2, 4, 6]	A	G				N		S	
F91-415 [4, 7]							O		
F97-154 [4, 7]							O		
Greyhound [3, 4]				L					
Mig				L					
Melody [3, 4]	A	G	K	L		N		S	T
Olympia [4, 5]							O		
Regal [4, 5, 7]							O		
Seven R [3, 4, 6]				L					
Teton [4, 5]							O		
Tigercat [4]				L					
Tyee [3, 4]	A	G	K	L		N		S	T
Unipak 151 [3, 4, 5, 6]				L					
Whale [2, 4, 5]								S	

[1] Abbreviations for state where recommended.
[2] Savoy type.
[3] Semi-savoy.
[4] Downy mildew tolerance/resistance.
[5] Bolting tolerant.
[6] Cucumber Mosaic Virus tolerance/resistance.
[7] White Rust tolerance/resistance.

Seed Treatment. Check with seed supplier to ensure seed were treated with an insecticide and fungicide.

SPINACH PLANTING DATES

	Spring	Fall
AL North	3/15–4/30	8/1–9/15
AL South	2/1–3/31	8/15–9/30
GA North	3/15–4/30	8/1–9/15
GA South	2/1–3/31	8/1–9/30
KY East	3/10-4/10	8/1-8/15
KY Central	3/1-4/1	8/15-9/1
KY West	2/15-3/15	9/1-9/15
LA North	2/1–3/15	9/1–11/15
LA South	2/1–3/15	9/15–11/15
MS	NR	NR
NC East	2/15–6/30	8/1–9/15
NC West	4/1–8/15	NR
OK	2/15–4/15	9/1–12/30
SC East	2/1–4/1	8/15–10/15
SC West	3/15–4/15	8/1–9/30
TN East	2/1-3/31	8/15-10/15
TN West	2/1-3/31	8/15-10/15

Seeding Rates. *Not clipped:* 10 to 14 pounds per acre. *Clipped:* 18 to 25 pounds per acre.

Spacing. *Processing:* rows on 12-inch centers. *Market:* rows on 12-inch centers. Planted into 6- and 8-row beds.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Seed Corn Maggot: To prevent maggot damage to spring-seeded plants, treat seed with an approved commercially available insecticide or use a broadcast application of a soil-incorporated insecticide. See the ”Maggots” section in Soil Pests-Their Detection and Control.

Garden Webworms: Sprays must be applied before webbing occurs.

HARVESTING AND STORAGE

See Table 14 For further postharvest information.

SUMMER SQUASH

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
SUMMER SQUASH								
Yellow Crook Neck								
Destiny III [3, 4, 5, 6]	A	G	K	L		N	S	T
Dixie	A			L		N	S	T
Gentry	A	G	K		M	N	S	T
Gold Star [6, 8]	A	G				N		
Medallion	A		K		M	N	S	T
Prelude II [3, 4, 5]	A	G	K	L		N	S	T
Supersett [2, 4, 5]	A	G		L	M	N	S	T
Yellow Straight Neck								
Cheetah [2, 4, 8]	A	G				N	S	T
Conqueror III [3, 4, 5, 6, 7]	A	G	K					T
Cougar [4, 5, 7]	A	G	K			N	S	T
Daisey	A	G						
Enterprise	A	G				N	S	T
Fortune [2]			K			N		T
Goldbar	A	G			M	N	S	T
Lioness [4, 5, 6, 7]		G	K			N		T
Multipik [2, 4, 5]	A	G	K	L		N	S	T
Solstice [4, 5]	A					N	S	T
Superpik [2, 4, 5]	A	G		L		N	S	
Zucchini								
Cash Flow						N		T
Elite	A					N	S	T
Independence II [3, 4, 5]	A	G	K	L		N	S	
Judgement III [3, 4, 5, 6]	A	G	K			N		T
Justice III [3, 4, 5, 6]	A	G	K			N		
Leopard [4, 7]						N	S	T
Lynx [4, 5, 7]								T
Paycheck [4, 5, 6, 8]	A	G	K			N		T
Payroll [4, 5, 6, 7]	A	G	K		M	N	S	T
President							S	
Senator	A	G		L	M		S	T
Spineless Beauty	A	G	K		M	N	S	T
Spineless Perfection [4, 5, 8]	A	G				N	S	
Tigress [4, 5, 7]	A	G	K		M	N	S	T
Total Eclipse								T
Zephyr [2] (bi-color)	A		K			N		T
Grey Zucchini								
Ishtar	A							T
Scalloped								
Patty Green Tint	A					N	S	
Peter Pan	A		K			N	S	T
Scallopini	A	G		L		N		
Sunburst	A	G	K	L		N	S	T

[1] Abbreviations for state where recommended.
[2] *Py* - Precocious yellow gene; has a prominent yellow stem.
[3] Transgenic.
[4] Zucchini Yellows Mosaic virus tolerance/resistance.
[5] Watermelon Mosaic virus tolerance/resistance.
[6] Cucumber Mosaic Virus tolerance/resistance.
[7] Papaya Ringspot Virus tolerance/resistance.
[8] Powdery mildew tolerance/resistance.

Seed Treatment. Check with seed supplier to determine if seed has been treated with an insecticide and/or fungicide.

Seeding, Transplanting, and Spacing. Use 4 to 6 pounds of seed per acre. Seed or container-grown transplants are planted when daily mean temperatures have reached 60°F. Seed as indicated in following table. Early plantings should be protected from winds with row covers, rye strips, or wind breaks. Space rows 3 to 6 feet apart with plants 1.5 to 2.5 feet apart in the row.

SUMMER SQUASH PLANTING DATES

	Spring	Fall
AL North	4/15–8/15	8/1–8/30
AL South	3/1–4/30	7/15–9/15
GA North	5/1–8/15	NR
GA South	3/1–4/30	7/15–9/15
KY East	5/15-7/15	NR
KY Central	5/10-8/1	NR
KY West	4/20-8/15	NR
LA North	3/15–5/15	7/15–8/31
LA South	3/1–5/15	8/1–9/15

SUMMER SQUASH PLANTING DATES (cont'd)

	Spring	Fall
MS North	4/15–6/15	7/25–8/14
MS South	2/15–5/1	8/14–9/14
NC East	4/1–5/30	7/15–8/15
NC West	5/15–7/31	NR
SC East	3/15-7/30	8/1–8/30
SC West	4/15–7/30	7/30–8/15
TN East	5/10-8/1	NR
TN West	4/15-7/15	NR

Mulching. Plastic mulch laid before field planting conserves moisture, increases soil temperature, reduces mechanical damage to fruit, and increases early and total yield. Plastic should be applied on well-prepared planting beds. The soil must be moist when laying the plastic. Black plastic mulch can be used without a herbicide. In most situations, 50 percent of the nitrogen(N) should be in the nitrate (NO_3) form.

Reflective, plastic mulches can be used to repel aphids that transmit viruses in fall-planted (after July 1) squash. Direct seeding through the mulch is recommended for maximum virus protection.

Growers should consider drip irrigation. See the section on "Irrigation" in this handbook.

SUGGESTED FERTIGATION SCHEDULE FOR SUMMER SQUASH* (N:K;1:2)

Days after planting	Daily nitrogen	Daily potash	Cumulative Nitrogen	Cumulative Potash
	(lb / A)			
Preplant			24.0	24.0
0–14	0.9	1.8	36.6	49.2
8–28	1.3	2.6	54.8	85.6
29–63	1.5	3.0	107.3	190.6

* Adjust based on tissue analysis.

ALTERNATIVE FERTIGATION SCHEDULE FOR SUMMER SQUASH* (N:K,1:1)

Days after planting	Daily nitrogen	Daily potash	Cumulative Nitrogen	Cumulative Potash
	(lb / A)			
Preplant			24.0	24.0
0–7	1.0	1.0	31.0	31.0
8–21	1.5	1.5	52.0	52.5
22–63	2.0	2.0	136.0	136.5

*Adjust based on tissue analysis.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Cucumber Beetle: Cucumber beetles cause direct feeding damage to the foliage. Young plants need to be protected with insecticide as soon as they emerge or are transplanted.

Squash Vine Borer: Pheromone baited sticky traps can be used soon after planting to monitor the activity of the adult moths. Start inspecting plants closely for squash vine borer eggs (1mm [1/25 inch] diameter oval, flattened, dull-red to brownish) as soon as moths are caught in the traps. The first application of insecticide should occur when eggs begin to hatch or just prior to hatching. Applications should be made in afternoons or evenings after flowers close to reduce the spraying of valuable pollinators, especially bees. If pheromone traps are not used, a preventive treatment should be applied when vines begin to run. Re-apply insecticide every seven days for four weeks. Continue monitoring the pheromone traps into August to detect the emergence of the new moths. When moths are caught, inspect plants for second-generation eggs, and begin the insecticide applications when eggs first begin to hatch or just prior to hatching.

Aphids: Aphid feeding can delay plant maturity. Thorough spray coverage, especially on the underside of the leaves is important. Treat seedlings every five to seven days, or as needed. The transmission of plant viruses by aphids has the potential to be the most damaging to the crop. Unfortunately, insecticide use for aphids does not reduce the spread of virus. A better approach is the application of Stylet Oil to fill tiny grooves between the leaf cells. When the aphid probes the leaf surface, its stylet must pass through a layer of oil. This reduces the infectivity of the virus resulting in less disease in the squash plant. The application of Stylet Oil can delay virus infection, but requires application every other day, thorough coverage and high-pressure sprays. Also, refer to the preceding "Mulches" section for information on metallized reflective mulch used to repel or disorient aphids that can spread viruses.

Squash Bug: Begin scouting shortly after plant emergence. Treat every 7 to 10 days when adults or nymphs appear. The control of squash bugs is particularly important where yellow vine disease occurs since squash bugs vector the pathogen responsible for this disease.

Spider Mites: Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow these areas after midsummer because this forces mites into the crop. Localized infestations can be spot-treated. **Note:** Continuous use of Sevin or pyrethroid sprays may result in mite outbreaks.

Disease Management. Viruses (CMV, WMV, PRSV and ZYMV): Plant infection by viruses often causes squash fruit to be distorted or off-color rendering them unmarketable. Certain yellow-fruited varieties contain the precocious (*Py*) gene. The varieties are distinguished by their yellow stem. Varieties with the *Py* gene should be used for late spring or summer plantings since viruses are more prevalent in the summer than spring plantings. The *Py* varieties can normally mask virus fruit symptoms of certain viruses for several harvests. Use resistant varieties where possible, but even these may not escape virus.

WEED MANAGEMENT

See the previous "Mulching" section for further information on weed control under clear plastic mulch.

For Seeding into Soil without Plastic Mulch. Stale bed technique: Prepare beds 3 to 5 weeks before seeding. Allow weed seedlings to emerge and spray with paraquat a week prior to seeding. Then seed beds without further tillage.

For Soil Strips between Rows of Plastic Mulch. Use the following land preparation, treatment, planting sequences, and herbicides labeled for squash, or crop injury may result.

1. Complete soil preparation and lay plastic and drip irrigation before herbicide application.

2. Spray preemergence herbicides on the soil and the shoulders of the plastic strips in bands before weeds germinate. DO NOT APPLY HERBICIDE TO THE BED SURFACE OF THE PLASTIC. Herbicides may wash from a large area of plastic into the plant hole and result in crop injury.

3. Incorporate herbicide into the soil with1/2 to 1 inch of rainfall or overhead irrigation within 48 hours of application and BEFORE PLANTING OR TRANSPLANTING.

4. Apply selective postemergence herbicides broadcast or in bands to the soil strips between mulch to control susceptible weeds.

POLLINATION

Honey bees are important for producing high yields and quality fruit. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See section on “Pollination” in the General Production Recommendations.

HARVESTING AND STORAGE

See Table 14 for postharvest information.

SWEET CORN

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
CORN, SWEET								
White - Early								
Silver Princess (se)	A					N		T
Sweet Ice (se)	A	G	K			N	S	
White Out (se)								T
White - Mid-Season								
Alpine (se)	A					N		
Argent (se)		G	K	L		N		T
Avalon (se)	A		K					T
Biscayne (sh_2)	A		K			N	S	
Devotion (sh_2)	A					N		T
Ice Queen (sh_2)	A	G	K	L			S	
Munition (sh_2)	A		K			N	S	
Snow White (sh_2)	A					N		T
Summer Sweet 8101R (sh_2)	A	G	K	L	M	N	S	T
WH0809 (sh_2) [2]		G						T
Xtra-Tender Brand 375A (sh_2)		G				N	S	
Xtra-Tender Brand 372A (sh_2)	A	G					S	T
Xtra-Tender Brand 378A (sh_2)		G				N	S	T
White - Late season								
Silver King (se)	A					N	S	T
Silver Queen (su)	A	G	K	L	M	N	S	T
Tahoe (sh_2)	A	G	K		M	N		
WSS 0987 (sh_2) [2]		G		L		N		T
Yellow - Early								
Bodacious (se)					M	N	S	T
Mirai 130Y (sh_2)	A	G			M	N	S	T
Seneca Horizon (su)	A	G		L	M	N		T
Sweet Riser (se)		G				N	S	
Xtra-Tender XT 372 (sh_2)	A						S	
Yellow - Mid-Season								
Bandit (sh_2)		G	K			N	S	
Garrison (sh_2)	A		K			N		
Gold Queen (su)							S	
GH0851 (se) [2]	A	G	K			N	S	T
GSS 0966 (sh_2) [2]	A	G		L		N	S	
Honey Select (se)	A	G	K					T
Incredible (se)				L	M	N	S	T
Merit (su)	A	G	K	L	M	N	S	T
Passion (sh_2)	A	G						
Passion II (sh_2) [2, 3]	A		K			N		
Prime Plus (sh_2)	A			L		N	S	
Summer Sweet 7210 (sh_2)	A				M	N		
Vision (sh_2)	A				M		S	T
XT H1273 (sh_2)							S	T
Xtra-Tender 1178 (sh_2)					M	N	S	T
Xtra-Tender 1575 (sh_2)						N	S	T
Bicolor - Early								
Lancelot (se)	A					N	S	T
Precious Gem (se)	A			L		N	S	T
Temptation (se)	A					N	S	T
Temptation II (se) [2, 3]	A					N		
Xtra-Tender Brand 270A (sh_2)							S	
Bicolor - Mid-Season								
Awesome (sh_2)								T
BC 0805 (sh_2)[2]		G	K					T
Big Time (sh_2)	A	G				N	S	T

[1] Abbreviations for state where recommended. [2] BT sweet corn (transgenic). [3] RoundUp Ready sweet corn (transgenic).

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
CORN, SWEET (cont'd)								
***Bicolor - Mid-Season* (cont'd)**								
BSS 0977 (sh_2)[2]	A	G	K	L		N	S	T
BSS 0982 (sh_2)[2]		G	K	L				
Cameo (sh_2)[2]			K	L				T
Legion (sh_2)	A		K			N	S	
Marquette (sh_2)	A		K			N	S	
Mirai 301BC (sh_2)			K		M		S	T
Mirai 350 BC (sh_2)	A				M			
Montauk (sh_2)			K					T
Obsession (sh_2)	A	G	K			N	S	T
Obsession II (sh_2) [2, 3]	A		K			N	S	
Providence (sh_2)			K					T
Summer Sweet 8102R (sh_2)	A	G	K		M	N	S	T
Sweet Chorus (se)	A	G				N		T
Sweet G90 (su)				L	M	N	S	T
Sweet Rhythm (se)	A	G					S	
Xtra-Tender Brand 282A (sh_2)	A				M	N	S	

[1] Abbreviations for state where recommended. [2] BT sweet corn (transgenic). [3] RoundUp Ready sweet corn (transgenic).

There are three primary genes contributing to sweetness in sweet corn. They are; normal sugary (*su*), sugary enhanced (*se*), and supersweet or shrunken-2 (sh_2).

Normal sugary sweet corn (*su*) has been enjoyed for many years. *Su* sweet corn is known for its creamy texture and mild sugars; however, sugars in these cultivars are rapidly converted into starch if not cooked the day of harvest. These cultivars are commonly sold in farmer's markets and roadside stands. Examples of cultivars of the normal sugary sweet corn are 'Silver Queen' (white kernel), 'Merit' (yellow kernel) and 'Butter and Sugar' (bicolor kernel).

The sugary enhanced (*se*) sweet corn gene, known under trade names such as Everlasting Heritage have varying degrees of increased sugar content with a creamier kernel texture as compared to *su* sweet corn types. This translates into increased sweetness with a smoother kernel texture. Another advantage is that *se* sweet corn types maintain their quality for a longer period of time than normal sugary sweet corn types (*su*).

Cultivars of "Supersweet" or "shrunken" sweet corn (sh_2) derive their name from the appearance of the dried kernel which is much smaller than kernels of *su* or *se* sweet corn types. Recently germination of sh_2 sweet corn cultivars has been improved and is now comparable with the su and se types. Seed of supersweet (sh_2) sweet corn cultivars should be handled very gently and the use of plateless planter is recommended to prevent damage to seed. Many older supersweet cultivars require warm soil (70°F or higher) to germinate since they are less vigorous than the *se* or *su* genotypes. Supersweet sweet corn (sh_2) cultivars have a crunchier kernel, are sweeter than su and se cultivars, and will delay the conversion of sugar to starch extending their shelf life.

Xtra-tender, *Ultrasweet*, and *Triplesweet* are names for the latest development in sweet corn cultivars. These new types of sweet corn combine the genetics of sh_2, *se*, and *su* genotypes. These cultivars are high in sugar levels, hold well in storage, and have a pericarp which is tender (this improves the eating quality of the sweet corn). Plant these cultivars using the same recommendations as those of the sh_2 types of sweet corn.

Isolation requirements for the sweet corn genotype are important in order to obtain the highest quality sweet corn. Supersweet (sh_2) sweet corn must be isolated by a distance of 300 feet or 12 days difference in silking date to avoid cross pollination from field corn, pop corn, normal sugary (*su*), and/or sugar enhanced (*se*) types. Failure to properly isolate the sh_2 genotype will result in it producing starchy, tough kernels. Isolation of sugary enhanced from normal sugary sweet corn types is recommended to maximize quality; however, quality is usually very minimally affected should cross pollination occur. It is recommended that augmented sweet corn types be isolated from all other sweet corn types for best quality.

Another important development in sweet corn cultivar development is the incorporation of the *BT* gene (called *BT* sweet corn). *BT* sweet corn has been genetically modified by incorporating a small amount of genetic material from another organism through modern molecular techniques. In sweet corn, the incorporated *BT* genes is particularly effective in providing protection against European corn borer and corn earworm. The protein produced by the *BT* gene is very selective, generally not harming insects in other orders (such as beetles, flies, bees, or wasps) but more importantly this protein is safe for consumption by humans, other mammals, fish, and birds. Syngenta Seeds has incorporated the *BT* gene into several sweet corn cultivars that are sold commercially under the trade name of *Attribute* followed by a series of numerals to identify the cultivar. Certain restrictions such as isolation, minimum acreage requirements, and destruction of the crop are part of the terms of contract when purchasing *BT* sweet corn seed.

In general, when selecting a cultivar, be sure to evaluate its acceptance in the market. Plant small acreages of new cultivars to test market their acceptance.

Seed Treatment. Check with seed supplier to ensure seed was treated with an insecticide and fungicide.

Seeding and Spacing. Seed is sown as early as February in more southern regions on light, sandy soils. Use a high vigor seed variety for early plantings. Seed is drilled in the field about 1 inch deep. Varieties are spaced 30 to 42 inches apart between rows depending on cultural practices, equipment, and seed size. In-row spacings range from 6 to 12 inches apart, with small-eared, early seasons varieties planted closest.

SWEET CORN PLANTING DATES

	Spring	Fall
AL North	4/15–5/30	NR
AL South	2/1–4/30	7/15-8/15
GA North	4/15–4/30	NR
GA South	2/1–3/31	7/15–8/15
KY East	5/1-6/15	NR
KY Central	4/20-7/10	NR
KY West	4/10-7/20	NR
LA North	3/1–5/15	NR
LA South	2/15–5/1	NR
MS North	3/20–4/9	NR
MS South	2/21–3/14	NR
NC East	3/15–4/30	NR
NC West	4/15–6/15	NR
SC East	3/1–4/15	NR
SC West	3/30–5/30	NR
TN East	4/15-6/30	NR
TN West	4/15-6/15	NR

Mulching. The use of clear plastic mulch will improve stands, conserve moisture, and produce earlier maturity. Corn is seeded in the usual manner, except 10 to 20 days earlier in double rows 14 inches apart and on 5- to 6-foot centers. Apply herbicide and then cover with clear, 4-foot-wide plastic. Allow plastic to remain over plants for 30 days after emergence, then cut and remove plastic from field. Plants can then be cultured in the usual manner. A nematode assay is recommended before using this system. If nematodes are present in the soil, control measures are necessary before planting. Use a high vigor seed variety to avoid uneven and reduced stand.

Minimum Tillage. No-tillage is the most commonly used minimum tillage practice with sweet corn. No-till planters currently in use with row crop production will plant sweet corn seed with minimal modifications. Type of winter cover crop residue can affect sweet corn seed depth. Inspect seed placement and adjust for correct depth. Early spring planting with no-tillage in sweet corn may delay growth and days to harvest. Planting after soils warm in the spring will improve vigor. Use of small grain cover residue may require additional nitrogen (20 to 30 lbs N/acre in addition to the normal recommendation) if cover crop is fairly mature when killed. No additional nitrogen above recommendations is required if a legume cover crop (hairy vetch, winter peas, or crimson clover) is used as residue.

SPECIAL NOTES FOR PEST MANAGEMENT

(listed as "Corn, Sweet" in the Pest Management section)

INSECT MANAGEMENT

Corn Earworm (CEW): CEW initiates egg laying when the plants begin to silk and ends when the silks wilt. Eggs are laid singly on the fresh silks. Begin to control CEW when 10% of the ears are silked. Repeat sprays at three to five day intervals until 90% of the silks have wilted. Control is more difficult late in the season. Direct sprays toward the middle third of the plant. Corn hybrids having a long, tight-fitting shuck appear to suffer less damage than those with loose shucks.

Another management tactic for CEW and European corn borer (ECB) control is the use of BT sweet corn. These hybrids produce their own natural insecticide for control of these pests. However, under high pressure, supplemental sprays may be needed to achieve damage-free ears. Minimum acreage and resistance management practices are required with BTs sweet corn. Some markets may not accept these hybrids.

Corn Flea Beetle: Flea beetles transmit a bacterial wilt disease, known as Stewart's Wilt, and these beetles are numerous after mild winters. Treat susceptible varieties at spike stage when 6 or more beetles per 100 plants can be found. Repeat every 3 to 5 days as needed. **Note:** Soil-applied insecticides may be ineffective during the first week of plant growth if soil temperatures are cool. Foliar applications of an insecticide may be necessary during this period.

European Corn Borer (ECB): Thorough spray coverage in whorls and on plants is essential. Many insecticides are highly toxic to bees. Granular formulations, if applied over the whorl, are generally more effective than liquid formulations for ECB control.

Sap Beetle (SB): Loose-husked varieties tend to be more susceptible to sap beetle attack. Ears damaged by other insects attract SB. Begin sampling at pollen shed and treat when 5% of the ears have adults and/or eggs. **Note:** Insecticides used for worm control at silk may not control SB infestations.

Fall Armyworm (FAW): Direct granules over the plants so that they fall into leaf whorls when FAW first appear and repeat application, if necessary. For foliar spray applications, high-spray gallonage (50 to 75 gallons per acre) is necessary for effective FAW control.

INSECT MANAGEMENT DECISION-MAKING

Whorl/Tassel Infestation: In general, insect larval feeding (ECB and FAW) during the whorl stage of sweet corn development has a greater impact on early planted, short-season varieties. For ECB on early plantings, apply first spray or granular application when 15% of the plants show fresh feeding signs. Additional applications may be necessary if infestation remains above 15%. An early tassel treatment is usually more effective than a whorl treatment because larvae are more exposed to the chemicals.

The impact of infestation on mid-and late-season plantings depends on the stage of the plants when the infestation occurs. Treat for FAW during the early whorl stage when more than 15% of the plants are infested. During mid- to late-whorl stages, treatment for both FAW and ECB may be necessary if more than 30% of the plants are infested. Treat fields in early tassel stage if more than

15% of the emerging tassels are infested with ECB, FAW, or young corn earworm (CEW) larvae.

Ear Infestation: Direct sampling for CEW, FAW, and ECB during silking is not practical because of the low thresholds for ear damage. Begin treatment when 10% of the ears show silk. If CEW populations are heavy, it may be necessary to begin treatments when the very first silks appear. Silk sprays should continue on a schedule based on area blacklight and pheromone trap counts, geographical location, and time of year. Early in the season, silk sprays may be required on a 3- to 6-day schedule. When CEW populations are heavy, it may be necessary to treat on a 1-to 3-day schedule. Applications during low populations can end up to 5 days before last harvest. During heavy populations and high temperatures, treatments will need to be made according to the legal "days to harvest" of the chemical.

For best control during heavy populations, maximize the gallonage of water per acre, use a wetting agent, and make applications with a high pressure sprayer (200+ psi) with drop nozzles directed at the silks.

HARVESTING AND STORAGE

See Table 14 for postharvest information.

SWEETPOTATO

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
SWEETPOTATO								
Beauregard	A	G	K	L	M	N	S	
Bonita [3]	A			L	M	N	S	
Carolina Ruby						N		
Covington	A		K			N	S	
Evangeline		G		L	M	N		
Hernandez	A	G	K			N	S	
Japanese/Grand Asia [2]						N		
Jewel	A	G	K		M	N	S	
L 07-146 [4]				L				
Murasaki [2]	A		K			N		
O' Henry	A		K			N		
Orleans				L				
White Delite	A					N		
White Hayman	A					N		

[1] Abbreviations for state where recommended.
[2] Purple skin, white flesh, high dry matter.
[3] Tan skin, white flesh.
[4] Red skin, orange flesh.

Plant Production. A presprout procedure started 3 to 4 weeks before normal bedding time is recommended. To presprout, store seed roots at 85°F and 90% relative humidity until the sprouts are 1 to 1.5 inches long (20 to 28 days). Seed roots can then be bedded. Bed seed stock in land not planted with sweetpotato for 3–5 years, and cover with 2 to 3 inches of soil. Fertilize with 75 pounds of 8-8-8 or its equivalent per 100 square yards of bed space. Cover beds with clear or black plastic to promote earliness. The plastic should be left on the bed until danger of frost has passed. Plastic should be ventilated after 7 days with one 2-inch hole every 4 linear feet of bed to prevent accumulation of carbon dioxide. Clear or white plastic may also be used over greenhouse hoops with thermostatically controlled fans and vents. Keep beds moist and temperature between 75° to 85°F.

About 500 sprouts can be produced from 1 bushel of seed stock. One bushel of seed stock requires 20 to 30 square feet of bed area. When sprouts are ready to be transplanted, they should be cut from the beds by snipping above (1") the soil line. This minimizes the transfer of diseases that could be on sweetpotato roots (scurf and other root rots).

Field Planting. Plant in the field as indicated in the following table for your area. Well-rooted, 8 to10-inch long sprouts can be set with the transplanter on ridges 8 to 10 inches high. Row spacing is 36 to 48 inches; distance between plants in the row is 8 to 14 inches. Use a high-phosphate starter solution (15–30–15 or equivalent at the rate of 3 pounds in 50 gallons of water) during transplanting.

SWEETPOTATO PLANTING DATES

AL North	5/1–6/30	MS	4/25–5/20
AL South	3/15–5/15	NC East	5/1–7/15
GA North	5/15–6/15	NC West	5/25–6/30
GA South	4/1–6/15	SC East	4/15–6/15
KY East	5/20-6/1	SC West	5/1–6/15
KY Central	5/10-6/10	TN East	5/15-6/30
KY West	5/1-7/15	TN West	5/1-6/30
LA North	5/1–6/30		
LA South	4/15–6/30		

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Lepidoptera Larvae: Sweetpotato hornworm, corn earworm, southern armyworm, yellowstriped armyworm, beet armyworm, fall armyworm, and soybean looper all feed on foliage leaving small to large holes. In plant beds and newly set fields, damage may be serious. Mid to late season foliar feeding may reduce yields or delay sizing of roots when coupled with plant stress. After harvest, larvae may continue feeding on sweetpotatoes left in the field and in storage. Apply insecticide to plant beds and in fields as needed. Cuttings should be free of insects before planting. Where worms are abundant at harvest, spray fields 2 to 3 days before digging. Remove harvested sweetpotatoes from the field immediately.

Cucumber Beetles (rootworms): Adults and larvae of the banded cucumber beetle, *Diabrotica balteata*, and the spotted cucumber beetle, *Diabrotica undecimpunctata* feed on sweet potato. Both species are highly mobile and will also feed on several other host plants including, various vegetable plant species, soybeans, and corn. Adult beetles feed on sweet potato foliage, creating irregular holes in the leaves. Adult beetles lay eggs in the soil and larvae developing in the soil feed on developing sweet potato roots. Feeding on the roots can occur throughout the production season, but damage from these insects increases late season. Feeding injury results

in unsightly blemishes on the roots at harvest. The larval stage lasts from 8-30 days depending on the temperature and food supply. Pupae are found just below the soil surface. Adults will emerge in approximately one week. Numerous generations of these insects can develop and injure sweet potatoes throughout the production season. Soil applied insecticides can reduce damage from these insects if applied close to planting. Adults should be scouted weekly during the production season and labeled insecticides should be applied when the number of beetles sampled reaches or exceeds the treatment threshold of 2 beetles/100 sweeps.

Tortoise Beetle: Generally, damage by tortoise beetles threatens newly set plants or plants under stress. Leaves of infested plants are riddled with large, round holes. Adults and larvae which feed on sweetpotato foliage include: mottled tortoise beetle, striped tortoise beetle, and argus tortoise beetle, blacklegged tortoise, and golden tortoise beetle. Isolate plant beds and control morningglory. Monitor movement of ornamental sweetpotatoes which often contain tortoise beetles and other insects. Apply insecticides to young plants if needed. Control beetles in plant beds and fields.

Sweetpotato Weevil: This is the most serious worldwide pest of sweetpotatoes. Adults and larvae feed on foliage, but prefer stems and roots. Infested sweetpotatoes are riddled with small holes and galleries especially in the stem end. They turn bitter and are unfit for consumption by either humans or livestock. Use only "seed" and plants produced in approved and trapped weevil-free areas. All purchased roots/plants, including those produced out-of-state, must be certified. Use pheromone traps in plant beds, greenhouses, and in fields to detect sweetpotato weevil. Some varietal tolerance exists. Chemical control with weekly or biweekly sprays is difficult; however, sweetpotato weevil is not in commercial production areas in Alabama, Louisiana, Mississippi, North Carolina or South Carolina.

Sweetpotato Flea Beetle: Adult beetles overwinter in debris, along fence rows, and at the edges of wooded areas. In the spring, eggs are laid in the soil near host plants. There are several generations per year. Adults feed on foliage leaving channels on the upper leaf surfaces. Larvae feed on roots etching shallow, winding, sunken trails on the surface, which enlarge, darken and split. Monitor adults with yellow sticky cups. Control morningglories and weeds along field margins and plow under crop debris. Use resistant or tolerant varieties. Beauregard is very susceptible to flea beetles. In fields with a history of infestation use a preplant or a side-dressed soil insecticide over the foliage up to the last cultivation. Control adults with insecticides.

Whitefringed Beetle: Larvae feed on roots causing damage similar to that of wireworms and white grubs. Only flightless, female adults occur and feed at the base of plants leaving scars on the stem. They also feed and notch leaves. They are most active in July and August and produce eggs in groups without mating. Avoid infested fields and rotate crops. Only grasses are not suitable as hosts. Monitor for adults or leaf notching. Limited control may be achieved by using tolerant varieties, foliar insecticides applied every two weeks and soil insecticides. Record whitefringed beetle sites and do not plant sweetpotatoes in these locations.

Wireworms: Tobacco wireworm, southern potato wireworm, corn wireworm leave small, irregular, shallow or deep holes in the surface of sweetpotato roots. Larvae are identified by differences in their last abdominal segment. Wireworm adults (click beetles) lay their eggs in grassy, undisturbed soil. Adults feed on weed seeds (pigweed) and corn pollen. Avoid land previously in sod or fallow. Wireworms may be detected prior to planting using corn, wheat, or oatmeal bait stations. If necessary, broadcast and incorporate a preplant insecticide, or use a granular material at root swell. Timed foliar sprays are of limited value, as adults do not feed on sweetpotato and are only controlled when sprays contact adults or larvae move into a treated area. Control weeds and do not allow them to mature to seed. Resistant varieties are available. Avoid planting in fields with corn wireworm. Avoid planting behind corn, grain, and grain sorghum. Tobacco wireworm adults can be monitored with yellow sticky cups. Wireworm adults are attracted to black-light insect traps.

White Grubs: These can cause large, shallow, irregular damage on the surface of sweetpotatoes. Species include Japanese beetle, spring rose beetle, and green June beetle. Adults lay eggs in grassy areas (also see section on wireworms). Pheromone traps are under evaluation. Japanese beetles are attracted to traps. White bucket traps attract spring rose beetles. Use a preplant insecticide and foliar sprays when adults are active.

Fruit Fly: Fruit flies may be a nuisance in storage houses when sweetpotatoes decay due to other causes such as souring, chilling, and Rhizopus soft rot. Fruit flies feed on decaying vegetables. Maggots may be seen in decaying roots. Fruit flies may become established in cull piles and spread to the storage house. They do not cause rots. Harvest, cure and store only sound sweetpotatoes. Dispose of culls, inspect the storage house and use traps. If necessary, spray with an appropriate insecticide.

PRODUCING QUALITY SWEETPOTATOES

Quality sweetpotatoes are the result of sound production, pest management, and handling practices. The market place demands a high quality sweetpotato root. Tolerant cultivars to some diseases and insects exist. *Hayman*, *Regal*, *Sumor* and *Resisto* have some tolerance to insects. *Jewel* is tolerant to sweetpotato flea beetle. Cultivar tolerance exists to such diseases as bacterial root rot, *Fusarium* wilt, *Rhizopus* soft rot, soil rot, and Sweetpotato Feathery Mottle Virus. Some cultivars are resistant to nematodes.

HARVESTING AND STORAGE

A 3 to 4 month growing season is required for root development. After the roots are dug, they should be cured in the storage house at 80° to 85°F and 90% relative humidity for 6 to 8 days. After curing, temperature should be lowered to 55°F, but relative humidity should be maintained at 85%. Temperature should never go below 50°F or chilling injury may result, depending on length of exposure. Above 60°F, sprouting will occur and root weight decrease. See Table 14 for further postharvest information.

TOMATOES

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
TOMATOES								
Fresh Market								
Amelia VR [2, 10, 11, 12, 18]		G	K	L	M	N	S	
Applause [8, 10, 11, 15, 25]	A				M			
Bella Rosa [2, 3, 8, 10, 11, 15, 18]	A	G		L	M			
BHN 589 [10, 11, 18, 20, 25]	A				M			
BHN 602 [2, 10, 11, 12, 18]	A	G	K	L	M	N	S	T
BHN 640 [2, 10, 11, 12, 18]	A	G	K		M	N	S	T
Big Beef [8, 10, 11, 14, 15, 18, 25]			K	L	M			
Carolina Gold [10, 11, 17, 18]	A	G	K	L	M	N	S	T
Celebrity [25]	A					N		T
Crista [2, 10, 11, 12, 14, 18]	A	G	K	L	M	N	S	T
Finishline [2, 10, 11, 12, 15, 18]	A			L				
Fletcher [2, 14]	A					N		T
Floralina [8, 10, 11, 12, 15, 18]	A		K	L		N	S	T
Florida 47R [8, 10, 11, 15, 18]	A	G	K	L	M	N	S	T
Florida 91 [3, 8, 10, 11, 15, 18]				L	M			T
Mountain Crest [10, 11, 18]	A	G	K	L		N	S	T
Mountain Fresh Plus [10, 11, 14, 18, 19]	A	G	K	L	M	N	S	T
Mountain Glory [2, 10, 11, 12, 18]	A		K			N		T
Mountain Magic [10, 11, 18, 19, 24]	A	G	K	L	M	N	S	T
Mountain Spring [10, 11, 15, 18, 25]	A	G	K	L	M	N	S	T
Phoenix [3, 8, 10, 11, 15, 18]	A	G	K	L		N		T
Primo Red [2, 10, 11, 15, 16]	A					N		T
Red Deuce [8, 10, 11, 15, 18, 20]	A				M			
Red Defender [2, 8, 10, 11, 15, 18, 25]	A	G	K	L				T
Redline [3, 10, 11, 12, 18]	A	G		L				
Red Morning [2, 10, 11, 12, 18]	A							
Red Mountain [2, 10, 11, 12, 14, 18]	A							
Rocky Top[10, 11, 12, 15, 18, 25]	A		K		M	N	S	
Solar Set (Fall only) [3, 8, 10, 11, 18]			K	L	M	N	S	
Talladega [2, 10, 11, 15]		G		L				
Tygress [10, 11, 15, 18, 21]				L				
Cherry Types								
Cherry Grande [8, 10, 11, 15, 18]	A	G	K	L	M	N	S	T
Marcelino [6]						N		
Mountain Belle [10, 18]	A	G	K	L	M	N	S	T
Sun Gold [17]	A			L	M	N		T
Grape Types								
Cupid [8, 9, 10, 15]	A	G						T
Elfin [7]	A	G				N	S	
Golden Sunshine [22]	A							T
Jolly Elf [11, 18]	A	G			M	N	S	T
Navidad [11]	A	G	K		M	N	S	
Rosa	A					N		
St. Nick	A	G			M	N		
Smarty [10, 18]	A					N	S	T

[1] Abbreviations for state where recommended.
[2] Tomato Spotted Wilt Virus resistance (TSWV).
[3] Heat set (heat tolerance).
[4] Southern Bacterial Wilt resistance.
[5] Local markets only.
[6] Super sweet medium sized cherry,superior quality.
[7] Determinant grape tomato.
[8] *Alternaria* Stem Canker tolerance/resistance (ASC).
[9] Bacterial Speck tolerance/resistance (BSK-0).
[10, 11, 12] *Fusarium* Wilt race 1, 2 or 3 tolerance/resistance (F).
[13] *Fusarium* Crown Root Rot tolerance/resistance (FCRR).
[14] Nematode resistance (N).
[15] Gray Leaf Spot resistance (St).
[16] Tobacco Mosaic Virus resistance (TMV).
[17] Yellow fruit.
[18] *Verticillium* Wilt resistance (V).
[19] Early Blight tolerance.
[20] Tomato Mosaic Virus resistance (ToMV).
[21] Tomato Yellow Leaf Curl Virus resistance (TYLCV).
[22] Orange fruit.
[23] Salad size (Campari type).
[24] Late blight tolerance/resistance.
[25] Suitable for high tunnel production.
[26a-e] *Cladosporium* race A,B, C, D, E tolerance/resistance.
[27] Powdery mildew tolerance/resistance.

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
TOMATOES (cont'd)								
Roma Types								
BHN 410 [9, 10, 11, 18]	A	G				N	S	T
Mariana [8, 10, 11, 14, 15, 18]						N		T
Muriel [2, 8, 10, 11, 14, 15, 18]	A	G	K					T
Picus [2, 8, 10, 15, 18]	A						S	
Plum Crimson [10, 11, 12, 18, 19]	A	G	K			N		T
Plum Regal [2, 10, 11, 18, 19, 24]	A		K	L		N	S	T
Pony Express [9, 10, 11, 12, 14, 18, 20]			K					T
Sunoma [9, 10, 11, 14, 15, 18, 20]								T
Greenhouse Types – Beefsteak								
Big Dena [10, 11, 13, 16, 18]	A			L	M			
Geronimo [11, 13, 16, 18, 26a-e, 27]	A		K	L	M			T
Starbuck [10, 13, 18, 20, 26a-e]	A			L	M			
Torero [11, 13, 16, 18, 26a-e, 27]	A			L	M			
Trust [11, 13, 16, 18, 26a-e]	A	G	K		M	N		T

[1] Abbreviations for state where recommended.
[2] Tomato Spotted Wilt Virus resistance (TSWV).
[3] Heat set (heat tolerance).
[4] Southern Bacterial Wilt resistance.
[5] Local markets only.
[6] Super sweet medium sized cherry,superior quality.
[7] Determinant grape tomato.
[8] *Alternaria* Stem Canker tolerance/resistance (ASC).
[9] Bacterial Speck tolerance/resistance (BSK-0).
[10, 11, 12] *Fusarium* Wilt race 1, 2 or 3 tolerance/resistance (F).
[13] *Fusarium* Crown Root Rot tolerance/resistance (FCRR).
[14] Nematode resistance (N).
[15] Gray Leaf Spot resistance (St).
[16] Tobacco Mosaic Virus resistance (TMV).
[17] Yellow fruit.
[18] *Verticillium* Wilt resistance (V).
[19] Early Blight tolerance.
[20] Tomato Mosaic Virus resistance (ToMV).
[21] Tomato Yellow Leaf Curl Virus resistance (TYLCV).
[22] Orange fruit.
[23] Salad size (Campari type).
[24] Late blight tolerance/resistance.
[25] Suitable for high tunnel production.
[26a-e] *Cladosporium* race A,B, C, D, E tolerance/resistance.
[27] Powdery mildew tolerance/resistance.

Seed Treatment. To minimize the occurrence of bacterial canker, bacterial spot, and bacterial speck, seed should be treated with chlorine. If seed is not treated with chlorine by the seed company, then dip seed in a solution containing 1 quart of household bleach and 4 quarts of water plus one-half teaspoon of surfactant for 1 minute. Provide constant agitation. Use 1 gallon of solution per pound of seed. Prepare a fresh solution for each batch of seed. Wash seed in running water for 5 minutes and dry seed thoroughly. The final rinse should be done with acidified water (1 oz. vinegar per gallon of water).

TOMATO PLANTING DATES

	Spring	Fall
AL North	4/15–6/15	7/1-8/1
AL South	3/1–4/30	7/15–8/30
GA North	4/15–6/15	7/1-8/1
GA South	3/1–4/30	7/15–8/30
KY East	5/15-6/1	NR
KY Central	5/5-6/15	NR
KY West	4/20-7/1	NR
LA North	3/15–6/30	7/1–8/10
LA South	3/1–6/30	7/15–8/15
MS North	4/20–6/30	NR
MS South	3/1–3/15	NR
NC East	4/15–5/10	8/1–8/15
NC West	5/15–7/15	NR
SC Coastal Island	3/1-4/30	7/1-7/15
SC East	3/15–4/30	7/1–7/15
SC West	5/1–6/30	NR

TOMATO PLANTING DATES (cont'd)

	Spring	Fall
TN East	5/1-6/30	NR
TN West	4/20-6/20	NR

Hardening Transplants. It is usually desirable to harden tender tomato seedlings before planting them in the field. Recent research has shown that hardening tomato plants by exposure to cool temperatures (60° to 65°F/day and 50°to 60°F/night) for a week or more causes catfacing. Harden plants by withholding water. Allow plants to wilt slightly between light waterings. Do not harden transplants by withholding fertilizer.

Drip Fertilization. Before mulching, adjust soil pH to 6.5 and, in the absence of a soil test, apply enough fertilizer to supply 50 pounds per acre of N, P_2O_5 and K_2O, (some soils will require 100 pounds per acre of K_2O) then thoroughly incorporate into the soil.

After mulching and installing the drip irrigation system, the soluble fertilizer program should be initiated according to that described in the following table. On soils testing low to low-medium boron, also include 0.5 pound per acre of actual boron.

The first soluble fertilizer application should be applied through the drip irrigation system within a week after field-transplanting the tomatoes. Continue fertigating until the last harvest.

SUGGESTED FERTIGATION SCHEDULE FOR TOMATO* (low soil potassium)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			50.0	125.0
0–14	0.5	0.5	57.0	132.0
15–28	0.7	1.4	66.8	151.6
29–42	1.0	2.0	80.8	179.6
43–56	1.5	3.0	101.8	221.5
57–77	2.2	4.4	148.0	313.9
78–98	2.5	5.0	200.5	418.9

SUGGESTED FERTIGATION SCHEDULE FOR TOMATO* (high soil potassium)

Days after planting	Daily nitrogen	Daily potash	Cumulative	
			Nitrogen	Potash
	(lb / A)			
Preplant			50.0	125.0
0–14	0.5	0.5	57.0	132.0
15–28	0.7	0.7	66.8	141.8
29–42	1.0	1.0	80.8	155.8
43–56	1.5	1.5	101.8	176.5
57–77	2.2	2.2	148.0	223.0
78–98	2.5	2.5	200.5	275.5

*Adjust based on tissue analysis.

Fresh Market. Yield, fruit size, and fruit quality of fresh market tomatoes are increased by the use of black plastic mulch in combination with drip irrigation. When air temperature exceed 85F use white on black plastic mulch, or paint black plastic with a 5:1 (v/v) mixture of exterior, flat white latex paint and water. Form-raised, dome-shaped beds to aid in disease control. Lay black plastic mulch tightly over the beds.

See the "Drip Irrigation" section of General Production Recommendations for detailed recommendations on fertilizing tomatoes grown with plastic mulch and drip irrigation. Lay black plastic mulch tightly over the beds.

Ground Culture. Space *determinate* varieties in rows 4 to 5 feet apart with plants 15 to 24 inches apart in the row. For *indeterminate* varieties, space rows 5 to 6 feet apart with plants 24 to 36 inches apart in the row.

Stake Culture. Staking tomatoes is a highly specialized production system. The following recommendations are for the short-stake cultural system using determinate cultivars that grow 3 to 4 feet in height or for indeterminate varieties that grow 6 to 7 feet in height. Use between row spacings of 5 to 6 feet with in-row spacings of 18 to 24 inches. See state specific guides for a full description of staking.

Pruning: Pruning is practiced to establish a desired balance between vine growth and fruit growth. Little to no pruning results in a plant with a heavy load of smaller fruit. Moderate pruning results in fewer fruits that are larger and easier to harvest. Pruning can result in earlier maturity of the crown fruit and improves spray coverage and pest control.

Removing all suckers up to the one immediately below the first flower cluster is adequate for most determinate cultivars. Removing the sucker immediately below the first flower cluster or pruning above the first flower cluster can result in severe leaf curling and stunting of the plant and should be avoided.

Prune when the suckers are no more than 2 to 4 inches long. A second pruning may be required to remove suckers that are too small to be easily removed during the first pruning and to remove ground suckers that may develop. Pruning when suckers are too large requires more time and can damage the plants, delay maturity, and increase disease incidence. Do not prune plants when they are wet to avoid spread of diseases. Pruning should be done before the first stringing because the string can slow the pruning process. Pruning is variety-and fertility-dependent.

Less-vigorous determinate cultivars generally require less pruning. Growers should experiment with several degrees of pruning on a small scale to determine pruning requirements for specific cultivars and cultural practices.

***Staking*:** Staking improves fruit quality by keeping plants and fruit off the ground and providing better spray coverage. Staked tomatoes are easier to harvest than ground tomatoes.

Staking tomatoes consists of a series of wooden stakes with twine woven around the stakes to train the plants to grow vertically off the ground. Stakes 4 to 4.5-feet long by 1-inch square are driven about 12 inches into the soil between the plants.

Vigorous cultivars may require larger and longer stakes. A stake placed between every other plant is adequate to support most determinate varieties. Placing an additional stake at an angle and tied to the end stake of each section will strengthen the trellis system. Stakes can be driven by hand with a homemade driving tool or with a commercially available, power-driven stake driving tool. Drive stakes to a consistent depth so that spray booms can be operated in the field without damaging the trellis system.

Select "tomato twine" that is resistant to weathering and stretching and that binds well to the wooden stakes. Tomato twine is available in 3- to 4-pound boxes. Approximately 30 pounds of twine is required per acre. To make tying convenient, use a homemade stringing tool. This tool can be made from a length of metal conduit, schedule 40PVC pipe, broom handle, or wooden dowel. With conduit, the string is fed through the pipe. With a broom handle or wooden dowel, two small parallel holes, each about 1 inch from the end, must be drilled to feed the string through one hole along the length of the tool and through the other hole. The tool serves as an extension of the worker's arm (the length cut to the worker's preference) and helps to keep the string tight.

Proper stringing consists of tying the twine to an end stake passing the string along one side of the plants, and then looping the twine around each stake until the end of a row or section (100-foot sections with alleys may be helpful for harvesting) is reached. The same process is continued on the other side of the row. The string tension must be tight enough to hold the plants upright. **Note:** If strings are too tight, they can make harvesting fruit difficult and can scar fruit.

The first stringing should be strung 8 to 10 inches above the ground when plants are 12 to 15 inches tall and before they fall over. Run the next string 6 to 8 inches above the preceding string before plants start to fall over. Three to four stringings are required for most determinate varieties. Stringing should be done when the foliage is dry to prevent the spread of diseases.

Heirloom Tomatoes. Heirloom tomatoes are varieties that have been available for 50 years or more, are open pollinated, and grow "true to type" from seed saved from fruit each year. They are generally indeterminate, requiring trellising and constant pruning. Most varieties have little disease resistance. The fruit are usually thin-skinned, soft, and tend to crack. Consumers are attracted to heirloom tomatoes because many varieties are very flavorful, colorful, come in many sizes and shapes, and have interesting names. For the growers, heirloom tomatoes are challenging to produce and difficult to ship, but can bring high prices on the local market.

There are hundreds of varieties of heirloom tomatoes available. Some of the most popular varieties include Brandywine, German Johnson, Mr. Stripey, Cherokee Purple, and Green Zebra.

Because most heirloom tomatoes are indeterminate, they must be grown on a tall, strong trellis. A trellis can be constructed of 3 inch diameter, or larger, posts set 10-15 feet apart within the row. Use 7-8 ft. long posts, leaving 6-7 ft. above ground. Run a stout wire (12 gauge) across the tops of the posts and secure it with staples. Pieces of twine, long enough to reach the ground, should be tied to the top wire above each plant. The twine can be anchored with a loop to each plant or to a bottom line of twine that is strung about 6 in. off the ground and secured to the posts. Some growers use the standard string and weave-staked culture system for heirloom tomatoes, as described for the determinate tomatoes, but they use 6-ft. long stakes instead of the normal 4-ft. long stakes.

In a trellis system, plants are usually spaced 8-10 in. apart within the row and pruned to a single stem system. A two stem system may also be used, in which the plants should be spaced 18-30 in. apart within the row. If using a standard staking system, plants should be spaced 18-24 in. apart. Once the plants are established, suckers must be removed several times a week. If the main growing point is broken off, a sucker can be trained to take its place.

Because most heirloom tomatoes have little disease resistance, it is important to maintain a good fungicide spray schedule. For organic production, it might be necessary to grow heirloom tomatoes under high tunnels, especially in areas with high disease pressure. Grafting heirloom varieties onto diseases resistant rootstocks might also increase your success at growing organically.

TOMATO DISORDERS

Your local county Extension office has bulletins that describes fruit disorders in detail. Here are several common disorders of tomato and their causes: **catfacing** (cool day and/or night temperatures or very hot dry days), **internal browning, graywall and blotchy ripening**, (tobacco mosaic virus, overcast cloudy environment, high N, low K or soil compaction), **yellow shoulder** (direct sun exposure, worse on green shouldered varieties), **sunburn and sunscald** (direct rapid exposure to the sun), **weathercheck** (fruit exposed to dew), **blossom end rot** (low soil calcium and/or soil moisture), **cracking** (variety, irregular water, growth, and/or nutrition).

SPECIAL NOTES ON PEST MANAGEMENT

INSECT MANAGEMENT

Colorado Potato Beetle (CPB), Flea Beetles (FB): While flea beetles are a common pest of tomato throughout the southeastern US, Colorado potato beetle are most common in areas where significant acreage of potatoes is also grown. Flea beetles are primarily a problem early in the season shortly after planting, and are usually controlled by insecticides applied for other insects. Adults feed on foliage, resulting in small round holes on leaves. In most situations this damage does not affect early season growth or subsequent yields, but control may be necessary when populations are high (20-30% defoliation).

Colorado potato beetle adults and larvae feed on tomato foliage and can cause extensive defoliation if not controlled. CPB feed only on solanaceous plants, and populations tend to be concentrated in areas where potato, eggplant and tomato have previously been grown. Consequently, rotation to non-solanaceous crops is very effective in helping to avoid infestations. Thoroughly scout fields and spray only when necessary. Treatment should be made if populations exceed 15 adults per 10 plants or a combination of 20 CPB larvae and/or adults per 10 plants. Insecticide sprays should be made after most egg masses have hatched, but before larvae become large. CPB have developed resistance to many different insecticides, so knowledge of the resistance status of populations is essential in choosing which insecticides to use.

Tomato Fruitworm: The tomato fruitworm, also known as the corn earworm and cotton bollworm, is potentially the most damaging pest of tomato. However, there are many insecticides that provide excellent control. The key to controlling this insect is to ensure that there is a toxic pesticide residue on the plant during egg laying periods so that larvae are killed shortly after hatching, because larvae feed on leaf tissue for only a short time before boring into fruit. Tomato fruitworm moth activity can be monitored with pheromone traps and serves as a measure of the adult population within an area. Corn that is in the silking stage is a preferred host of fruitworm, but when corn silks begins to dry, moths will switch egg laying to other hosts, including tomato.

Armyworms: At least three species of armyworms are potential pests of tomato, including the beet armyworm, southern armyworm and yellowstriped armyworm. Infestations are usually sporadic in the more northern regions of the southeastern US, but are an annual problem in more southern areas. In contrast to tomato fruitworm, armyworms will also feed extensively on foliage as well as fruit, and the presence of feeding damage on leaves can help differentiate between fruitworm and armyworm damage. Beet armyworm is notorious for exhibiting resistance to a wide range of insecticides, but the recent registration of newer insecticides has greatly aided the management of this pest.

Tomato Pinworm: The tomato pinworm is more common in the southern compared with northern regions of the southeast, but late-season infestations are common in northern areas. Moths lay eggs on foliage, and larvae feed within leaves, creating blotchy mines. As larvae increase in age they bore into stems and/or fruit. The use of pheromone-based mating disruption is an effective control method. Initiate mating disruption at the first sign of mines on foliage. Numerous insecticides also control pinworm.

Stink Bugs: The green and brown stink bug can be important direct pests of tomato, but they are sporadic in occurrence. Stink bugs are most common in smaller fields (i.e., 5 acres or less) that are surrounded by weedy borders, or fields that are adjacent to soy-

beans. In fact, chemical control of stink bugs is often not necessary in fields that do not fit the previous description. Unfortunately, there is not a good sampling method to assess population densities before damage occurs, and preventive strategies are used. Depending on the surrounding habitat and abundance of stink bugs within an area, one to three applications of an insecticide are necessary to prevent damage.

Thrips: Thrips can cause direct damage to tomato fruit by their feeding or oviposition scars on small fruits, and are also indirect pests of tomato due to their ability to transmit tomato spotted wilt virus (TSWV). The tobacco thrips and western flower thrips are vectors of tomato spotted wilt virus. The majority of virus infections are the result of primary spread (thrips transmitting the virus from surrounding weeds directly to tomatoes or greenhouse infections), and insecticides do not kill thrips quickly enough to prevent inoculation. However, an aggressive early insecticide control program early in the season (3 to 4 weeks after transplanting) and the use of reflective mulches have helped to reduce the incidence of TSWV in tomatoes. Thrips can also cause direct damage to tomato fruit. This is the result of thrips feeding and/or laying eggs in small fruits before stamens are shed from flowers. This damage appears as small dimples in fruit. Sample thrips in tomato flowers by placing a white index card below flowers and tapping the flowers with a finger. An average of 1 thrips per flower has worked well as a treatment threshold level.

Whiteflies: The greenhouse whitefly and silverleaf whitefly can both infest tomatoes in the southeast. Generally, the silverleaf whitefly is more common in the southern region and the greenhouse whitefly is more common in the northern region of the southeast. Once whitefly populations of either species become established on a crop, they are very difficult to control. Therefore, preventive control is usually necessary for effective, season-long management. Preventive control can be achieved with soil-applied systemic insecticides applied to the soil or at planting, or the application of other insecticides when populations are low.

Mites: Mites have become an increasingly important problem on tomatoes and other vegetables grown in the southeast. Twospotted spider mite is the most common mite pest, but the broad mite and carmine spider mite can also infest tomatoes. Mites overwinter on weeds and move into tomatoes in the spring as weeds die. Mites can also move from other crops (including other tomato fields) into tomatoes throughout the season. Localized infestations can be spot treated, but thorough coverage of foliage is important. Mites can be sampled by using a sample of 10 leaflets (terminal leaflet on a leaf from the upper one-third of the plant), from a minimum of 5 sample sites per field. When mites reach an average of 2 mites/leaflet, a miticide should be applied. Note that certain pesticides, such as pyrethroids and some neonictinoids, aggravate mite populations and can lead to high mite densities.

DISEASE MANAGEMENT

Damping-Off: *Plantbed:* Use seed treatment and plant in a disease-free mix.

VIRUSES

Aphid-transmitted Viruses (TMV, PVX, CMV, TEV, PVY): Use tolerant or resistant varieties to control these viruses when available and provided that the fruit quality is consistent with market demands. Use these varieties in areas where these viruses have been prevalent or when high aphid pressure is expected. Generally, these viruses cannot be adequately controlled with insecticide applications, but symptom expression can be delayed through their use combined with the use of reflective mulches.. Because aphids transmit these virus, growers may wish to use yellow trap pans containing water to determine when mass flights of winged aphids occur.

Thrips-transmitted Viruses (Tomato Spotted Wilt Virus, TSWV): Use tolerant or resistant varieties. TSWV can be severe on tomatoes during both greenhouse production of transplants and during field production of the crop. The virus is spread to tomatoes by thrips. During transplant production, thrips transmit the virus from infected ornamental plants (flowers). Be sure not to grow any ornamental bedding plants in the same greenhouse as tomato transplants. Monitor greenhouses and scout fields for thrips. Begin an insecticide program BEFORE a problem is observed.

Nematode Management. Use nematicides listed in the "Nematode Control in Vegetate Crops" table in the Disease Control section.

HARVESTING AND STORAGE

See Table 14 for postharvest information.

WATERMELON

VARIETIES[1]	AL	GA	KY	LA	MS	NC	SC	TN
WATERMELONS								
Diploid, Open-pollinated								
AU Producer [IR]	A	G						
Crimson Sweet [MS]	A	G		L	M	N	S	T
Jubilee II [IR]	A	G		L	M	N	S	T
Diploid, Hybrid								
Jamboree [IR]		G		L		N	S	T
Lemon Krush [2, IR, PM]	A	G			M		S	
Mardi Gras [R]	A	G				N	S	T
Regency [IR]	A	G		L		N		
Royal Sweet [R]	A	G	K	L	M	N	S	T
Sangria [R]	A	G	K	L		N	S	
Sentinel [S]						N		
Starbrite [S]	A	G	K	L	M	N	S	T
Summer Gold [2, 4]	A			L		N		
Top Gun	A	G				N	S	
Icebox								
Mickylee [R]	A	G		L	M	N	S	
Sugar Baby [S]			K	L				T
Triploid								
Amarillo [2, S]							S	
Buttercup [2, S]	A	G				N	S	T
Crunchy Red [S]	A	G	K			N	S	T
Declaration [S]	A		K			N	S	
Distinction [IR]	A				M	N	S	
Fascination [R]	A	G				N	S	
Gypsy [S]		G	K			N	S	T
Imagination [S]		G	K			N	S	T
Liberty [S]	A	G		L		N	S	T
Liberator [S]	A					N	S	
Majestic [S]	A				M	N	S	
Matrix [IR]		G				N	S	T
Melody [IR]	A		K		M	N	S	
Millionaire [MS]	A	G		L	M	N	S	T
Orange Crisp [3]	A					N		
Premiere [S]						N	S	
Revolution [R]	A	G	K	L	M	N	S	T
Superseedless 7187Hq [S]	A	G		L		N	S	
Sweet Polly [IR]	A					N	S	
Tri-X Palomar [S]	A					N	S	T
Tri-X 212 [S]	A	G				N	S	T
Tri-X 313 [S]	A	G	K	L	M	N	S	T
Vagabond [IR]						N	S	
Wrigley [S]		G				N	S	
Triploid Mini *(NOTE: many of these varieties only available under contract)*								
Bambino [S]					M	N	S	
Extazy	A	G				N	S	T
Leopard [S]			K			N		T
Mielheart [S]	A	G				N	S	
Sweet Bite	A	G				N	S	
Vanessa [S]	A	G				N	S	T

[1] Abbreviations for state where recommended.
[2] Yellow flesh fruit.
[3] Orange flesh fruit.
[4] Local markets only.
[MS] Moderately susceptible to *Fusarium* wilt race 1.
[IR] Intermediate resistance to *Fusarium* wilt race 1.
[S] Susceptible to *Fusarium* wilt race 1.
[R] Resistant to *Fusarium* wilt race 1.
[PM] Powdery mildew tolerance/resistance.

Seed Treatment. Check with seed supplier to determine if seed has been treated with an insecticide or fungicide. Be sure that seeds have been assayed for bacterial fruit blotch.

Plant Production. Transplants should be grown in containers that provide a space of at least 1.5 inches by 1.5 inches for each plant. Smaller pots or cells will restrict root growth and provide less protection to the newly set transplant. If the seed is of good quality with high germination, one seed per pot is sufficient. The seed coat of seedless watermelons tends to adhere to the seedling as it emerges, at times slowing growth or reducing stand. Seedless watermelon seed must be planted with the point of the seed facing up (root end). Temperatures in the greenhouse should be maintained at 80° to 90°F. Growing media should be kept slightly drier than normal until 10 to 15% emergence, then resume normal watering. The required amount of seed can be estimated using Table 6.

Planting. *Transplants:* Transplant container-grown plants into plastic mulch when daily mean temperatures have reached 60°F. Planting dates vary, so consult the following table for your area. Early plantings should be protected from winds with row covers, rye strips, or windbreaks.

Seedless watermelons must be transplanted since these seed require a specific environment in order to achieve a high percentage of germination. (Seedless watermelons produce inadequate pollen, so a "pollenizer" variety is required to ensure good pollination of seedless watermelons.) Seeded (diploid) or specialized "pollenizers" must be used for seedless watermelon production.

Several seed companies have developed new varieties for use soley as a pollenizer. These pollenizers can be interplanted into a field totally devoted towards the production of triploid watermelons. Unique, compact growth habits prevent these pollenizers from competing for space with triploid plants.

POLLINATION AND PLANTING ARRANGEMENT WITH TRIPLOIDS

Fruit set and enlargement in watermelon is dependent upon growth regulators from pollen grains and from embryos in the developing seeds within the fruit. Inadequate pollination results in triploid watermelon fruit that are triangular in shape and of inferior quality. Additionally, inadequate pollination increases the incidence of hollowheart. Triploid watermelon flowers do not produce sufficient, viable pollen which is required to induce fruit set and development. Therefore, pollen from a "normal" (i.e., diploid/seeded) or a special pollenizer watermelon variety must be present. Fields should be interplanted with pollenizer plants or diploid watermelon plants in order to provide sufficient, viable pollen using one of the following methods.

There are two methods that can be used to incorporate pollenizer plants into the field. *Method 1: Use of a Dedicated Pollenizer Row.* Dedicated row pollenizer plantings place the pollenizer variety in the outside row and then every third or fourth row throughout the field. When using *Method 1*, it is important to use a pollenizer variety that is marketable because up to one-third of all watermelons produced in the field will be from this seeded variety. The rind pattern and/or shape of the fruit from the pollenizer must be easily distinguished from that of the fruit from the seedless variety in order to reduce confusion at harvest.

Method 2: Planting Pollenizer Within Each Row. A second method is to plant the pollenizer between every third or fourth plant within each row without changing the plant spacing of the seedless/triploid watermelons. When this method is chosen, the use of a special pollenizer is recommended. However, growers can use a normal diploid/seeded watermelon as a pollenizer. In this case, saleable watermelons are produced from the pollenizer requiring a market. The use of standard diploid variety when using *Method 2* might decrease the overall yields of the triploid plants. When selecting a diploid/seeded pollenizer variety that will also be harvested, growers must take into account market demand, plant vigor, pollen production, disease resistance, and environmental conditions.

Special pollenizer varieties have been developed solely for pollen production and most do not produce marketable fruit. The use of special pollenizers with *Method 2* allows the field to be dedicated to the production of seedless watermelons. Many growers prefer special pollenizers because they do not have markets for seeded watermelons. In addition, using a special pollenizer makes harvesting easier for crews who can more easily distinguish between fruit produced from the seeded, special pollenizer and fruit from the seedless watermelon varieties.

With *Method 2*, fruit of most special pollenizers are easily distinguishable from fruit produced by triploids in terms of size. If mini-seedless watermelons are planted; however, their rind pattern must be used to distinguish between fruit produced by the pollenizer and fruit produced by the mini seedless watermelons.

Special pollenizer varieties found to work well in the southeast are: Accomplice, Ace, Jenny, Patron, Pollimax, Sidekick and SP-5 (resistant to *Fusarium* wilt races 0, 1, and 2). Be sure to follow the seed suppliers' instructions when using a special pollenizer. New, improved specialized pollenizer varieties are continually being developed with better germination, flowering habit, and/or disease resistances/tolerances. **Under no circumstances should the pollenizer variety and the seedless variety be planted in separate or adjacent blocks! The pollenizer variety must be planted within 10 to 15 feet of the triploid variety to assure good pollination. Specialized pollenizer varieties should be placed within 10 feet of the planted triploids as these varieties tend to have less aggressive vining than normal seeded pollenizers.**

It is important that pollen from the diploid pollenizer variety be available when the female blossoms on the triploid plants are open and ready for pollination. As a general rule, the pollenizer variety should be seeded on the same day that the triploid seed is seeded in the greenhouse. Smaller seeded, slower to germinate pollenizers such as SP-5; however, should be planted one week prior to planting triploid seed.

Honeybees are important for high fruit yields and quality. Populations of pollinating insects may be adversely affected by insecticides applied to flowers or weeds in bloom. Apply insecticides only in the evening hours or wait until bloom is completed before application. See section on "Pollination" in the General Production Recommendations for further information.

Direct-seeded: Seed when soil temperatures reach 55°F. Seed 3 - 5 pounds of seed per acre. The recommended spacing for watermelons is 6 - 10 feet between rows with 24 - 30 square feet per plant.

WATERMELON PLANTING DATES

AL North	5/15–6/30	MS North	4/15–5/15
AL South	3/1–6/30	MS South	2/15–5/1
GA North	5/15–6/15	NC East	4/15–6/30
GA South	3/1–6/30	NC West	5/25–6/30
KY East	5/15-6/15	SC East	4/1–4/30
KY Central	5/5-7/1	SC West	4/15–6/15
KY West	4/20-7/15	TN East	5/5-6/30
LA North	3/10–6/30	TN West	4/25-5/30
LA South	3/1–7/5		

Drip Fertilization and Mulching. Before mulching, adjust soil pH to 6.5, and in the absence of a soil test, apply enough fertilizer to supply 50 pounds per acre of N, P_2O_5 and K_2O, (some soils will require 100 pounds per acre of K_2O) then thoroughly incorporate into the soil.

After mulching and installing the drip irrigation system, the soluble fertilizer program should then be initiated according to that described in the following table. On soils testing low to low-medium boron, also include 0.5 pound per acre of actual boron.

The first soluble fertilizer application should be applied through the drip irrigation system within a week after field transplanting or direct-seeding the watermelons. Continue fertigating until the last harvest.

SUGGESTED FERTIGATION SCHEDULE FOR WATERMELONS*

Growth Stage [1]	Days after planting	Daily nitrogen	Daily potash	Cumulative nitrogen	Cumulative potash
		(lb / A)			
Preplant				35.0	35.0
Planting to Vining	0 - 14	0.5	0.5	42.0	42.0
Vining to Flowering	15 - 28	1.0	1.0	56.0	56.0
Flowering to Fruit Set	29 - 49	1.5	1.5	86.0	86.0
Fruit Set to Initial Ripening	50 - 77	2.0	2.0	140.0	140.0
Harvest	78 - 91	1.0	1.0	153.0	153.0

*Adjust based on tissue analysis.

[1] Growth Stage can vary from season to season. For optimal results, fertigate watermelons based on their growth stage as opposed to days after planting.

MINI SEEDLESS WATERMELON

The mini seedless watermelon was introduced in 2003 and the demand for this product is year around. These fruit generally range from 3 to 7 pounds and offer an attractive alternative for the consumer that has limited refrigerator space or a small family. Besides the smaller size, some mini melons have a thinner fruit rind and are marketed as PureHeart. Although there is more edible flesh in mini watermelons marketed under the PureHeart label, these thinner rind mini watermelons might have a higher incidence of internal bruising. These fruit must be handled carefully to minimize bruising. Some varieties of mini seedless watermelons are grown under specific labels such as "PureHeart" but are only available under a contract basis. The varieties Bambino, Extazy, Leopard, Meilhart, Sweet Bite, and Vanessa are readily available to watermelon producers and are recommended for production in certain states. These varieties have performed well either commercially or in University trials.

Spacing trials have also been conducted with mini watermelons at various locations across the southeastern US. Generally, a mini watermelon plant requires 10 to 12 square feet per plant. For example, if rows are spaced on 8 ft. centers, mini watermelon plants should be spaced 15 inches apart within the row.

FUNGAL DISEASE MANAGEMENT

***Fusarium* Wilt:** *Fusarium* wilt of watermelon is widespread throughout the southeastern US. Most varieties of watermelon, other than heirloom varieties, are resistant to race 0. Many seeded (diploid), hybrid varieties are resistant to race 1, while all round, seedless (triploid) varieties are susceptible to race 1.

All commercial watermelon varieties are susceptible to race 2, which is present in parts of Florida, Georgia, and South Carolina. The superscripts "S" for susceptible, "MS" for moderately susceptible, "IR" for intermediate resistance, and "R" for resistant are listed next to each recommended variety. These superscripts indicate the reaction of commonly grown diploid and triploid varieties to race 1 of *Fusarium* wilt. Growers should choose resistant varieties whenever possible, including the pollenizers that they select for seedless watermelon production.

SPECIAL NOTES FOR PEST MANAGEMENT

INSECT MANAGEMENT

Cucumber Beetle: Watermelons are resistant to bacterial wilt; however, control may be needed to prevent feeding damage to seedlings. Treat when an average of two beetles per plant is found.

Aphids: Aphids can delay fruit maturation. Thorough spray coverage beneath leaves is important. For further information on aphid controls, see the preceding "Drip Fertilization and Mulching" section. Treat seedlings every 5 to 7 days or as needed.

Mites: Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow or maintain these areas after midsummer because this forces mites into the crop. Localized infestations can be spot-treated. **Note:** Continuous use of Sevin or the pyrethroids may result in mite outbreaks.

HARVESTING AND STORAGE

See Table 14 for postharvest information.

Soil Pests—Their Detection and Control

WIREWORMS

Wireworms injure vegetable crops by killing seeds or seedlings and tunneling and scarring tubers, roots, or bulbs.

Detection: The above injury to young plants or tubers frequently is sufficient evidence to warrant control measures. Further evidence can be obtained by sampling, using either of the following methods:

Method 1

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

Because wireworm infestations are often localized within a field, it will be necessary to place the bait stations randomly throughout the field such as placing two bait stations at the highest elevation in the field, then two stations on a slope and finally two stations in the lowest point in the field. One bait station per acre is desirable.

Follow this procedure for baiting:

1. Mix 1 cup of wheat, corn, or oat seed at each station.
2. Bury the bait about 4 inches deep. Cover the ground over each bait station with an 18-inch square of black plastic. The plastic collects solar heat and speeds germination of the corn and wheat, which entices overwintering wireworms.
3. Mark each station with a flag or stake.
4. Dig up the bait stations in 10 to 14 days and count the number of wireworms.

Method 2

1. Be sure the soil temperature at the 6-inch depth ranges between 45° and 85°F and that soil moisture is equivalent to that desired for planting.
2. Collect soil samples from 20 scattered sites per acre. Each sample should represent a soil profile 12 inches deep and 6 inches in diameter.
3. Sift soil and count wireworms.

Control: If you find an average of one wireworm per bait station (Method 1) or if you find five or more wireworms in 20 soil samples (Method 2), a labeled soil insecticide should be used. In some instances, several wireworms may be found in one bait station and none in others. Wireworm infestations tend to concentrate in some locations. It may be possible to limit treatment to areas of the field where the wireworm concentration is heaviest.

When to apply: Insecticides can be applied either in the spring or fall when the soil temperature at the 6-inch depth is at least 50°F and soil moisture is equivalent to that desired for planting. Frequently, the insecticide is applied immediately before planting. When early spring planting is required, a fall treatment is suggested.

What to Use: See the crop protectant section for each crop for appropriate chemical to use.

How to apply: When intended as a broadcast application, use a low-gallonage sprayer or granule distributor designed for low dosages. Immediately after application, mix insecticide with soil to a depth of at least 6 inches by disking twice in opposite directions.

In a band treatment as with potatoes, apply an appropriate soil insecticide at planting 3 to 6 inches deep along both sides of the row.

GARDEN CENTIPEDES (SYMPHYLANS)

Garden centipedes are arthropods that are related to insects. They feed on germinating seed and fibrous roots of many plants, including most vegetable species, and on decaying plant material. They are often associated with moist areas of a field and typically establish in spots or field edges. Rotation does not appear to be an effective control. If a spot becomes established, the crops planted into that area have a difficult time growing out of the damage, because the symphylans are continuously grazing on the fibrous roots.

Detection: The first symptom is an area or patch of poorly developing plants, similar to other root problems. Check the soil in these areas so that treatment can be made before planting the next crop, as there is no practical post-planting control. A common practice is to flag off the spot and treat that area with soil insecticides in the following fall or spring. Soil solarization has not been an effective control. It is reasonable to assume that symphylans can be transported in soil on field equipment. Dig up the soil and look for small, slender (less than 0.25 inch) white centipede-like animals that move quickly and try to avoid light. Another method of sampling is to drop the soil into a bucket of water. The symphylans will float to the top. Symphylans have 12 pairs of legs on 14 body segments. Do not confuse the symphylans with true centipedes—centipedes eat other arthropods and are considered beneficial. Symphylans have beaded antennae. Centipedes are not typically white in color and have large Chilicerae with venomous fangs. Dry or cold [less than 45°F] soil will reveal few, if any, symphylans.

When to treat: If samples are taken in the spring, control is generally warranted if there is an average of over two symphylans per shovelful of soil. Samples taken in September or October may average four or five per shovelful and will warrant treatment before the next crop. Insecticides are generally applied before spring planting, and fumigant treatments are usually made in the fall. Note: Effectiveness of soil-applied insecticides decreases as soil temperature decreases below 55°F.

What to use: See the crop protectant section for each crop for appropriate materials to apply. Apply fumigants in the same manner as described in the in the "Nematode Control in Vegetate Crops" table in the Disease Control section. Follow all label directions and restrictions when using these materials.

CUTWORMS

There are a number of cutworm species that attack vegetable plants. Some attack the tuber, spear, or fruit by chewing the edible portion, rendering them unmarketable. Others attack the seedlings or transplants, killing them outright or causing them to be unproductive. Cutworms are attracted to light and can lay eggs on transplants growing in greenhouses that are lighted at night. The cutworm eggs and larvae may be accidentally transferred to the field with the plants.

Most cutworms are night feeders and hide under sod clumps, stones, decaying vegetation, etc., during the day. Weedy or minimum-tillage fields are especially attractive egg-laying sites for cutworm adults (moths). During periods of drought, low-lying areas in fields are more subject to attack than other areas, presumably because of more desirable conditions.

Control: Where cutworms are suspected, a broadcast incorporation treatment may be necessary just before planting. This treatment should be worked into the soil immediately after applying and just before planting.

Even if a broadcast treatment is used, fields should be scouted for cutworm damage within a week of planting or plant emergence. If cutworms are actively cutting plants, a postplanting contact treatment maybe necessary. The following procedures may help improve control when a contact insecticide treatment is used:

1. Direct sprays at the base of the plants where cutworms are actively feeding.
2. Increase the amount of water used to at least 30 gallons per acre, especially in dry weather.
3. Spray between midnight and 5 A.M., when cutworms are most active.
4. Cultivate after insecticide application to improve contact with cutworms, especially in dry weather. In all cases, consult the label for application details.

GRUBS

Grubs are the larvae of Scarab beetles and can be serious soil pests in vegetable crops. Most vegetables can be attacked, and serious problems have occurred in potatoes, sweetpotatoes, beans, corn and spinach. Grubs cause damage by feeding on the roots and underground parts of the plant from one to several inches below the soil surface. The plants may yellow and wilt, which causes a pattern of patchy growth in fields where plants are dead or dying. If injured plants are pulled up, the roots will be found to have been eaten off, and usually the curve-bodied grubs can be found in the soil.

Adult beetles lay eggs in the soil during June and July. As the soil cools in the fall, the grubs work their way deep into the soil and return to the surface the following spring. Depending on the insect, grubs may take from 1 to 3 years to become adults and may cause problems year after year.

Control: Grub damage is usually associated with grassy or weedy fields. Cleaning fields may help prevent serious grub damage. Problems may often occur in crops planted to fields that were previously in sod or turfgrass.

No effective insecticides are labeled for grub control in vegetables. However, soil insecticides that are applied for wireworm control may also be effective in reducing grub populations.

MAGGOTS

The two most important maggots can become significant pests during the growing season. The adult of the maggot (a fly) fluctuates in abundance in different areas in different years; because it is impossible to determine when and where maggots will attack and because nothing can be done once the injury is noted, preventive controls are good insurance before planting if there were previous maggot problems.

Seed Corn Maggot: Seed attacked by seed maggots usually fails to sprout or, if it does, it is weak or sickly. Injury is most severe in wet, cold springs and on land high in organic matter. Manure and other organic matter should be thoroughly worked into the soil in the fall so is not as attractive to the egg laying seed corn maggot flies in the spring.

Control: Best control is achieved by using a seed treatment. Seed treatment options are listed in the insect control section.

Cabbage Root Maggot: Plants whose roots are attacked by the root maggot will appear riddled with maggot tunnels, and underground fleshy parts of these plants rot. Above ground, plants appear off-color, will wilt, and will seldom reach full growth.

Control: Seed treatments, transplant water treatments, in-furrow treatments, preplant broadcast, and post-plant treatments may be recommended depending on the crop. Refer to the insect control section for specific recommendations.

SLUGS

Slugs are not insects, but are related to snails. All slugs require damp or humid surroundings for development. During the day, slugs seek shelter under protective debris and will avoid the drying effects of sun and wind. As a result, weed control is a useful management tool to any slug problem.

Control: Beer traps are very effective in small areas. Place 1/2 inch of beer in a shallow flat pan. Slugs are attracted to the beer and drown upon entering the pan. Baits are often the most effective means of control. Consult your local Extension office for treatment options.

NEMATODES

Determine the degree of infestation *before* applying a nematicide. To do this, collect soil and root samples and submit these samples to your state's Plant Diagnostic Laboratory or Nematode Detection Laboratory.

Procedures for submission and sampling are noted below. Contact your local Extension office for specific information on how to submit your samples.

HOW TO COLLECT SOIL AND ROOT SAMPLES FOR NEMATODE DETECTION

Whenever nematode damage is suspected, an examination of both soil and roots is necessary to determine to what extent nematodes are involved.

The following suggestions are made so that samples will be collected properly and arrive at the laboratory in good condition.

Collecting: If a large area in a field is believed to be involved, collect samples from edges of the affected area. Take a mixture of roots and soil from at least 10 separate sites within the root zone or under at least 10 plants. This can be accomplished by unearthing each plant with a shovel and taking a handful of soil and roots or by using a soil sampling tube (3/4-inch diameter) until 1 quart of soil is obtained.

Samples collected after the host plant is plowed down are very misleading and should not be used. Send only a single blended sample from each field. Do not mix samples from several fields.

Handling: After collecting and mixing a composite soil and root sample, place it in a plastic freezer bag and close the bag tightly to prevent the sample from drying out. Protect the samples from high or freezing temperatures.

Submitting. Consult your state's diagnostic lab for its procedure and form required. The following information may be necessary so that control recommendations, if any, can be made.

Include with each sample:

1. Date collected.
2. Crop to be planted, present crop, and history of affected area.
3. Name and address of person submitting the sample and grower.
4. Plant symptoms.

**Be sure to mark samples: "For Nematode Detection."

Selecting a Nematicide: Dosage, restrictions, and crop specificity are listed on the manufacturer's label and must be carefully followed to ensure satisfactory results.

Rates for nematicides and multipurpose soil fumigants are provided in the NEMATODE CONTROL IN VEGETABLE CROPS section of this handbook.

A plastic film seal is needed when methyl bromide or certain other fumigants are used as noted on the product label. These plastic films increase the efficiency of treatments.

Apply fumigant-type nematicides to a depth of 6 to 8 inches. Immediately after application, soils should be dragged, rolled, or cultipacked to delay loss of fumigant. A light irrigation through sprinklers will also delay gas escape.

At least 2 to 3 weeks should intervene between the application of the nematicide and the time a crop is planted. See manufacturer's label recommendations for specific crops and waiting times. There are many fumigants and nematicides available, consult the disease control section of this handbook for a list of options.

One week after application, work soil to a depth of several inches so that gases may escape. Severe injury or death of sensitive plants, such as tomato, may occur on heavy soils following heavy rains or if increased rates of a fumigant are used.

Because of a reduction of nitrifying bacteria by the nematicide, at least 50% of the nitrogen in the initial fertilizer application should be in the nitrate form.

Calibrating Chemical Application Equipment

PURPOSE

To determine if the proper amount of chemical is being applied, the operator must measure the output of the application equipment. This technique is known as *calibration*. Calibration not only ensures accuracy, a critical factor with regard to many chemicals, but it can also save time and money and benefit the environment.

GETTING STARTED

Careful and accurate control of ground speed is important for any type of chemical application procedure. From large self-propelled sprayers and spreaders to small walk-behind or backpack units, precise ground speed is a key for success. Ground speed can be determined by one of two methods. The first method requires a test course and stopwatch. For this procedure, measure a suitable test course in the field and record the time it takes to cover the course with the equipment. The course should be between 100 and 300 feet long. Drive or walk the course at least twice, once in each direction and average the times for greater accuracy. Calculate the speed with Equation 1 below.

Equation 1. Ground Speed (MPH) =

$$\frac{\text{Distance} \times 60}{\text{Seconds} \times 88}$$

The second method is to use a true ground speed indicator such as a tractor-mounted radar or similar system. Do not rely on transmission speed charts and engine tachometers. They are not accurate enough for calibration.

CALIBRATING A SPRAYER:

PREPARING TO CALIBRATE

For calibration to be successful, several items need to be taken care of before going to the field. Calibration will not be worthwhile if the equipment is not properly prepared. Whenever possible, calibration should be performed using water only. If you must calibrate using spray mixture, calibrate the equipment on a site listed on the chemical label and with wind speeds less than 5 MPH. Follow the steps outlined below to prepare spraying equipment for calibration.

1. Inspect the sprayer. Be sure all components are in good working order and undamaged. On backpack sprayers, pay particular attention to the pump, control wand, strainers, and hoses. On boom sprayers, pay attention to the pump, control valves, strainers, and hoses. On airblast sprayers, be sure to inspect the fan and air tubes or deflectors as well. Be sure there are no obstructions or leaks in the sprayer.
2. Check the label of the product or products to be applied and record the following:
    - *Application Rate*, Gallons per Acre (GPA)
    - *Nozzle Type*, droplet size and shape of pattern
    - *Nozzle Pressure,* Pounds per Square Inch (PSI)
    - *Type of Application*, broadcast, band, or directed
3. Next, determine some information about the sprayer and how it is to be operated. This includes:
    - *Type of Sprayer:* backpack, boom, or airblast. The type of sprayer may suggest the type of calibration procedure to use.
    - *Nozzle Spacing (inches):* for broadcast applications, nozzle spacing is the distance between nozzles.
    - *Nozzle Spray Width (inches):* For broadcast applications, nozzle spray width is the same as nozzle spacing—the distance between nozzles. For band applications, use the width of the sprayed band if the treated area in the band is specified on the chemical label; use nozzle spacing if the total area is specified. For directed spray applications, use the row spacing divided by the number of nozzles per row. Some directed spray applications use more than one type or size of nozzle per row. In this case, the nozzles on each row are added together and treated as one. Spray width would be the row spacing.

In most cases, a backpack sprayer uses a single nozzle. Some sprayers use mini-booms or multiple nozzles. The spray width is the effective width of the area sprayed, being sure to account for overlap. If you are using a sweeping motion from side to side, be sure to use the full width sprayed as you walk forward. If you are spraying on foliage in a row, use the row spacing. Dyes are available to blend with the spray to show what has been covered.

- *Spray Swath (feet):* The width covered by all the nozzles on the boom of a sprayer. For airblast or other boomless sprayers, it is the effective width covered in one pass through the field.
- *Ground Speed, miles per hour (MPH).* When using a backpack sprayer, walk a comfortable pace that is easy to maintain. Slow walking speeds will take longer to complete the task while high speeds may be tiresome. Choose a safe, comfortable speed that will enable you to finish the job in a timely manner. On tractor-mounted sprayers, select a ground speed appropriate for the crop and type of sprayer used. Slow speeds will take longer to complete the task, while high speeds may be difficult to control and unsafe. Choose a safe, controllable speed that will enable you to finish the job in a timely manner. Ground speed can be determined from Equation 1.

4. The *discharge rate,* gallons per minute (GPM), required for the nozzles must be calculated in order to choose the right nozzle size. Discharge rate depends on the application rate; ground speed; and nozzle spacing, spray width, or spray swath.

For applications using nozzle spacing or nozzle spray width (inches), use Equation 2.

Equation 2. Discharge Rate =

$$\frac{\text{Application Rate x Ground Speed x Nozzle Spray Width}}{5{,}940}$$

For applications using the spray swath (feet):

Equation 3. Discharge Rate =

$$\frac{\text{Application Rate x Ground Speed x Spray Swath}}{495}$$

5. Choose an appropriate nozzle or nozzles from the manufacturer's charts and install them on the sprayer. Check each nozzle to be sure it is clean and that the proper strainer is installed with it.
6. Fill the tank half full of water and adjust the nozzle pressure to the recommended setting. Measure the discharge rate for the nozzle. This can be done by using a flow meter or by using a collection cup and stopwatch. The flow meter should read in gallons per minute (GPM). If you are using the collection cup and stopwatch method, the following equation is helpful to convert ounces collected and collection time, in seconds, into gallons per minute.

Equation 4. Discharge Rate =

$$\frac{\text{Ounces Collected x 60}}{\text{Collection Time x 128}}$$

7. Whenever possible, calibrate with water instead of spray solution. Do not calibrate with spray solution unless required by the chemical label. Follow all recommendations on the label. If the spray solution has a density different than water, the rate can be corrected using the procedure shown in Calibration Variables.
8. On boom sprayers or sprayers with multiple nozzles, average the discharge rates of all the nozzles on the sprayer. Reject any nozzle that has a bad pattern or that has a discharge rate 10 percent more or less than the overall average. Install a new nozzle to replace the rejected one and measure its output. Calculate a new average and recheck the nozzles compared to the new average. Again, reject any nozzle that is 10 percent more or less than the average or has a bad pattern. When finished, select a nozzle that is closest to the average to use later as your "quick check" nozzle.

On backpack sprayers or sprayers with a single nozzle, compare the discharge rate of the nozzle on the sprayer to the manufacturer's tables for that nozzle size. Reject any nozzle that has a bad pattern or that has a discharge rate 10 percent more or less than the advertised rate. Install a new nozzle to replace the rejected one and measure its output.

Once the sprayer has been properly prepared for calibration, select a calibration method. When calibrating a sprayer, changes are often necessary to achieve the application rates needed. The sprayer operator needs to understand the changes that can be made to the adjust rate and the limits of each adjustment. The adjustments and the recommended approach are:

- *Pressure:* if the error in application rate is less than 10 percent, adjust the pressure.
- *Ground speed:* if the error is greater than 10 percent but less than 25 percent, change the ground speed of the sprayer.
- *Nozzle size:* if the error is greater than 25 percent, change nozzle size. The goal is to have application rate errors less than 5 percent.

Calibration Methods

There are four methods commonly used to calibrate a sprayer:

The *basic*, *nozzle*, and *128th acre* methods are "time-based methods" which require using a stopwatch or watch with a second hand to ensure accuracy. The area method is based on spraying a test course measured in the field. Each method offers certain advantages. Some are easier to use with certain types of sprayers. For example, the basic and area methods can be used with any type of sprayer. The 128th acre and nozzle methods work well for boom and backpack sprayers. Choose a method you are comfortable with and use it whenever calibration is required.

BASIC METHOD

1. Accurate ground speed is very important to good calibration with the basic method. For tractor-mounted sprayers, set the tractor for the desired ground speed and run the course at least twice. For backpack sprayers, walk the course and measure the time required. Walk across the course at least twice. Average the times required for the course distance and determine ground speed from Equation 1.
2. Calculate the application rate based on the average discharge rate measured for the nozzles, the ground speed over the test course, and the nozzle spacing, nozzle spray width, or spray swath on the sprayer.

When using nozzle spacing or nozzle spray width measured in inches, use the following equation:

Equation 5. Application Rate =

$$\frac{\text{5,940 x Discharge Rate}}{\text{Ground Speed x Nozzle Spray Width}}$$

For spray swath applications measured in feet:

Equation 6. Application Rate =

$$\frac{\text{495 x Discharge Rate}}{\text{Ground Speed x Spray Swath}}$$

3. Compare the application rate calculated to the rate required. If the rates are not the same, choose the appropriate adjustment and reset the sprayer.
4. Recheck the system if necessary. Once you have the accuracy you want, calibration is complete.

NOZZLE METHOD

1. Accurate ground speed is very important to good calibration with the nozzle method. For tractor-mounted sprayers, set the tractor for the desired ground speed and run the course at least twice. For backpack sprayers, walk the course and measure the time required. Walk across the course at least twice. Average the times required for the course distance and determine ground speed from Equation 1.
2. Calculate the nozzle discharge rate based on the application rate required the ground speed over the test course, and the nozzle spacing, spray width, or spray swath of the sprayer. For nozzle spacing or spray width measured in inches.

Equation 7. Discharge Rate =

$$\frac{\text{Application Rate} \times \text{Speed} \times \text{Spray Width}}{5{,}940}$$

For spray swath measured in feet:

Equation 8. Discharge Rate =

$$\frac{\text{Application Rate} \times \text{Speed} \times \text{Spray Swath}}{495}$$

Set the sprayer and determine the average nozzle rate.

3. Compare the rate calculated to the average rate from the nozzles. If the two don't match, choose the appropriate adjustment and reset the system.
4. Recheck the system if necessary. Once you have the accuracy you want, calibration is complete.

128TH ACRE METHOD

1. The distance for one nozzle to cover 128th of an acre must be calculated. The nozzle spacing or spray width in inches is used to determine the spray distance. Spray distance is measured in feet. On backpack sprayers, be sure to measure the full width sprayed as you walk forward. Use Equation 9.

Equation 9. Spray Distance =

$$\frac{4{,}084}{\text{Spray Width}}$$

2. Measure the spray distance on a test course in the field. Check the ground speed as you travel across the course. Be sure to maintain an accurate and consistent speed. Travel the course at least twice and average the time to cover the course.
3. For backpack sprayers, collect the output from the nozzle for the time measured in step 2. For tractor-mounted sprayers, park the sprayer, select the nozzle closest to the average, and collect the output for the time determined in step 4. Ounces collected will equal application rate in GPA.
4. Compare the application rate measured for the nozzle to the rate determined in step 3. If the rates are not the same, choose the appropriate adjustment and reset the system.
5. Recheck the system if necessary. Once you have the accuracy you want, calibration is complete.

AREA METHOD

1. Determine the distance that can be sprayed by one tank using the full spray swath measured in feet.

Equation 10. Tank Spray Distance (ft) =

$$\frac{\text{Tank Volume (gal)} \times 43{,}560}{\text{Application Rate (GPA)} \times \text{Swath (ft)}}$$

2. Lay out a test course that is at least 10 percent of the tank spray distance from Step 1. Fill the sprayer tank with water only, mark the level in the tank, set the sprayer as recommended, and spray the water out on the course. Be sure to maintain an accurate and consistent speed.
3. After spraying the test course, carefully measure the volume of water required to refill the tank to the original level. Calculate the application rate as shown:

Equation 11. Application Rate (GPA) =

$$\frac{\text{Volume Sprayed (gal)} \times 43{,}560}{\text{Test Course Distance (ft)} \times \text{Swath (ft)}}$$

4. Compare the application rate measured to the rate required. If the rates are not the same, choose the appropriate adjustment method and reset the sprayer.
5. Recheck the system. Once you have the accuracy you want, calibration is complete.

CALIBRATING A GRANULAR APPLICATOR:

PREPARING TO CALIBRATE

Granular application calibration is usually done with the chemical to be applied. It is difficult to find a blank material that matches the granular product. Extra care should be taken in handling this product. Minimize worker exposure and take precautions against spills during calibration.

To prepare for calibration, follow these steps:

1. Before calibrating, carefully inspected the equipment to ensure that all components are in proper working order. Check the hopper, the metering rotor, the orifice, and the drop tubes. Be sure there are no leaks or obstructions.
2. Determine the type of application required for the product: ·
   - Broadcast: treats the entire area (includes band applications based on broadcast rates).
   - Band: treats only the area under the band.
   - Row: treats along the length of the row.
3. Determine the application rate needed: ·
   - Broadcast: pounds per acre. ·
   - Band: pounds per acre of treated band width. ·
   - Row: pounds per acre or pounds per 1,000 feet of row length.
4. What type of drive system does the applicator use?
   - Independent: uses PTO, hydraulic, or electric motor drive.
   - Ground Drive: uses ground driven wheel.
5. Regardless of how the application rate is expressed or type of application, calibration is easier if the rate is expressed in terms of pounds per foot of row length. Use one of the following steps to determine the correct row rate in pounds per foot.

For broadcast and row applications (Application Rate = lb/ac):

Equation 12. Row Rate, lb/ft =

$$\frac{\text{Application Rate} \times \text{Row Width (ft)}}{43{,}560}$$

For banded applications (Application Rate = lb/ac of Band Width):

Equation 13. Row Rate, lb/ft =

$$\frac{\text{Application Rate} \times \text{Band Width (ft)}}{43{,}560}$$

For directed (row) applications (Application Rate = lb per 1,000 ft):

Equation 14. Row Rate, lb/ft =

$$\frac{\text{Application Rate}}{1{,}000}$$

6. Choose a calibration distance to work with and measure a test course of this distance in the field you will be working in. Choose an area that is representative of field conditions. The calibration distance should be at least 50 feet but not more than 500 feet. Longer distances are generally more accurate.
7. Calculate the weight of material that should be collected for the calibration distance chosen.

Equation 15. Weight Collected =

Row Rate x Calibration Distance

8. Select a ground speed appropriate for the crop and type of equipment used. Slow speeds take longer to finish the task, while high speeds may be inefficient and unsafe. Consult your equipment manual for a recommended speed. Even ground-driven application equipment can be sensitive to changes in speed. Maintaining an accurate and consistent speed is very important. Choose a safe, controllable speed that will enable you to complete the job in a timely and efficient manner.
9. Set your equipment according to recommendations from the equipment or chemical manufacturer. Most equipment manufacturers and chemical manufacturers provide rate charts to determine the correct orifice setting or rotor speed for each applicator. Fill the hopper at least half full to represent average capacity for calibration.
10. Attach a suitable collection container to each outlet on the applicator. You should be able to collect all material discharged from the applicator. Locate a scale capable of weighing the samples collected in calibration. Some samples may be very small, so a low-capacity scale may be needed. An accurate scale is very important.

Calibration Methods

Two methods for calibrating granular applicators are commonly used. The first is the *distance method*. This method is preferred by many operators because it applies to any type of granular machine and is easy to perform. The second method is the *time method*. This method is similar to sprayer calibration and can be used for applicators driven by PTO, hydraulic, or electric motors.

DISTANCE METHOD

1. On the test course selected in the field, collect the output from the applicator in a container as you travel the course and weigh the material collected. Record the time required to travel the course also. Run the course twice, once in each direction, and average the results for both weight and time.
2. Determine the weight of the product that should be collected for the calibration distance.

Equation 16. Weight Collected (lb) =

Row Rate (lb/ft) x Calibration Distance (ft)

3. Compare the weight of the product actually collected to the weight expected for the calibration distance. If the rates differ by more than 10 percent, adjust the orifice, rotor speed, or ground speed and repeat. Bear in mind, speed adjustments are not effective for ground-driven equipment.
4. Repeat the procedure until the error is less than 10 percent.

TIME METHOD

1. On the test course selected in the field, record the time required to travel the course. Run the course twice, once in each direction, and average the results. Accurate ground speed is very important to good calibration with the time method.
2. With the equipment parked, set the orifice control as recommended and run the applicator for the time measured to run the calibration distance. Collect and weigh the output of the applicator for this time measurement.
3. Determine the weight of the product that should be collected for the calibration distance.

Equation 17. Weight Collected (lb) =
Row Rate (lb/ft) x Calibration Distance (ft)

4. Compare the weight of the product actually collected during the time it took to cover the calibration distance to the weight expected for the calibration distance. If the rates differ by more than 10 percent, adjust the orifice, rotor speed, or ground speed and repeat. Bear in mind, speed adjustments are not effective for ground-driven equipment.
5. Repeat the procedure until the error is less than 10 percent.

CALIBRATING A BROADCAST SPREADER:
PREPARING TO CALIBRATE

Broadcast spreaders include machines designed to apply materials broadcast across the surface of the field. They include *drop*, *spinner*, and *pendulum* spreading devices. Calibration of a broadcast spreader is usually done using the product to be applied. Blank material is available and can be used, but may be hard to find. Use extra care and preparation when calibrating with the chemical. To begin, follow these steps:

1. Carefully inspect all machine components. Repair or replace any elements that are not in good working order.
2. Determine the type of drive system that is being used: ground drive or independent PTO. This may help determine the method of calibration.
3. Determine the application rate and the bulk density of the product to be applied.
4. Determine the spreader pattern and swath of the spreader. Check the pattern to ensure uniformity. To check the pattern, place collection pans across the path of the spreader. For drop spreaders, be sure to place a pan under each outlet. For centrifugal and pendulum spreaders, space the pans uniformly with one in the center and an equal number on each side. The pattern should be the same on each side of the center and should taper smoothly as you go to the outer edge. The swath would be set as the width from side to side where a pan holds 50 percent of the maximum amount collected in the center pan.
5. Fill the hopper half full to simulate average conditions.
6. Set the ground speed of the spreader.
7. Set the spreader according to the manufacturer's recommendations and begin calibration.

Calibration Methods

There are two common methods used to calibrate broadcast spreaders. The first method is the *discharge* method. To use this procedure, collect and measure the total discharge from the spreader as it runs across a test course. The second method, the *pan* method, is used on centrifugal and pendulum spreaders. The pattern test pans used to determine pattern shape and swath are used to determine the application rate.

DISCHARGE METHOD

1. Determine the test distance to use. Longer distances may give better accuracy but may be difficult to manage. A distance of 300 to 400 feet is usually adequate. Use shorter distances if necessary to avoid collecting more material than you can reasonably handle or weigh.
2. Set the ground speed. Be sure to maintain a constant ground speed at all times.
3. If using a ground drive spreader, attach a collection bin to the discharge chute or under the outlets and collect all the material discharged from the spreader as it runs across the test distance. If using an independent drive spreader, record the time required to run the test course. Park the spreader at a convenient location and measure the discharge from the spreader for the time measured on the test distance. The course should be run twice and the times averaged for better accuracy.
4. Calculate the application rate (pounds per acre):

Equation 18. Application Rate, lb/ac =

$$\frac{\text{Weight Collected (lb)} \times 43{,}560}{\text{Distance (ft)} \times \text{Swath (ft)}}$$

5. Compare the application rate measured to the rate required. Adjust and repeat as necessary.

PAN METHOD

1. Place pans in the field across the swath to be spread. Pans should be uniformly spaced to cover the full swath. One pan should be at the center of the swath with equal numbers of pans on each side. Use enough pans, 11 or more, to get a good measurement.
2. Make three passes with the spreader using the driving pattern to be used in the field. One pass should be directly over the center pan and the other passes at the recommended distance, lane spacing, to the left and right of the center pass.
3. Combine the material collected in the pans and determine the weight or volume collected. Divide by the number of pans used to determine the average weight or volume per pan.
4. Calculate the application rate.

If you are measuring the weight in the pans in grams:

Equation 19. Application Rate, lb/ac =

$$\frac{13{,}829 \times \text{Weight (grams)}}{\text{Pan Area (inches}^2\text{)}}$$

If you are measuring the volume in the pans in cubic centimeters (cc):

Equation 20. Application Rate, lb/ac =

$$\frac{13{,}829 \times \text{Bulk Density (lb/ft}^3\text{)} \times \text{Volume (cc)}}{\text{Pan Area (inches}^2\text{)} \times 62.4}$$

5. Compare the rate measured to the rate required.

CALIBRATION VARIABLES

Several factors can affect proper calibration. The ground speed of any type of PTO-powered machine can make a difference. On the other hand, ground-driven machines are usually only slightly affected by changes in ground speed. If using dry or granular material, product density will affect the discharge rate and may change the pattern for broadcast spreaders. For liquids, calibration can be affected by pressure, nozzle size, density and viscosity of the liquid, and application type—band or broadcast. The following adjustments may help in adjusting these variables.

SPEED

For PTO-powered equipment or other equipment in which the discharge rate is independent of ground speed, Equation 10 is useful.

Equation 21. New Application Rate =

Old Application Rate x (Old Speed/New Speed)

For ground-driven equipment, there should be little or no change in application rate when speed is changed.

PRESSURE

For liquids in sprayers, the discharge rate changes in proportion to the square root of the ratio of the pressures.

Equation 22. New Discharge Rate =

$$\text{Old Discharge Rate} \times \sqrt{\frac{\text{New Pressure}}{\text{Old Pressure}}}$$

DENSITY

For liquids in sprayers, the discharge rate changes if the specific gravity (S.G.) of the liquid changes. Use water for calibration and adjust as shown below. Calibrate with spray solution only if recommended by the supplier.

Equation 23. Water Discharge Rate =

$$\text{Spray Discharge Rate} \times \sqrt{\text{S.G. of Spray Solution}}$$

BAND APPLICATION VERSUS BROADCAST APPLICATION

Some pesticide application recommendations are based on area of cropland covered. Other recommendations are based on area of land treated in the band covered. Check the label for the product you are using to see how it is listed.

Broadcast application is based on area of cropland covered. Nozzle spacing is the distance between nozzles. Band applications in which the area of covered cropland is used for calibration and those applications in which multiple nozzles per row are used are both treated like broadcast applications. Divide the row spacing by the number of nozzles used per row to get a nozzle spacing for calibration.

For band applications in which area of treated land—not cropland covered—is specified, use the width of the band at the ground as the spacing for calibration.

DETERMINING UPPER AND LOWER LIMITS

Upper and lower limits provide a range of acceptable error. To set these limits for a given sample size, use the equations below. First, however, you must decide upon the degree of accuracy you wish to achieve. Select a percent error: 2 percent, 5 percent, 10 percent, or any other level of accuracy.

Equation 24. Upper Limit =

Target Rate x (1 + Percent Error/100%)

Equation 25. Lower Limit =

Target Rate x (1 – Percent Error/100%)

Registered Fungicides, Insecticides, And Miticides For Vegetables

Recommendations of specific chemicals are based upon information on the manufacturer's label and performance in a limited number of trials. Because environmental conditions and methods of application by growers may vary widely, performance of the chemical will not always conform to the safety and pest control standards indicated by experimental data.

Recommendations for the use of agricultural chemicals are included in this publication as a convenience to the reader. The use of brand names and any mention or listing of commercial products or services in this publication does not imply endorsement by Auburn University, Clemson University, Louisiana State University, Mississippi State University, North Carolina State University, Oklahoma State University, Texas A&M, University of Florida, University of Georgia, University of Kentucky, University of Tennessee, and Virginia Tech nor discrimination against similar products or services not mentioned. Individuals who use agricultural chemicals are responsible for ensuring that the intended use complies with current regulations and conforms to the product label. Be sure to obtain current information about usage regulations and examine a current product label before applying any chemical. For assistance, contact your local county Extension office.

BE SURE TO CHECK THE PRODUCT LABEL BEFORE USING ANY PESTICIDE.

RESISTANCE MANAGEMENT AND THE INSECTICIDE RESISTANCE ACTION COMMITTEE (IRAC) CODES FOR MODES OF ACTION OF INSECTICIDES

Many insecticides affect a particular chemical involved in the function of an insect's nervous, digestive, respiratory, or other system. Some broad-spectrum insecticides affect chemicals that occur in many places within the insect and have a wide ranging effect on the insect. Usually, these are older insecticides that have been in use for many years. The chemicals that these insecticides affect are often found in other animals as well. This can result in the insecticide having undesirable effects on these other animals (non-target effects). Also, non-target effects and persistence in nature have contributed to concerns about these older insecticides.

Many new insecticides have been developed over the last decade, specifically to minimize non-target effects and reduce persistence in the environment compared to older insecticides. This limited persistence in the environment also reduces the potential for non-target effects. However, the primary means of reducing non-target effects has been to make these newer insecticides very specific for a particular chemical (usually an enzyme produced by a single gene) found only in certain insects or groups of insects; thus making the insecticide selective for a particular type of insect. Unfortunately, there is a negative aspect to this specificity. Because only one enzyme is affected, the natural process of **mutation** can result in genetic modifications that alter the enzyme so that it is unaffected by the insecticide. Insects possessing the modified gene will not be affected by the particular insecticide. These insects will reproduce and, in time with continued exposure to the insecticide, will produce a population of insects that is **resistant** to the insecticide. Since most of the new insecticides have been developed to be very specific, resistance will develop much more quickly than with previous insecticides.

Different insecticides affect different enzymes, and insecticides are placed into classes based on which enzymes are affected. These classes are called **Modes of Action (MOA)**. Although insecticides may have different names, they can have the same mode of action and affect the same enzyme or system. It is the mode of action to which the insect will become resistant. Because of this, an insect management program **MUST** rotate the modes of action of the insecticides used during the cropping cycle. To prevent the development of resistance, it is important not to apply insecticides with the same mode of action to successive generations of the same insect. Insect development time can vary by species and environmental conditions, and generations often overlap in the field; proper scouting is necessary to determine when modes of action should be rotated. To make it easier to determine an insecticide's mode of action, the **IRAC** has developed a numerical code with a different number corresponding to each mode of action. New packaging has been developed with a colored banner on the top of the package and label giving the **IRAC code.** For example, the insecticide, Movento®, has a new mode of action and the package says:

GROUP 23 INSECTICIDES

Growers can now easily identify the mode of action of a specific insecticide. This will help them to plan their rotation of materials to avoid rapid development of insecticide resistance and help prolong the life of these important new crop protection materials while providing adequate management of their pest problems. More information about insecticide resistance and a concise chart of all of the **IRAC codes** can be found at the website: www.irac-online.org.

GENERAL INFORMATION

LAWS AND REGULATIONS

Be sure to check current state and federal laws and regulations regarding the proper use, storage, and disposal of pesticides before applying any chemicals. For restricted-use pesticides, an applicator is required to be certified or to work under the direct supervision of a certified individual. dditional information on Worker Protection Standards (WPS) can be found at http://www.epa.gov/agriculture/htc.html.

CERTIFICATION–PESTICIDE APPLICATORS

The Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (FIFRA) requires each state to set up a program to certify. This certification is designed to show that users of pesticides know how to use pesticides safely in order that they do not endanger the user, fellow humans, or the environment. Users of pesticides are classified as either private applicators or commercial applicators. The certification process is somewhat different for each group. The definitions of private and commercial applicators are as follows:

Private Applicator: Any person who uses, or supervises the use of a restricted-use pesticide for the purpose of raising some type of agricultural commodity. The application can be done on land owned or rented by the applicator or the applicator's employer. However, any applications done on a "for-hire" basis are considered commercial applications. Examples of private applicators are dairy farmers, vegetable or fruit growers, greenhouse growers, and ranchers.

Commercial Applicator: Any person who uses, or supervises the use of, pesticides on a "for-hire" basis; any person who applies pesticides for nonagricultural purposes; any person who applies pesticides as a part of his or her job with any governmental agency (public operator). Examples of commercial applicators are: exterminators; landscapers; tree services; aerial applicators; weed-control firms; and owners of apartments, motels, nursing homes, restaurants, etc., who do their own pest control work.

For detailed information on certification of pesticide applicators, call your state's Department of Agriculture or your local Extension office for information.

HANDLING PESTICIDES

Before opening a pesticide container, all applicators should carefully read the label, and accurately follow all directions and precautions specified on the labeling. In order to handle and apply pesticides safely, it is essential to use the proper personal protective equipment (PPE). For the custom or professional applicator, which includes both private and commercial applicators, safety equipment should at least consist of the PPE listed on the product label.

Your physician should be advised of the types of pesticides used in your work. Before the start of the spray season, each applicator should have a baseline blood cholinesterase level determined if you will be applying any organophosphate or carbamate insecticides.

When applying pesticides, be sure to have a decontamination site as required by the EPA's Worker Protection Standards (WPS) and a supply of clean water and liquid detergent available for drenching and washing in case of an accident. A single drop of certain pesticides in the eye is extremely hazardous. Be prepared to wash a contaminated eye with clean water for 15 minutes.

Only an experienced applicator wearing the protective clothing and safety equipment required by the manufacturer should handle highly toxic pesticides, such as Guthion, Lannate, and Temik.

APPLYING PESTICIDES

Before using a pesticide, read and obey all labeling instructions. Always have the label readily available when applying a pesticide.

Do **not** handle or apply pesticides if you have a headache or do not feel well. **Never smoke, eat or drink while using pesticides. Avoid inhaling pesticide sprays, dusts, and vapors.**

If hands, skin, or other body parts become contaminated or exposed, wash the area immediately with clean water and a liquid detergent. If clothing becomes contaminated, remove it immediately. Wash contaminated clothing separately. After each spraying or dusting, bathe and change clothing; always begin the day with clean clothing.

Always have someone present or in close contact when using highly toxic pesticides -those with the signal word **DANGER** plus the skull and crossbones symbol.

APPLY THE CORRECT DOSAGE

- To avoid excessive residues on crops for feed and food
- To achieve optimum pest control and minimum danger to desirable organisms
- To avoid chemical damage to the crops
- To obtain the most economical control of pests.

Use pesticides for only those crops specified on the label, and use only those that have state and federal registration. Avoid drift to nontarget areas. Dusts drift more than sprays; airblast sprays drift more than boom sprays. When cleaning or filling application equipment, **do not contaminate** streams, ponds, or other water supplies. Keep a record of all pesticides used.

TREATED AREAS

Be sure all treated areas are posted so as to keep out unauthorized personnel. This should be a regular procedure for greenhouse operators.

REENTRY PERIOD

Persons must not be allowed to enter the treated area until after sprays have dried or dusts have settled and until sufficient time has passed to ensure that there is no danger of excessive exposure. This time period is listed on the pesticide label as the Restricted Entry Interval (REI). In no case during the reentry period are farm workers allowed to enter the treated area to engage in activity requiring substantial contact with the treated crop. PPE is required for any early entry into the treated area and is only allowed for trained applicators.

FARM WORKER SAFETY

Federal pesticide legislation sets an interval during which unprotected persons may not reenter areas treated with certain pesticides to ensure that there is no danger to excessive exposure. These intervals (days to reentry) are listed on each pesticide's label. Points for special attention are:

1. No pesticide shall be applied while any person not involved in the application is in the field being treated.
2. No owner shall permit any worker not wearing protective clothing (that is, PPE) to enter a field treated with pesticides until sprays have dried or dusts have settled, unless they are exempted from such. **Protective clothing:** hat or head covering; woven, long-sleeved shirt and long-legged pants; and shoes and socks. Additional safety equipment may be needed.
3. Pesticides classified in EPA Category 1 have a reentry time of at least 24 hours.
4. If the label states a longer reentry time or has more stringent requirements than indicated here, the label restrictions must be followed. Existing safety standards specified on the label remain in force.
5. When workers are expected to be working in the vicinity of a field treated or to be treated with a pesticide, a timely (written or oral) warning to such workers shall be given.
    a. For all pesticides, workers must be warned by posting a bulletin board at all point(s) where workers might assemble. This bulletin board should include a map of the farm which designates the different areas of the farm that might be treated and listing of the following information:
        i. Location and name of crop treated
        ii. Brand and common chemical name of pesticide applied.
    b. Date of application
    c. Date of safe reentry into treated area
    d. When a pesticide having a reentry time greater than 7 days is applied, warning signs must be posted for the duration of the reentry time. The signs must be clearly readable at a distance of 25 feet and printed in English and the language of the worker, if other than English.
    e. The sign must contain the words:

        Danger

        Name of the pesticide

        Treatment date

        Do not enter until _____
6. The sign must not be removed during the reentry time, but must be removed before workers are allowed to have contact with the treated plants.

For additional information on these and other state farm worker safety regulations, contact the Pesticide Control Program office or the Cooperative Extension pesticide office in your state.

STORAGE

Pesticides should always be stored in their original containers and kept tightly closed. For the protection of others, especially firefighters, the storage area should be posted as *Pesticide Storage* and kept securely locked.

Herbicides, especially hormone-like weedkillers such as 2,4-D, should not be stored with other pesticides—primarily insecticides and fungicides—to prevent the accidental substitution of the herbicide for these chemicals.

Store the pesticides in a cool, dry, well-ventilated area that is not accessible to children and others who do not know and understand the safe and proper use of pesticides. Pesticides should be stored under lock and key. Special precautions may be needed in case of a fire in these storage areas.

Any restricted use pesticide (RUP) or container contaminated by restricted pesticides **must** be stored in a secure, locked enclosure while unattended. This enclosure **must** bear a warning that pesticides are stored there. In many states, it is illegal to store any pesticide in any container other than its original container.

Keep an inventory of all pesticides held in storage and locate the inventory list in an accessible place away from the storage site so that it may be referred to in case of an emergency at the storage site.

Keep your local fire department informed of the location of all pesticide storages. Fighting a fire that includes smoke from burning pesticides can be extremely hazardous to firefighters. Firefighters should be cautioned to avoid breathing any smoke from such a fire. A fire with smoke from burning pesticides may endanger the people of the immediate area or community. The people of an area or community may have to be evacuated if the smoke from a pesticide fire-drifts in their direction. To obtain Prefire Planning Guides, contact the US National Response Team (NRT) at at http://www.nrt.org or at http://ipm.ncsu.edu (under "Information for Pesticide Applicators/Dealers").

Pesticide Formulation	General Signs of Deterioration
EC	Evidence of separation is such as a sludge or sediment Milky appearance does not occur when water is added.
Oils	Milky appearance does not occur when water is added.
WP, SP, WGD	Excessive lumping; powder does not suspend in water.
D, G, WDG	Excessive lumping or caking.

After freezing, place pesticides in warm storage [50°-80°F] and shake or roll container every few hours to mix product or eliminate layering. If layering persists or if all crystals do not completely dissolve, do not use the product. If in doubt, call the manufacturer.

PESTICIDE TRANSPORT

Containers must be well-secured to prevent breakage or spillage. An adequate supply of absorbent material, a shovel, and a fire extinguisher must be available. While under transport, pesticides must be stored in a separate compartment from the driver. All pesticide containers and equipment must be secured to the vehicle so as to prevent removal by unauthorized person(s) when the vehicle is unattended. The door or hatch of any service vehicle tank containing a pesticide must be equipped with a cover that will prevent spillage when the vehicle is in motion.

The above requirements do not apply if the pesticide is being transported within the application equipment tank.

For additional information on pesticide transport, contact the state Pesticide Control Program office or Extension.

DISPOSAL

Pesticides should not be disposed of in sanitary landfills or by incineration, unless these locations and equipment are especially designed and licensed for this purpose by the state.

The best method to dispose of a pesticide is to use it in accordance with current label registrations. The **triple rinse-and-drain** (see below) procedure or the **pressure-rinse procedure** (see below) is the recommended method to prepare pesticide containers for safe disposal. This method can save money as well as protect the environment.

Crush or puncture the container for disposal in a sanitary landfill or deposit in landfills that accept industrial waste, or deliver the intact container to a drum reconditioner or recycling plant. Check with the landfill operator prior to taking empty containers for disposal. For additional information on the disposal of pesticides themselves or unrinsed containers or rinsate, call the state agency responsible for hazardous wastes. See back cover for telephone numbers.

Triple Rinse–and–Drain Method. To empty a pesticide container for disposal, drain the container into the spray tank by holding the container in a vertical position for 30 seconds. Add water to the pesticide container. Agitate the container thoroughly, then drain the liquid (rinsate) into the spray tank by holding in a vertical position for 30 seconds. Repeat two more times. Puncture or otherwise create a hole in the bottom of the pesticide container to prevent its reuse.

Pressure Rinse Method. An optional method to rinse small pesticide containers is to use a special rinsing device on the end of a standard water hose. The rinsing device has a sharp probe to puncture the container and several orifices to provide multiple spray jets of water. After the container has been drained into the sprayer tank (container is upside down), jab the pointed pressure rinser through the bottom of the inverted container. Rinse for at least 30 seconds. The spray jets of water rinse the inside of the container and the pesticide residue is washed down into the sprayer tank for proper use. Thirty seconds of rinse time is equivalent to triple rinsing. An added benefit is that the container is rendered unusable.

PROTECT OUR ENVIRONMENT

- Do not burn pesticides. The smoke from burning pesticides is dangerous and can pollute air.
- Do not dump pesticides in sewage disposal or storm sewers because this will contaminate water.
- Avoid using excess quantities of pesticides. Calibrate sprayers to make sure of the output.
- Adjust equipment to keep spray on target. Chemicals off-target pollute and can do harm to fish, wildlife, honey bees, and other desirable organisms.

Keep pesticides out of ponds, streams, and water supplies, except those intended for such use. A small amount of drift can be hazardous to food crops and to wildlife. Empty and clean sprayers away from water areas (such as ponds, lakes, streams, etc.)

Protect bees and other beneficial insects by choosing the proper chemical and time of day for application. See additional precautions in section ”Protecting Our Groundwater.”

MINIMIZE SPRAY DRIFT

- Avoid spraying when there is strong wind.
- Use large orifice nozzles at relatively low pressure.
- Use nozzles that do not produce small droplets.
- Adjust boom height as low as practical.
- Do not spray at high travel speeds.
- Spray when soil is coolest and relative humidity is highest.
- Use nonvolatile pesticides.
- Use drift control additives when permitted by the pesticide label.

PESTICIDE POISONING

If any of the following symptoms are experienced during or shortly after using pesticides: headache, blurred vision, pinpoint pupils, weakness, nausea, cramps, diarrhea, and discomfort in the chest, seek medical assistance immediately. Be sure to take a copy of the pesticide label. For minor symptoms, call the appropriate Poison Control Center in your state. See back cover for emergency telephone numbers. Prompt action and treatment may save a life.

IN CASE OF AN ACCIDENT

Remove the person from exposure:

- Get away from the treated or contaminated area immediately
- Remove contaminated clothing.
- Wash with soap and clean water.
- Call a physician and the state Poison Control Center or Agency. See back cover for emergency telephone numbers.
- Be prepared to give the active ingredient name (common name)

PESTICIDE SPILLS

Keep a supply of absorbent on hand to scatter over liquid spills in the storage room. Sawdust or janitorial sweeping compound works well in absorbing the liquids in a cleanup. Use a respirator and rubber gloves to clean up spills; cover the contaminated surface with household lye, trisodium phosphate, or liquid detergent. Let it soak a couple of hours and reabsorb the solution from the floor. This procedure is recommended for cleaning truck beds that are contaminated. Specific information concerning pesticide cleanup can be obtained by calling the manufacturer directly. The phone numbers for emergencies are listed on every product label. Information can also be obtained by calling CHEMTREC at 800/424-9300. Report pesticide spills to the proper state agency. See back cover for telephone numbers.

RESPIRATORY PROTECTIVE DEVICES FOR PESTICIDES

For many toxic chemicals, the respiratory (breathing) system is the quickest and most direct route of entry into the circulatory system. From the blood capillaries of the lungs, these toxic substances are rapidly transported throughout the body.

Respiratory protective devices vary in design, use, and protective capability. In selecting a respiratory protective device, the user must first consider the degree of hazard associated with breathing the toxic substance, and then understand the specific uses and limitations of the available equipment. Select a respirator that is designed for the intended use, and always follow the manufacturer's instructions concerning the use and maintenance of that particular respirator. Different respirators may be needed for application of different chemicals or groups of chemicals. Select only equipment approved by the National Institute of Occupational Safety and Health (NIOSH). The NIOSH approval numbers begin with the letters TC. *NOTE*: The label will specify which respirator is needed for that particular pesticide.

TYPES OF RESPIRATORS

Respiratory protective devices can be categorized into three classes: air-purifying, supplied-air, and self-contained. Because most pesticide contaminants can be removed from the atmosphere by air-purifying devices, we will look at these in greatest detail.

Air-purifying devices include chemical cartridge respirators, mechanical filters, gas masks (also referred to as canister filter respirators), and battery powered respirators. They can be used only in atmospheres containing sufficient oxygen to sustain life.

- Chemical cartridge respirators provide respiratory protection against certain gases and vapors in concentrations not greater than 0.1% by volume, provided that this concentration does not exceed an amount that is immediately dangerous to life and health. They are for use only when exposure to high continual concentrations of pesticide is unlikely, such as when mixing pesticides outdoors. They are available either as halfmasks, covering only the nose and mouth, or as full-facepiece respirators for both respiratory and eye protection.
- Mechanical filter respirators (dust masks) provide respiratory protection against particulate matter such as mists, metal fumes, and nonvolatile dusts. They are available either as disposable or reusable halfmasks that cover the nose and mouth, or as reusable full-facepieces. Dust masks should never be used when mixing or applying liquids because splashed or spilled liquids, or pesticide vapors can be absorbed by the mask.
- Many respiratory protective devices are combinations of chemical cartridge and mechanical filter (prefilter) respirators. These can provide respiratory protection against both gases and particulate matter.
- Full-face piece respirators provide respiratory protection against particulate matter, and/or against certain specific gases and vapors, provided that their concentration does not exceed an amount that is immediately dangerous to life and health. Gas masks, like full-facepieces, cover the eyes, nose, and mouth, but will last longer than cartridges when continuously exposed to some pesticides. A gas mask will not, however, provide protection when the air supply is low. A special respirator with a self-contained air supply should be worn in these situations.
- Battery powered air-purifying respirators equipped with pesticide filters/cartridges are also effective in filtering out pesticide particles and vapors. They are available as halfmasks, full-face masks, hoods, and protective helmets, and are connected by a breathing hose to a battery powered filtration system. This type of filtration system has the additional advantage of cooling the person wearing it. But, like other air purifying devices, this system does not supply oxygen and must be worn only when the oxygen supply is not limited.

Chemical cartridge respirators protect against light concentrations of certain organic vapors. However, no single type of cartridge is able to remove all kinds of chemical vapors. A different type of chemical cartridge (or canister) must be used for different contaminants. For example, cartridges and canisters that protect against certain organic vapors differ chemically from those that protect against ammonia gases. Be sure that the cartridge or canister is approved for the pesticide you intend to use. Cartridge respirators are not recommended for use against chemicals that possess poor warning properties. Thus, the user's senses (smell, taste, irritation) must be able to detect the substance at a safe level if cartridge respirators are to be used correctly.

The effective life of a respirator cartridge or canister depends on the conditions associated with its use—such as the type and concentration of the contaminants, the user's breathing rate, and the humidity. Cartridge longevity is dependent on its gas and vapor adsorption capacity. When the chemical cartridge becomes saturated, a contaminant can pass through the cartridge, usually allowing the user to smell it. At this point, the cartridge must be changed immediately. There are times when the mechanical prefilter also needs to be changed. A prefilter should be replaced whenever the respirator user feels that breathing is becoming difficult. Dispose of all spent cartridges to avoid their being used inadvertently by another applicator who is unaware of their contaminated condition.

Chemical cartridge respirators cannot provide protection against extremely toxic gases such as hydrogen cyanide, methyl bromide, or other fumigants. Masks with a self-contained air supply are necessary for these purposes.

USE AND CARE OF RESPIRATORS

Respirators are worn as needed for protection when handling certain pesticides. The use of respirators is now regulated requiring a health screening prior to their use by a health professional. This is due in part to the Fumigant re-registration decisions by EPA. These prerequisites are outlined in the OSHA Respiratory Protection Act. Prior to using a respirator, read and understand the instructions on the cartridge or canister and all supplemental information about its proper use and care. Be sure the filter is approved for protection against the pesticide intended to be used. Respirators labeled only for protection against particulates must not be used for gases and vapors. Similarly, respirators labeled only for protection against gases and vapors should not be used for particulates. Remember, cartridges and filters do not supply oxygen. Do

not use them where oxygen may be limited. All respirators must be inspected for wear and deterioration of their components before and after each use. Special attention should be given to rubber or plastic parts which can deteriorate. The facepiece, valves, connecting tubes or hoses, fittings, and filters must be maintained in good condition.

All valves, mechanical filters, and chemical filters (cartridges or canisters) should be properly positioned and sealed. Fit the respirator on the face to ensure a tight but comfortable seal. Facial hair will prevent a tight seal and consequently OSHA regulations prohibit the use of a respirator when the user has a beard or facial hair. Two tests can be done to check the fit of most chemical cartridge respirators. The first test requires that you place your hand tightly over the outside exhaust valve. If there is a good seal, exhalation should cause slight pressure inside the facepiece. If air escapes between the face and facepiece, readjust the headbands until a tight seal is obtained. Readjusting the headbands may at times not be sufficient to obtain a good seal. It may be necessary to reposition the facepiece to prevent air from escaping between the face and facepiece. The second test involves covering the inhalation valve(s) by placing a hand over the cartridge(s). If there is a good seal, inhalation should cause the facepiece to collapse. If air enters, adjust the headbands or reposition the facepiece until a good seal is obtained.

Get to fresh air immediately if any of the following danger signals are sensed:

- Contaminants are smelled or tasted
- Eyes, nose, or throat become irritated
- Breathing becomes difficult
- The air being breathed becomes uncomfortably warm
- Nauseous or dizzy sensations are experienced

Cartridges or filters may be used up or abnormal conditions may be creating contaminant concentrations which exceed the capacity of the respirator to remove the contamination.

After each use of the respirator, remove all mechanical and chemical filters. Wash the facepiece with soap and warm water, and then immerse it in a sanitizing solution such as household bleach (two tablespoons per gallon of water) for two minutes, followed by a thorough rinsing with clean water to remove all traces of soap and bleach. Wipe the facepiece with a clean cloth and allow to air dry.

Store the respirator facepiece, cartridges, canisters, and mechanical filters in a clean, dry place, preferably in a tightly sealed plastic bag. ***Do not store respirators with pesticides or other agricultural chemicals.***

Handle respirators with the same care given to other protective equipment and clothing.

PROTECTING OUR GROUNDWATER

Groundwater is the water contained below the topsoil. This water is used by 90% of the rural population in the United States as their sole source of drinking water. Contamination of the water supply by pesticides and other pollutants is becoming a serious problem. One source of contamination is agricultural practices. Protection of our groundwater by the agricultural community is essential.

Groundwater collects under our soils in aquifers that are comprised of layers of sand, gravel, or fractured bedrock which, by their nature, hold water. This water comes from rainfall, snowfall, etc., that moves down through the soil layers to the aquifer. The depth of the aquifer below the surface depends on many factors. Where it is shallow, we see lakes, ponds and wetlands. In areas where it is deep, we find arid regions.

FACTORS THAT AFFECT MOVEMENT OF WATER AND CONTAMINANTS

The depth of aquifers, in conjunction with soil types, influences how much surface water reaches the aquifer. Their depth also affects how quickly water and contaminants reach an aquifer. Thus, shallow water tables tend to be more vulnerable to contamination than deeper ones.

This tendency, however, depends on the soil type. Soils with high clay or organic matter content may hold water longer and retard its movement to the aquifer.Conversely, sandy soils allow water to move downward at a fast rate. High levels of clay and/or organic content in soils also provide a large surface area for binding contaminants that can slow their movement into groundwater. Soil texture also influences downward water movement. Finer textured soils have fewer spaces between particles than coarser ones, thus decreasing movement of water and contaminants.

CHEMISTRY PLAYS A ROLE

The characteristics of an individual pesticide affect its ability to reach groundwater. The most important characteristics are solubility in water, adsorption to soils, and persistence in the environment.

Pesticides that are highly soluble in water have a higher potential for contaminating groundwater than those that are less soluble. The water solubility of a chemical indicates how much chemical will dissolve in water and is measured in parts per million (ppm). Those chemicals with a water solubility greater than 30 ppm may create problems. Be sure to read the Environmental Precautions on each pesticide label.

A chemical's ability to adhere to soil particles plays an important role. Chemicals with a high affinity for soil adsorption are less likely to reach the aquifer. Adsorption is also affected by the amount of organic matter in the soil. Soils with high organic matter content are less vulnerable than those with low organic matter content.

Finally, how persistent a chemical is in the environment may affect its ability to reach groundwater. Those that persist for a long time may be more likely to cause contamination than materials that breakdown quickly. Persistence is measured by the time it takes half of a given pesticide to degrade. This is called the chemical's half-life. Chemicals with an overall estimated half-life longer than 3 weeks pose a threat to groundwater.

HOW TO PREVENT CONTAMINATION OF GROUND WATER

Examine the chemical properties of the pesticides used. If using materials that persist for long periods of time, are very water soluble, or are not tightly held by the soil, then your groundwater

may become contaminated. Another material may be selected that has a shorter persistence, lower water solubility, or higher potential for soil adsorption. The following chart assists with these decisions.

1. Determine the local soil and geologic circumstances. If in an area with a shallow water table or the soil is low in organic matter or sandy in nature, there is a greater risk of contaminating your groundwater. In these cases, choose a pesticide that has a low water solubility and is not persistent.
2. Evaluate management practices. These practices maybe the most important factors in determining the risk of contaminating groundwater. If the same materials are used year after year, or many times a season, the potential for contamination can be increased due to the amount of pesticide in the soil. The timing of pesticide applications has an effect on groundwater contamination. If applications during periods of high rainfall or heavy irrigation are made, it is more likely that contamination may occur. Also, the water table in the spring may be higher than at other times. Early season applications, therefore, may pose a greater chance for groundwater contamination.
3. The method of application may have an effect. Direct injection, incorporation, and chemigation all increase the chance of contamination. If using these techniques, be sure to follow the procedures listed on the material's label.
4. The location of wells can be important. If the sprayer loading area or pesticide storage building is too close to a well, the risk of contamination may be greater. Wells should be located a minimum distance from all pesticide storage and loading areas. This distance differs between states but is generally between 50 and 100 ft. In the event of an accident, this distance should prevent contamination. This minimum distance should also be followed for field irrigation wells. If they are too close to application areas, contamination might occur.
5. Check the condition of any wells in the vicinity of sprayer loading areas, pesticide storage areas, or field applications. If they have cracked casings trouble is being invited. Cracks in a well casing provide a direct point of entry for pesticide-contaminated water that is in the soil.
6. Use some type of anti back-flow device in any system used for chemigation or to fill the sprayer with water. In the event of a pump shutoff or other failure, if any back-flow into the water system occurs, these devices will prevent pesticides from entering the well. Many state laws require that anti back-flow devices be placed on all sprayer water intake systems prior to the water entering the tank. The use of an air gap only is no longer acceptable in some states.
7. Care and maintenance of equipment is also an important consideration. If the equipment does not function properly, over-delivery may occur, which increases the chance of groundwater contamination. Prior to the beginning of the season, inspect all of the working parts of the sprayer or chemigation system. Check the pump to ensure that it is working properly. For both sprayers and chemigation systems, check the water lines for clogs and leaks. For sprayers, check the nozzles for wear and clogs. Clogged, leaking, or worn lines and nozzles can cause pesticides to be delivered in too high an amount or into unwanted areas. Be sure to calibrate equipment. Uncalibrated equipment can cause over-delivery as well. Equipment should be calibrated at the beginning of the season, periodically during the remainder of the season, and any time changes or adjustments are made to the equipment.
8. Apply materials only when needed. The use of pesticides, when not needed, can increase the threat of contamination. Check irrigation practices as well. Do not irrigate immediately after a pesticide application, unless required by a pesticide's label. The increased water content in the soil might speed up the downward movement of a pesticide.

REMEMBER, GROUNDWATER MUST BE PROTECTED.

TOXICITY OF CHEMICALS USED IN PEST CONTROL

The danger in handling pesticides does not depend exclusively on toxicity values. Hazard is a function of both toxicity and the amount and type of exposure. Some chemicals are very hazardous from dermal (skin) exposure as well as oral (ingestion). Although inhalation values are not given, this type of exposure is similar to ingestion. A compound may be highly toxic but present little hazard to the applicator if the precautions are followed carefully.

Toxicity values are expressed as acute oral LD_{50} in terms of milligrams of the substance per kilogram (mg/kg) of test animal body weight required to kill 50 percent of the population. The acute dermal LD_{50} is also expressed in mg/kg. These acute values are for a single exposure and not for repeated exposures such as may occur in the field. Rats are used to obtain the oral LD_{50} and the test animals used to obtain the dermal values are usually rabbits.

CATEGORIES OF TOXICITY[1]

Categories	Signal Word	LD_{50} Value (mg/kg)	
		Oral	Dermal
I	Danger-Poison	0 – 50	0 – 200
II	Warning	50-500	200-2,000
III	Caution	500-5,000	2,000-20,000
IV	None[2]	5,000	5,000 20,000

[1] EPA accepted categories.

[2] No signal word required based on acute toxicity; however, products in this category usually display "Caution."

Read all labels and become familiar with the symptoms of pesticide poisoning. For help in a pesticide emergency, seek immediate medical attention and call the appropriate poison information number on the back cover of this book.

TOXICITY AND LD_{50} CALCULATIONS WEIGHT CONVERSIONS

1 ounce (oz) = 28 grams (gr)
1 pound (lb) = 454 grams (gr)
1 gram (gr) = 1,000 milligrams (mg)
1,000 mg = 0.035 oz
1 mg = 0.000035 oz

CONVERSIONS: BODY WEIGHT IN POUNDS (LB) TO BODY WEIGHT IN KILOGRAMS (KG)

(lb)		(kg)
25	=	11.25
50	=	22.5
75	=	33.75
100	=	45

To determine an exact weight, multiply known body weight in pounds by 0.45. *Example*: 100 lb x 0.45 = 45 kg

Note: All the following calculations use a body weight of 100 pounds. To determine the LD_{50}, first convert body weight to kilograms; to do this multiply weight in lb by 0.45.
Example: 100 x 0.45 = 45 kg

Next, multiply given LD_{50} by body weight in kg. **Note**: LD_{50} numbers are given by the manufacturer.
Example: LD_{50} of 11 x 45 kg = 495 mg

Next, to convert milligrams (mg) to ounces (oz), multiply mg by 0.000035. *Example*: 495 mg x 0.000035 = 0.017 oz.

The following is a chart of LD_{50} figures converted to ounces for three commonly used products in the agricultural industry.

		Body Weight in Pounds				
	LD_{50}	30	60	100	150	200
		Ounces				
Insecticide Furadan	11	0.005	0.010	0.017	0.026	0.035
Herbicide Micro-Tech/Partner	1,800	0.9	1.7	2.8	4.3	5.7
Fungicide Chlorothalonil	10,000	4.9	9.5	15.7	23.8	31.5

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Insect Control for Commercial Vegetables

Read the pesticide label before application. High pressure (200 psi) and high volume (50 gallons per acre) aid in vegetable insect control. Ground sprays with airblast sprayers or sprayers with hollow cone drop nozzles are suggested. Incorporate several methods of control for best results. In recent years, the number of generic products has increased significantly. For brevity, these generic products typically are not listed within each section. The trade names listed are intended to aid in identification of products and are neither intended to promote use of specific trade names nor to discourage use of generic products. A list of active ingredients and generic brand names appears in a separate table at the end of this section.

Insecticides are placed into IRAC MOA classes based on their mode of action (insecticides in the same MOA class have the same mode of action). Effective insecticide resistance management involves the use of alternations, rotations, or sequences of different insecticide MOA classes. To prevent the development of resistance, it is important not to apply insecticides with the same MOA to successive generations of the same insect.

TABLE 2-1. INSECT CONTROL FOR ASPARAGUS

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	dimethoate 400, MOA 1B	1 pt	48 hrs	180	Do not exceed 5 pt per acre per year.
	malathion, MOA 1B (various) 57 EC	2 pt	12 hrs	1	Aphid colonies appear by early September. The use of carbamates may result in aphid buildup.
	pymetrozine, MOA 9B (Fulfill) 50 WDG	2.75 oz	12 hrs	—	For aphid control on ferns after harvest.
Asparagus beetle, Japanese beetle, Grasshopper	carbaryl, MOA 1A (Sevin) 50 WP (Sevin) 80 S (Sevin) XLR Plus	 2 to 4 lb 1.25 to 2.5 lb 1 to 2 qt	12 hrs	 1 1 1	Low rate to be used on seedlings or spears. Do not apply more often than once every 3 days. With established beetle populations, three consecutive weekly sprays are required. Manage beetles and grasshoppers in the fall.
	dimethoate 400, MOA 1B	1 pt	48 hrs	180	Do not exceed 5 pt per acre per year.
	malathion, MOA 1B (various) 57 EC	2 pt	12 hrs	1	Apply as needed.
	methomyl, MOA 1A (Lannate) 2.4 LV	1.5 pt	48 hrs	1	Let a row on edge of field near overwintering sites of asparagus beetles fern out. This will attract and hold beetles for that directed insecticide spray (trap and destroy).
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	spinetoram, MOA 5 (Radiant) 1 SC	4 to 8 fl oz	4 hrs	60	For asparagus beetle only. This use is only for asparagus ferns; do not apply within 60 days of spear harvest.
Beet armyworm, Cutworm, Yellow-striped armyworm	*Bacillus thuringiensis,* MOA 11A (Dipel) DF	0.5 to1 lb	4 hrs	0	
	chlorantraniliprole, MOA 28 (Coragen) 1.67SC	3.5 to 5 fl oz	4 hrs	1	
	methomyl, MOA 1A (Lannate) 2.4 LV (Lannate) 90 SP	 1.5 to 3 pt 0.5 to 1 lb	48 hrs	 1 1	
	spinetoram, MOA 5 (Radiant) 1 SC	4 to 8 fl oz	4 hrs	60	This use is only for asparagus ferns; do not apply within 60 days of spear harvest.
	spinosad MOA 5 (Entrust 2SC)	4 to 6 fl oz	4 hrs	60	This use is only for asparagus ferns; do not apply within 60 days of spear harvest. **OMRI approved.**

TABLE 2-2. INSECT CONTROL FOR BEANS (SNAP, LIMA, POLE)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	acephate, MOA 1B (Orthene) 97 PE	 0.5 to 1 lb	24 hrs	 14	Do not apply more than 2.66 lb per acre per season. Will not control black bean aphid. Lima bean may be harvested one day after treatment.
	acetamiprid MOA 4A (Assail) 30SG	 2.5 to 5.3 oz	12 hrs	 7	
	dimethoate 4 EC, MOA 1B	0.5 to 1 pt	48 hrs	0	On foliage as needed. Re-entry interval of 48 hr.
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	See label for soil application instructions. Also controls leafhoppers and thrips
	Foliar treatment Admire Pro 4.6 F (various) 1.6 F	 1.2 fl oz 3.5 fl oz	12 hrs	 7 7	
	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	spirotetramat, MOA 23 (Movento) 2 SC	 4 to 5 fl oz	24 hrs	 1 (succulent) 7 (dried)	
Thrips	acephate, MOA 1B (Orthene) 97 PE	 0.5 to 1 lb	24 hrs	 14	Lima beans may be treated and harvested the same day. Do not apply more than 2 lb ai per acre per season.
	acetamiprid MOA 4A (Assail) 30SG	 2.5 to 5.3 oz	12 hrs	 7	
	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	methomyl, MOA 1A (Lannate) 90 SP (Lannate) 2.4 LV	 0.5 lb 1.5 pt	48 hrs	 1	
	novaluron MOA 15 (Rimon) 0.83 EC	 12 fl oz	12 hrs	 1	Effective against immature thrips only.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 6 fl oz	4 hrs	 3 (succulent) 28 (dried)	Do not apply more than 28 fl oz per acre per season on succulent beans or more than 12 fl oz on dried beans.
Corn earworm, European corn borer, Lesser cornstalk borer, Looper	acephate, MOA 1B (Orthene) 75 S, 75 WSP (Orthene) 97 PE	 1 to 1.333 lb 0.75 to 1 lb	24 hrs	 14 14	Do not apply more 2 lb ai per acre per season. Lima beans may be treated and harvested the same day.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	
	flubendiamide, MOA 28 (Belt) 4 SC	 2 to 3 fl oz	12 hrs	 1 (succulent) 14 (dried)	1-day PHI for podded and succulent, 14 for dry beans.
	novaluron MOA 15 (Rimon) 0.83 EC	 6 to 12 fl oz	12 hrs	 1	
	spinetoram, MOA 5 (Radiant) 1 SC	 4.5 to 6 fl oz	4 hrs	 3 (succulent) 28 (dried)	Do not apply more than 28 fl oz per acre per season on succulent beans or more than 12 fl oz on dried beans.
	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Cowpea curculio	pyrethroid, MOA 3	12 hrs			See **Table 2-26** for a list of registered pyrethroids and pre-harvest intervals. Control may be poor in areas where resistant populations occur, primarily in the Gulf Coast areas.
Cucumber beetle, Bean leaf beetle, Japanese beetle	carbaryl, MOA 1A (Sevin) 50 WP 80 S XLR Plus	 4 lb 2.5 lb 1 qt	12 hrs	 3 (succulent) 21 (dried)	
	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Cutworm	acephate, MOA 1B (Orthene) 97 PE	 0.5 to 1 lb	24 hrs	 14	Do not apply more 2 lb ai per acre per season. Lima beans may be harvested one day after treatment.
	carbaryl, MOA 1A (Sevin) 50 WP 80 S XLR Plus	 2 to 2.5 lb 1.25 to 1.875 lb 1 qt	12 hrs	 3 (succulent) 21 (dried)	
	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.

TABLE 2-2. INSECT CONTROL FOR BEANS (SNAP, LIMA, POLE) (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Grasshopper	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Leafminer	cryomazine, MOA 17 (Trigard) 75 WP	2.66 oz	12 hrs	7	
	naled, MOA 1B (Dibrom) 8 EC	1 pt	48 hrs	1	Re-entry interval is 48 hr.
	spinetoram, MOA 5 (Radiant) 1 SC	4 to 8 fl oz	4 hrs	3 (succulent) 28 (dried)	Do not apply more than 28 fl oz per acre per season on succulent beans or more than 12 fl oz on dried beans.
Lygus bug	acephate, MOA 1B (Orthene) 75 S, 75 WSP 97 PE	0.67 lb 0.5 to 1 lb	24 hrs	14	Do not apply more than 2 lb ai per acre per season. Lima beans may be treated and harvested the same day.
	carbaryl, MOA 1A (Sevin) 50 WP 80 S XLR Plus	3 lb 1.875 lb 1.5 qt	12 hrs	3 (succulent) 21 (dried)	On foliage when pods begin to form.
	dimethoate, MOA 1B (Dimethoate) 4 EC	1 pt	48 hrs	7	Do not apply if bees are visiting area to be treated when crops or weeds are in bloom.
Mexican bean beetle	acephate, MOA 1B (Orthene) 75 S, 75 WSP (Orthene) 97 PE	0.67 lb 0.5 to 1 lb	24 hrs	14 14	Do not apply more than 2 lb ai per acre per season. Lima beans may be treated and harvested the same day.
	acetamiprid MOA 4A (Assail) 30SG	2.5 to 5.3 oz	12 hrs	7	
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	carbaryl, MOA 1A (Sevin) 50 WP (Sevin) 80 S (Sevin) XLR Plus	1 to 2 lb 0.625 to 1.25 lb 1 qt	12 hrs	3 (succulent) 21 (dry)	On foliage as needed. Use low rate on young plants.
	dimethoate, MOA 1B (Dimethoate) 4 EC	1 pt	48 hrs	0	48-hr re-entry interval.
	novaluron MOA 15 (Rimon) 0.83 EC	9 to 12 oz	12 hrs	1	Controls immature stages only.
	phorate, MOA 1B (Thimet) 20 G	4.9 to 9.4 oz/1,000 ft row	48 hrs	60	Drill granules to the side of seed at planting. Avoid contact with seed.
Potato leafhopper	acephate, MOA 1B (Orthene) 97 PE	0.5 to 1 lb	24 hrs	14	Do not apply more than 2 lb ai per acre per season. Lima beans may be harvested one day after treatment.
	acetamiprid MOA 4A (Assail) 30SG	2.5 to 5.3 oz	12 hrs	7	
	carbaryl, MOA 1A (Sevin) 50 WP (Sevin) 80 S (Sevin) XLR Plus	4 lb 2.5 lb 1 qt	12 hrs	3 (succulent) 21 (dry)	On foliage as needed.
	dimethoate 4 EC, MOA 1B	0.5 to 1 pt	48 hrs	7	
	methomyl, MOA 1A (Lannate) 90 SP (Lannate) 2.4 L	0.5 lb 1.5 to 3 pt	48 hrs	1 1 to 3	Do not graze before 3 days or use for hay before 7 days.
	phorate, MOA 1B (Thimet) 20 G	4.9 to 9.4 oz/ 1,000 ft row	48 hrs	60	Drill granules to the side of seed at planting. Avoid contact with seed.
	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Seedcorn maggot, Wireworm	***Use seed pretreated with insecticide for seedcorn maggot control.***				Seed can be purchased pretreated. Pretreated seed will not control wireworms.
	bifenthrin MOA 3 (Empower) 1.15G	3.5 to 8.7 lb	9 days	9	Apply preplant broadcast incorporated in the top 1 to 3 inches of soil.

TABLE 2-2. INSECT CONTROL FOR BEANS (SNAP, LIMA, POLE) (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Seedcorn maggot, Wireworm (cont'd)	chlorpyrifos MOA 1B (Lorsban) 4E	2 pts	24 hrs		Can be applied preplant broadcast incorporated in the top 1 to 3 inches of soil, or at planting as a T-band application. For at planting application, apply 1.8 fl oz per 1000 ft of row at 30-inch row spacing. Apply the spray in a 3 to 5 inch wide band over the row behind the planting shoe and in front of the press wheel to achieve shallow incorporation. Do not make more than one application per year or apply more than 1 lb a.i per acre.
	phorate, MOA 1B (Thimet) 20 G	4.9 to 9.4 oz/ 1,000 ft row	12 hrs	60	Drill granules to the side of seed at planting. Avoid contact with seed.
Spider mite	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	bifenazate MOA 25 (Acramite) 4 SC	16 to 24 fl oz	12 hrs	3	
Stink bug, Kudzu bug	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	naled, MOA 1B (Dibrom) 8 EC	1.5 pt/100 gal water	48 hrs	1	
Whiteflies	acetamiprid MOA 4A (Assail) 30 SG	4.0 to 5.3 oz	12 hrs	7	
	buprofezin, MOA 16 (Courier) 40 SC	9 to 13.6 fl oz	12 hrs	14	For use on snap beans only.
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	See label for soil application instructions.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	 1.2 fl oz 3.5 fl oz	12 hrs	 7	
	Spirotetramat, MOA 23 (Movento)	4 to 5 fl oz	24 hrs	1 (succulent) 7 (dry)	PHI is 1 day for succulent beans and 7 days for dry beans.

TABLE 2-3. INSECT CONTROL FOR BEET

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	 4.4 to 10.5 fl oz 10 to 24 fl oz	12 hrs	 21 21	See label for soil application instructions. Will also control flea beetle.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	 1.2 fl oz 3.5 fl oz	12 hrs	 7 7	
	thiamethoxam, MOA 4A (Platinum) 75 SG	1.7 to 2.17 oz	12 hrs		Platinum may be applied to direct-seeded crops in-furrow at seed or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 12 oz per acre per season of Platinum. Check label for plant-back restrictions for a number of crops.
	(Actara) 25 WDG	1.5 to 3 oz	12 hrs	7	
Armyworm, Beet webworm	chlorantraniliprole MOA 28 (Coragen) 1.67 SC	3.5 to 5 fl oz	4 hrs	1	
	methoxyfenozide MOA 18 (Intrepid) 2F	6 to 16 fl oz	4 hrs	7	
	spinetoram, MOA 5 (Radiant) 1 SC	6 to 8 fl oz	4 hrs	7	Do not apply more than 32 fl oz per acre per season.
Blister beetle, Flea beetle	carbaryl, MOA 1A (Sevin) 50 WP 80 S XLR	 3 lb 1.875 lb 1 qt	12 hrs	 7 7 7	
	pyrethroid, MOA 3		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Leafminer	spinetoram, MOA 5 (Radiant) 1 SC	6 to 10 fl oz	4 hrs	7	Control will be improved with addition of a spray adjuvant.

TABLE 2-4. INSECT CONTROL FOR BROCCOLI, BRUSSELS SPROUT, CABBAGE, CAULIFLOWER

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	acetamiprid, MOA 4A (Assail) 30 SG	 2 to 3 oz	12 hrs	 7	
	clothianidin, MOA 4A (Belay) 50WD	 4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	 21 (foliar)	Soil application at planting only.
	dimethoate 4 EC, MOA 1B	0.5 to 1 pt	48 hrs	7	
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	 4.4 to 10.5 fl oz 10 to 24 fl oz	12 hrs	 21 21	Do not follow soil applications of Admire with foliar applications of any neonicotinoid insecticide. Use only one application method. See label for soil application instructions. Imidacloprid also controls whiteflies.
	Foliar treatment (Admire Pro) 4.6 F (various) 2 F	 1.3 fl oz 3.75 fl oz	12 hrs	 7 7	Imidacloprid also controls whiteflies. Not effective against flea beetle.
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 oz	12 hrs	 7	
	spirotetramat, MOA 23 (Movento) 2 SC	 4 to 5 fl oz	24 hrs	 1	Do not exceed 10 fl oz per season. Requires surfactant.
	thiamethoxam MOA 4A *Soil treatment* (Platinum) 75SG	 1.66 to 3.67 oz	12 hrs	 30	Platinum may be applied to direct-seeded crops in-furrow at seed or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 3.67 oz per acre per season.
	Foliar treatment (Actara) 25WDG	1.5 to 3.0 oz		0	Thiamethoxam also controls whiteflies and certain thrips species.
Diamondback moth, Cabbage looper, Imported cabbageworm, Corn earworm, Cross-striped cabbageworm, Cabbage webworm, Armyworm	***Insecticide-resistant populations, widespread in Southeastern U.S. may not be controlled with some registered insecticides. To manage resistance, avoid transplants from Georgia and Florida and avoid repeated use of the same materials for extended periods of time. Repeated use of pyrethroid insecticides destroys natural enemies and often aggravates diamondback moth problems. Do not allow populations to increase to large densities before treatments are initiated.***				
	Bacillus thuringiensis, MOA 11A (Dipel) 2X (Dipel) 4 L (Javelin) WG (Xentari) WDG	 8 oz 1 to 2 qt 0.5 to 1 lb 0.5 to 1 lb	4 hrs	 0 0 0 0	On foliage every 7 days. On summer or fall plantings, during periods when eggs and larvae are present. This usually occurs when true leaves appear; on other plantings, it may occur later. A spreader-sticker will be helpful. **NOT EFFECTIVE AGAINST CABBAGE WEBWORM**
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 3	
	emamectin benzoate, MOA 6 (Proclaim) 5 WDG	 3.2 to 4.8 oz	12 hrs	 7	
	flubendiamide, MOA 28 (Belt) 4SC	 2 to 2.4 fl oz	12 hrs	 1	
	indoxacarb, MOA 22 (Avaunt) 30 WDG	 2.5 to 3.5 oz	12 hrs	 3	Add a wetting agent to improve spray. Do not apply more than 14 oz (0.26 lb ai) per acre per crop. The minimum interval between sprays is 3 days.
	novaluron, MOA 15 (Rimon) 0.83 EC	 6 to 12 fl oz	12 hrs	 7	Use lower rates when targeting eggs or small larvae, and use higher rates when larvae are large. Make no more than three applications or 24 fl oz per acre per season.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	
	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for a list of registered pyrethroids and preharvest intervals. Not for use where diamondback moth is a concern.
Flea beetle	acetamiprid, MOA 4A (Assail) 30 SG	 2 to 3 oz	12 hrs	 7	
	chlorpyrifos, MOA 1B (Lorsban) 50 W 75 WG	 2 lb 1.33 lb	24 hrs	 21 21	On foliage when insects appear. Repeat as needed.
	clothianidin, MOA 4A (Belay) 50WDG	 4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	21 (Soil) 7 (foliar)	Soil application at planting only.

TABLE 2-4. INSECT CONTROL FOR BROCCOLI, BRUSSELS SPROUT, CABBAGE, CAULIFLOWER (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Flea beetle (cont'd)	dimethoate 4 EC, MOA 1B	0.5 to 1 pt	48 hrs	7	
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	 4.4 to 10.5 fl oz 10 to 24 fl oz	12 hrs	 21 21	
	pyrethroid MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Harlequin bug, Stink bug	clothianidin, MOA 4A (Belay) 50WDG	 4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	 21 (Soil) 7 (foliar)	Soil application at planting only.
	dinotefuran, MOA 4A (Venom 70 SG)	 3 to 4 oz	12 hrs	 1	Do not exceed 6 oz of Venom per season.
	pyrethroid, MOA 3A	12 hrs			See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Root maggot	chlorpyrifos, MOA 1B (Lorsban) 4 EC (Lorsban) 75 WG	 2 pt/100 gal 1.33 lb	24 hrs	 —	Directed spray to transplants: Spray the base of the plant immediately after transplanting, using a minimum of 40 gal per acre.
	chlorpyrifos, MOA 1B (Lorsban) 4 EC	 1.6 to 2.75 oz/ 1,000 ft row	24 hrs	 —	Direct seeded: Apply in a 4-in. wide band behind planter shoe and in front of press wheel for shallow incorporation.
	(Lorsban) 15 G	4.6 to 9.2 oz/ 1,000 ft row	24 hrs	—	Direct seeded: Place across seed row in 4-in. band behind planter shoe and in front of press wheel.
	diazinon, MOA 1B (Diazinon 50 W) 50 WP	 0.25 to 0.5 lb/ 50 gal	4 days	 —	Transplant water: Apply in transplant water or drench water at 4 to 6oz per plant at transplanting.
Thrips	dimethoate 4 EC, MOA 1B	0.5 to 1 pt	48 hrs	7	
	imidacloprid, MOA 4A (Admire Pro) 4.6F (various) 2F (various) 1.6 F	 1.3 fl oz 3.0 fl oz 3.75 fl oz	12 hrs	 7 7 7	Check label for rates for other formulations. Foliar applications only.
	methomyl, MOA 1A (Lannate) 2.4 LV	 1.5 fl oz	48 hrs	 1	
	novaluron, MOA 15 (Rimon) 0.83 EC	 6 to 12 fl oz	12 hrs	 7	Make no more than three applications, or 24 fl oz, per acre per season.
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 10 fl oz	4 hrs	 1	
Whitefly	acetamiprid, MOA 4A (Assail) 30 SG	 2.5 to 4.0 oz	12 hrs	 7	Use a spreader stick to improve control.
	dinotefuran, MOA 4A (Venom) 70 SG	 1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	 1 (foliar) 21 (soil)	Do not follow soil applications with foliar applications of any neonicotinoid insecticide. Use only one application method. Do not apply more than 6 oz per acre per season using foliar applications, or 12 oz per acre per season using soil applications. Soil applications may be applied by: a narrow band below or above the seed line at planting; a post-seeding or transplant drench with sufficient water to ensure incorporation to the root zone; or through drip irrigation.
	spiromesifen, MOA 23 (Oberon) 2 SC	 7 to 8.5 fl oz	12 hrs	 7	Do not exceed 25.5 fl oz per acre per season.
	spirotetramat, MOA 23 (Movento) 2 SC	 4 to 5 fl oz	24 hrs	 1	Do not exceed 10 fl oz per season. Requires surfactant.
	pyriproxyfen, MOA 7 (Knack) 0.86EC	 8 to 10 fl oz	12 hrs	 7	Only treat whole fields, and do not any crop other than those that Knack is registered within 30 days after the last application.
	spirotetramat, MOA 23 (Movento)	 4 to 5 fl oz	24 hrs	 1	Use a spreader-penetrator adjuvant.

TABLE 2-5. INSECT CONTROL FOR CANTALOUPE, MUSKMELON

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide applications in cucurbits should be made in late evening to protect pollinating insects. Refer to the pollination section of the general production recommendations in this publication for more information about protecting pollinators.					
Aphid	acetamiprid MOA 4A		12 hrs		Do not exceed 0.5 lb per acre per season.
	(Assail) 30SG	2.5 to 4.0 oz		0	
	clothianidin, MOA 4A		12 hrs		Soil application at planting only.
	(Belay) 50 WDG	4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)		7 (foliar) 21 (soil)	
	dimethoate, MOA 1B		48 hrs		
	(Dimethoate E267) 2E	2 pt		3	
	(Dimethoate E267) 2.67E	1.5 pt		3	
	flonicamid, MOA 9C		12 hrs		
	(Beleaf) 50 SG	2 to 2.8 oz		0	
	imidacloprid, MOA 4A		12 hrs		Must be applied to the soil. May be applied preplant; at planting; as a post-seeding drench, transplant water drench, or hill drench; subsurface sidedress or by chemigation using low-pressure drip, or trickle irrigation. See label for information on approved application methods. Will also control cucumber beetles and whiteflies.
	(Admire Pro) 4.6 F	7 to 10.5 fl oz		21	
	(various) 2 F	16 to 24 fl oz		21	
	pymetrozine, MOA 9B		12 hrs		Apply before aphids reach damaging levels. Do not exceed 5.5 oz per acre per season.
	(Fulfill) 50 WDG	2.75 oz		0	
	thiamethoxam, MOA 4A		12 hrs		Platinum is for soil application and may be applied to direct-seeded crops in-furrow at seed or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 8 oz per acre per season of Platinum. Check label for plant-back restrictions for a number of crops. Actara is for foliar application only.
	(Platinum) 75 SG	1.66 to 3.67 oz		30	
	(Actara) 25WDG	1.5 to 3 oz		0	
Armyworm, Cabbage looper	*Bacillus thuringiensis,* MOA 11A		4 hrs		On foliage as needed.
	(Crymax) WDG,	0.5 to 1.5 lb		0	
	(Dipel) 2X	8 oz		0	
	(Xentari) WDG	0.5 to 1 lb		0	
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for a list of registered pyrethroids and pre-harvest intervals. Not recommended for armyworm.
	chlorantraniliprole, MOA 28		4 hrs		Coragen may be used for foliar or drip chemigation.
	(Coragen) 1.67 SC	3.5 to 5 fl oz		1	
	flubendiamide, MOA 28		12 hrs		
	(Belt) 4SC	1.5 fl oz		1	
	indoxacarb, MOA 22		12 hrs		
	(Avaunt) 30WDG	2.5 to 6 oz		3	
	methoxyfenozide, MOA 18		4 hrs		Use higher rates against large larvae.
	(Intrepid) 2 F	4 to 10 fl oz		3	
	novaluron, MOA 15		12 hrs		
	(Rimon) 0.83EC	9 to 12 fl oz		1	
	spinetoram, MOA 5		4 hrs		
	(Radiant) 1 SC	5 to 10 fl oz		3	
Cucumber beetle	acetamiprid MOA 4A		12 hrs		Do not exceed 0.5 lb per acre per season.
	(Assail) 30SG	2.5 to 5.3 oz		0	
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	carbaryl MOA 1A		12 hrs		
	(Sevin) 50 WP	2 lb		3	
	(Sevin) 80 S	1.25 lb		3	
	(Sevin) XLR Plus	1 qt		3	
	clothianidin, MOA 4A		12 hrs		Soil application at planting only.
	(Belay) 50 WDG	4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)		7 (foliar) 21 (soil)	
	dinotefuran, MOA 4A		12 hrs		Do not make both a soil and foliar application, use one or the other. At planting applications are most effective against cucumber beetle.
	Soil application				
	(Venom) 70 SG	5 to 6 oz		21	
	(Scorpion) 35SL	9 to 10.5 fl oz		21	
	Foliar application	1 to 4 oz		1	
	(Venom) 70 SG	2 to 7 fl oz		1	
	(Scorpion) 35SL				

TABLE 2-5. INSECT CONTROL FOR CANTALOUPE, MUSKMELON (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide applications in cucurbits should be made in late evening to protect pollinating insects. Refer to the pollination section of the general production recommendations in this publication for more information about protecting pollinators.					
Cucumber beetle (cont'd)	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	Must be applied to the soil. See label for information on approved application methods. Will also control aphids and whiteflies.
Leafminer	abamectin, MOA 6 (Agri-Mek) 0.7 SC	 1.75 to 3.5 fl oz	12 hrs	 7	Do not use more than six applications per season.
	cyromazine, MOA 17 (Trigard) 75 WS	 2.7 oz	12 hrs	 0	
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 2 to 3.5 fl oz	4 hrs	 1	For foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 3	
	dimethoate 4 EC, MOA 1B	1 pt	48 hrs	3	
Pickleworm, Melonworm	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	carbaryl, MOA 1A (Sevin) 50 WP (Sevin) 80 S (Sevin) XLR Plus	 2 lb 1.25 lb 1 qt	12 hrs	 3 3 3	On foliage when worms appear in blossoms. Repeat as needed. Protect pollinators. Rarely a problem before July.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 2 to 3.5 fl oz	4 hrs	 1	For foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	flubendiamide, MOA 28 (Belt) 4SC	 1.5 fl oz	12 hrs	 1	
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 10 fl oz	4 hrs	 3	
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 3	
Spider mite	abamectin, MOA 6 (Agri-Mek) 0.7 SC	 1.75 to 3.4 fl oz	12 hrs	 7	
	bifenazate, MOA 25 (Acramite) 50 WS	 0.75 to 1.0 lb	12 hrs	 3	Do not make more than one application per season.
	etoxazole, MOA 10B (Zeal) 72 WSP	 2 to 3 oz	12 hrs	 7	Does not kill adults
	fenpyroximate MOA 21 (Portal) 0.4EC	 2 pt	12 hrs	 3	Do not make more than two applications per season.
	spiromesifen, MOA 23 (Oberon) 2 SC	 7 to 8.5 fl oz	12 hrs	 7	
Thrips	dimethoate 4EC, MOA 1B	1 pt	48 hrs	3	On foliage as needed.
	dinotefuran, MOA 4A (Venom) 70 SG	 1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	 1 (foliar) 21 (soil)	Do not follow soil applications of Venom with foliar applications of any neonicotinoid insecticide. Use only one application method. Do not apply more than 6 oz per acre per season using foliar applications, or 12 oz per acre per season using soil applications. Soil applications may be applied by: a narrow band below or above the seed line at planting; a post-seeding or transplant drench with sufficient water to ensure incorporation to the root zone; or through drip irrigation.
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 10 fl oz	4 hrs	 3	
Whiteflies	acetamiprid, MOA 4A (Assail)	 1.1 to 2.3 oz	12 hrs	 0	
	buprofezin, MOA 16 (Courier) 40 SC	 9 to 13.6 oz	12 hrs	 7	Use sufficient water to ensure good coverage. Do not apply more than twice per crop cycle.
	dinotefuran, MOA 4A (Venom) 70 SG	 1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	 1 (foliar) 21 (soil)	Do not follow soil applications with foliar applications. Use only one application method. Do not apply more than 6 oz per acre per season using foliar applications, or 12 oz per acre per season using soil applications. Soil applications may be applied by: a narrow band below or above the seed line at planting; a post-seeding or transplant drench with sufficient water to ensure incorporation to the root zone; or through drip irrigation.

TABLE 2-5. INSECT CONTROL FOR CANTALOUPE, MUSKMELON (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide applications in cucurbits should be made in late evening to protect pollinating insects. Refer to the pollination section of the general production recommendations in this publication for more information about protecting pollinators.					
Whiteflies (cont'd)	imidacloprid, MOA 4A		12 hrs		Must be applied to the soil. May be applied preplant; at planting; as a post-seeding drench or hill drench; subsurface sidedress; or by chemigation using low pressure drip or trickle irrigation. See label for information on approved application methods. Will also control aphids and cucumber beetles.
	(Admire Pro) 4.6 F	7 to 10.5 oz		21	
	(various) 2 F	16 to 24 fl oz		21	
	pyriproxyfen, MOA 7C		12 hrs		Do not make more than two applications per season, and do not make applications closer than 14 days apart.
	(Knack) 0.86 EC	8 to 10 oz		7	
	spiromesifen, MOA 23		12 hrs		Apply against adults, before nymphs are present. Do not exceed 3 applications per season.
	(Oberon) 2 SG	7 to 8.5 fl oz		7	
	thiamethoxam, MOA 4A		12 hrs		Platinum is for soil application and may be applied to direct-seeded crops in-furrow at seed or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 11 oz per acre per season of Platinum. Check label for plant-back restrictions for a number of crops.
	(Platinum) 75 SG	1.66 to 3.67 fl oz		30	
	(Actara) 25WDG	3 to 5.5 oz		0	Actara is for foliar application.
Wireworm	diazinon, MOA 1B		3 days	—	Broadcast on soil before planting and thoroughly work into upper 6 in.
	(Diazinon) AG 500	3 to 4 qt			

TABLE 2-6. INSECT CONTROL FOR CARROT

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	imidacloprid, MOA 4A		12 hrs		Must be applied to the soil. May be applied via chemigation into the root zone through low-pressure drip, trickle, micro-sprinkler, or equivalent equipment; in-furrow spray or shanked-in 1 to 2 in. below seed depth during planting; or in a narrow band (2 in. or less) 1 to 2 in. directly below the eventual seed row in a bedding operation 14 or fewer days before planting. Higher rates provide longer lasting control. See label for information on approved application methods and rate per 100 row feet for different row spacings.
	Soil treatment				
	(Admire Pro) 4.6 F	4.4 to 10.5 fl oz		21	
	(various) 2 F	10 to 24 fl oz		21	
	Foliar treatment		12 hrs		
	(Admire Pro) 4.6 F	1.2 fl oz		7	
	(various) 1.6 F	3.5 fl oz		7	
	thiamethoxam, MOA 4A		12 hrs		Platinum may be applied to direct-seeded crops in-furrow at seeding, immediately after seeding with sufficient water to ensure incorporation into the root zone, or through trickle irrigation.
	(Platinum) 75 SG	1.66 to 3.67 oz		30	
	(Actara) 25 WDG		12 hrs		Actara is applied to foliage. Do not exceed 4 oz Actara per acre per season.
		1.5 to 3 oz		7	
	flonicamid, MOA 9C		12 hrs		
	(Beleaf) 50SG	2 to 2.8 fl oz		3	
Armyworm, Parsleyworm, Leafhopper	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	carbaryl, MOA 1A		12 hrs		On foliage as needed.
	(Sevin) 80 S	1.25 lb		7	
	(Sevin) XLR Plus	1 qt		7	
	chlorantraniliprole, MOA 28		4 hrs		Coragen may be used for foliar or drip chemigation.
	(Coragen) 1.67 SC	3.5 to 5 fl oz		1	
	methomyl, MOA 1A		48 hrs		
	(Lannate) 2.4 LV	0.75 to 1.5 pt		1	
	(Lannate) 90 SP	0.25 to 0.5 lb		1	
	methoxyfenozide, MOA 18		4 hrs		Use higher rates against large larvae.
	(Intrepid) 2 F	4 to 10 fl oz		1	
	spinetoram, MOA 5		4 hrs		Radiant will not control leafhoppers. Do not make more than 4 applications per year.
	(Radiant) 1 SC	6 to 8 fl oz		3	
Leafminer	spinetoram, MOA 5		4 hrs		
	(Radiant) 1 SC	6 to 8 fl oz		3	
Wireworm	diazinon, MOA 1B		3 days		Broadcast and incorporate preplant.
	(Diazinon) (AG 500)	4 qt		—	

TABLE 2-7. INSECT CONTROL FOR CELERY

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid, Flea beetle	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	Apply via chemigation into the root zone, as an in-furrow spray at planting on/or below the seed, or as a post-seeding or transplant drench.
	spirotetramat, MOA 23 (Movento) 2SC	 4 to 5 fl oz	24 hrs	 3	Do not exceed 10 fl oz per season. Not for flea beetle. Requires surfactant.
Armyworm, Corn earworm, Looper	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	emamectin benzoate, MOA 6 (Proclaim) 5 WDG	 2.4 to 4.8 oz	12 hrs	 7	Do not make more than two sequential applications without rotating to another product with a different mode of action.
	methomyl, MOA 1A (Lannate) 2.4 LV	 3 pt	48 hrs	 7	Methomyl may induce leafminer infestations.
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 10 fl oz	4 hrs	 7	For early season applications only to young crop and small plants. For mid- to late-season applications and to heavier infestations and under conditions in which thorough coverage is more difficult. Do not apply more than 16 fl oz per application, and do not exceed 64 fl oz per season. See Rotational Crop Restrictions on label.
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	Use higher rates for armyworms.
Leafminer	abamectin, MOA 6 (Agri-Mek) 0.15EC	 1.75 to 3.5 fl oz	12 hrs	 7	
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 5 to 7.5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	cryomazine, MOA 17 (Trigard 75WP)	 2.66 oz	12 hrs	 7	
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 10 fl oz	4 hrs	 1	

TABLE 2-8. INSECT CONTROL FOR COLLARD, KALE, MUSTARD GREENS

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide-resistant diamondback moth populations may not be controlled with some registered insecticides. To manage resistance, avoid transplants from Georgia and Florida, and avoid the repeated use of the same materials for extended periods of time. Use of pyrethroid insecticides destroys natural enemies and aggravates diamondback moth problems. Therefore pyrethroid insecticides should be used judiciously. Do not allow populations to increase to large densities before treatments are initiated.					
Aphid	acetamiprid, MOA 4A (Assail) 30 SG	 2 to 3 oz	12 hrs	 7	
	chlorpyrifos, MOA 1B (Lorsban) 50 W	 2 lb	24 hrs	 21	
	clothianidin, (Belay) 50 WDG	 4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	 7 (foliar) 21 (soil)	Soil application at planting only.
	flonicamid, MOA 9C (Beleaf) 50SG	 2 to 2.8 fl oz	12 hrs	 0	
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	 4.4 to 10.5 fl oz 10 to 24 fl oz	12 hrs	 21 21	See label for soil application instructions. Admire Pro will also control flea beetle.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	 3.8 fl oz	12 hrs	 7	
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 oz	12 hrs	 7	
	spirotetramat, MOA 23 (Movento) 2SC	 4 to 5 fl oz	24 hrs	 1	Do not exceed 10 fl oz per season. Requires surfactant.

TABLE 2-8. INSECT CONTROL FOR COLLARD, KALE, MUSTARD GREENS (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide-resistant diamondback moth populations may not be controlled with some registered insecticides. To manage resistance, avoid transplants from Georgia and Florida, and avoid the repeated use of the same materials for extended periods of time. Use of pyrethroid insecticides destroys natural enemies and aggravates diamondback moth problems. Therefore pyrethroid insecticides should be used judiciously. Do not allow populations to increase to large densities before treatments are initiated.					
Diamondback moth, Caterpillars, including Cabbage looper, Imported cabbageworm, Cross-striped cabbageworm, Cabbage webworm, Armyworm	***Insecticide-resistant populations may not be controlled with some registered insecticides. To manage resistance, avoid transplants from Georgia and Florida, and avoid the repeated use of the same materials for extended periods of time. Use of pyrethroid insecticides destroys natural enemies and aggravates diamondback moth problems. Do not allow populations to increase to large densities before treatments are initiated.***				
	Bacillus thuringiensis, MOA 11A (Crymax) WDG (Dipel) 2 X, DF (Dipel) (Xentari) WDG	 0.5 to 1.5 lb 8 oz 1 pt 0.5 to 1 lb	4 hrs	 0 0 0 0	Use a spreader/sticker. Do not apply insecticides with the same mode of action more than twice to any generation of diamondback moth. After two applications, rotate to an insecticide with a different mode of action.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 4 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	emamectin benzoate, MOA 6 (Proclaim) 5 WDG	 2.4 to 4.8 oz	12 hrs	 14	
	flubendiamide, MOA 28 (Belt) 4SC	 2 to 2.4 fl oz	12 hrs	 1	
	indoxacarb, MOA 22 (Avaunt) 30 WDG	 3.5 oz	12 hrs	 3	Do not apply Avaunt more than twice to any generation of diamondback moth. After two applications, rotate to an insecticide with a different mode of action. **Do not make more than 6 applications (4 in GA), or exceed 14 oz per season per crop.**
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	
Flea beetle	carbaryl, MOA 1A (Sevin) 50 WP (Sevin) 80 S (Sevin) XLR	 3 lb 1.875 lb 1 qt	12 hrs	 14 14 14	
	acetamiprid, MOA 4A (Assail) 30SG	 2 to 4 oz	12 hrs	 7	
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Grasshopper	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for a list of registered pyrethroids and pre-harvest intervals. May flare diamondback moth populations.
Harlequin bug, Stink bug	acetamiprid, MOA 4A (Assail) 30 SG	 3 to 4 oz	12 hrs	 7	
	clothianidin, MOA 4A (Belay) 50 WDG	 4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	 7 (foliar) 21 (soil)	Soil application at planting only.
	pyrethroid, MOA 3			21	See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	thiamethoxam, MOA 4A (Actara) 25WDG	 3 to 5.5 oz	12 hrs	 7	
Root maggot	chlorpyrifos, MOA 1B (Lorsban) 4 EC (Lorsban) 75WDG	 1.6 to 2.75 fl oz 1.1 to 1.8/ 1,000 ft row	24 hrs	 — —	For directed-seeded crops, apply as a 4-in. band over the row after planting. For transplanted crops, apply as a directed spray immediately after transplanting.
Whitefly	acetamiprid, MOA 4A (Assail) 30 SG	 2.5 to 4.0 oz	12 hrs	 7	Apply against adults, before nymphs are present. Use a spreader stick to improve control.
	pyriproxyfen, MOA 7C (Knack) 0.86 EC	 8 to 10 fl oz	12 hrs	 7	Do not apply Knack more than twice per season or exceed 0.134 lb per acre per season.
	spiromesifen, MOA 23 (Oberon) 2 SC	 7 to 8.5 fl oz	12 hrs	 7	Do not make more than 3 applications or apply more than 25.5 fl oz per season.
	spirotetramat, MOA 23 (Movento) 2 SC	 4 to 5 fl oz	24 hrs	 1	Do not exceed 10 fl oz per season. Requires surfactant.

TABLE 2-9. INSECT CONTROL FOR CORN, SWEET

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Corn earworm, Fall armyworm, European corn borer	transgenic sweet corn varieties expressing *Bt* protein				Highly effective against European corn borer. Additional insecticide applications may be required to prevent damage to the ear tips.
	pyrethroid, MOA 3A		12 hrs		Check label for variety limitations and grazing restrictions. Apply as needed until first tassel shoots appear in whorl. To protect ears, spray when tassel shoots first appear, 3 days later, then every 2 to 3 days for 5 applications. Following the fifth application, apply at 2- to 3-days until harvest. Corn tasseling after July 1 may require daily applications from first silk through 60% dry silk followed by applications at 2-day intervals until harvest to ensure worm-free ears. Corn earworms and fall armyworms present in the late whorl stage must be controlled before tassel emergence to prevent migration to ears. Do not use methomyl for European corn borer control.
	chlorantraniliprole MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	
	Flubendiamide MOA 28 (Belt) 4 SC	 2.0 to 3.0 oz	12 hrs	 1	
	methomyl, MOA 1A (Lannate) 90 SP (Lannate) 2.4 LV	 4 to 6 oz 0.75 to 1.5 pt	48 hrs	 0 0	
	indoxacarb, MOA 22 (Avaunt) 30 WDG	 2.5 to 3.5 oz	12 hrs	 3	For control of fall armyworm and European corn borer in whorl stage only. Do not apply more than 14 oz Avaunt (0.26 lb ai) per acre per crop. Minimum interval between sprays is 3 days. Make no more than 4 applications per season.
	spinetoram, MOA 5 (Radiant) 1 SC	 3 to 6 fl oz	4 hrs	 1	Do not apply more than 36 oz per acre per year.
	thiodicarb, MOA 1A (Larvin) 3.2 EC	 20 to 30 fl oz	48 hrs	 0	After silk initiation, do not exceed 7.5 lb (300 fl oz) per acre each season. Do not feed to livestock. Larvin may not control corn earworm.
Cutworm	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Flea beetle, Grasshopper, Japanese beetle, Rootworm beetle	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Sap beetle	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	carbaryl, MOA 1A (Sevin) 50 WP (Sevin) 80 S (Sevin) XLR Plus	 2 lb 1.25 lb 1 qt	12 hrs	 2 2 2	Infestations usually associated with prior ear damage. Populations build on over mature and damaged fruit and vegetables. Sanitation is important.
Southern corn billbug, Rootworm, Wireworm	*Seed treatments:* clothianidin, MOA 4A (Poncho 600) imidacloprid, MOA 4A (Gaucho 600)	 1.13 fl oz per 80,000 seeds 4 to 8 oz per cwt seed	 — —	 — —	Seed treatments are applied by commercial seed treaters only. Not for use in hopper bins, slurry mixes, or any other type of on-farm treatment.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	chlorpyrifos, MOA 1B (Lorsban) 4 E	 4 pt	24 hrs	 0	Preplant incorporation treatment. For post emergence treatment use 2 to 3 pt.
	terbufos, MOA 1B (Counter) 15 G	Banded: 6.5 to 13 lb (40 in. row spacing) OR 8 to 16 oz/1,000 ft row In-Furrow: 6.5 lb (40 in. row) OR 8 oz/10 ft row	48 hrs	— —	Place granules in a 7-in. band over the row directly behind the planter shoe in front of press wheel. Place granules directly in the seed furrow behind the planter shoe. Rotation is advised.
Stink bug	pyrethroids, MOA 3		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	methomyl, MOA 1A (Lannate) 90SP	 0.5 lb	48 hrs	 0	Re-entry interval is 48 hr.

TABLE 2-10. INSECT CONTROL FOR CUCUMBER

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide applications in cucurbits should be made in late evening to protect pollinating insects. Refer to the pollination section of the general production recommendations in this publication for more information about protecting pollinators.					
Aphid	acetamiprid MOA 4A (Assail) 30SG	 2.5 to 4.0 oz	12 hrs	 0	Do not exceed 0.5 lb per acre per season.
	clothianidin, MOA 4A (Belay) 50 WDG	 4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	 21 (soil) 7 (foliar)	Soil application at plant only.
	flonicamid, MOA 9C (Beleaf) 50 SG	 2 to 2.8 oz	12 hrs	 0	
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	 7 to 10.5 fl oz 10 to 24 fl oz	12 hrs	 21 21	Must be applied to the soil. May be applied preplant; at planting; as a post-seeding drench, transplant water drench, or hill drench; subsurface side-dress; or by chemigation using low-pressure drip or trickle irrigation. See label for information on approved application methods. Will also control cucumber beetles and whiteflies.
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 oz	12 hrs	 0	Apply before aphids reach damaging levels. Do not exceed 5.5 oz per acre per season.
	thiamethoxam, MOA 4A (Platinum) 75 SG	 1.66 to 3.67 oz	12 hrs	 30	Platinum may be applied to direct-seeded crops in-furrow seeding or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 11 oz per acre per season of Platinum. Check label for plant-back restrictions for a number of crops.
	(Actara) 25 WDG	1.5 to 3 oz	12 hrs	0	
Cucumber beetle, Flea beetle	acetamiprid MOA 4A (Assail) 30SG	 2.5 to 5.3 oz	12 hrs	 0	Do not exceed 0.5 lb per acre per season.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	carbaryl, MOA 1A (Sevin) 50 WP (Sevin) 80 S (Sevin) XLR Plus	 2 lb 1.25 lb 1 qt	12 hrs	 0 0 0	On foliage as needed. Beetles are most destructive to seedlings. They also spread bacterial wilt disease.
	clothianidin, MOA 4A (Belay) 50 WDG	 4.8 to 6.4oz (soil) 1.6 to 2.1fl oz (foliar)	12 hrs	 21 (soil) 7 (foliar)	Soil application at plant only.
	dinotefuran, MOA 4A (Venom) 70 SG	 1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	 1 (foliar) 21 (soil)	Foliar applications should not be made after plants have started to bloom. Do not follow soil applications with foliar applications on any neonicotinoid insecticide. Use only one application method. Do not apply more than 6 oz per acre per season using foliar applications, or 12 oz per acre per season using soil applications. Soil application may be applied by: 1) a narrow band below or above the seed line at planting; 2) a post-seeding or transplant drench with sufficient water to ensure incorporation to the root zone; or 3) drip irrigation.
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	See application method under Aphid.
Cutworm	pyrethroid, MOA 3				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Leafminer	abamectin, MOA 6 (Agri-Mek) 0.7 SC	 1.75 to 3.5 fl oz	12 hrs	 7	
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 5 to 7.5 fl oz	4 hrs	 1	Soil, foliar, or drip chemigation. See label for application instructions.
	cyromazine, MOA 17 (Trigard) 75 WS	 2.7 oz	12 hrs	 0	Do not make more than six applications per season.
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 8 fl oz	4 hrs	 1	
Pickleworm, Melonworm, Cabbage looper	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	flubendiamide, MOA 28 (Belt) 4SC	 1.5 fl oz	12 hrs	 1	Do not apply more than 4.5 fl oz per crop per season.

TABLE 2-10. INSECT CONTROL FOR CUCUMBER (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide applications in cucurbits should be made in late evening to protect pollinating insects. Refer to the pollination section of the general production recommendations in this publication for more information about protecting pollinators.					
Pickleworm, Melonworm, Cabbage looper (cont'd)	indoxacarb, MOA 22 (Avaunt) 30 WDG	 2.5 to 6 oz	12 hrs	 3	
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	
Spider mite	abamectin, MOA 6 (Agri-Mek) 0.7 SC	 1.75 to 3.5 fl oz	12 hrs	 7	No more than two applications.
	bifenazate, MOA 25 (Acramite) 50 WS	 0.75 to 1 lb	12 hrs	 3	Do not make more than one application per season.
	extoxazole, MOA 10B (Zeal) 72 WSP	 2 to 3 oz	12 hrs	 7	
	fenpyroximate, MOA 21A (Portal) 4EC	 2 pts	12 hrs	 1	Do not apply within 75 ft of fish-bearing waters. Do not make more than two applications per crop per season, and allow 14 days between applications.
	spiromesifen, MOA 23 (Oberon) 2 SG	 7 to 8.5 fl oz	12 hrs	 7	
Thrips	dinotefuran, MOA 4A (Venom) 70 SG	 1 to 4 oz	12 hrs	 1	Foliar applications should not be made after plants have started to bloom. Do not follow soil applications with foliar applications on any neonicotinoid insecticide. Use only one application method. Do not apply more than 6 oz per acre per season using foliar applications, or 12 oz per acre per season using soil applications. Soil application may be applied by: 1) a narrow band below or above the seed line at planting; 2) a post-seeding or transplant drench with sufficient water to ensure incorporation to the root zone; or 3) drip irrigation.
	methomyl, MOA 1A (Lannate) 2.4 LV	 1.5 pt	48 hrs	 1	
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 10 fl oz	4 hrs	 1	
Whitefly	acetamiprid MOA 4A (Assail) 30SG	 2.5 to 5.3 oz	12 hrs	 0	Do not exceed 0.5 lb per acre per season.
	buprofezin, MOA 16 (Courier) 40 SC	 9 to 13.6 fl oz	12 hrs	 7	Use sufficient water to ensure good coverage. Do not apply more than twice per crop cycle.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 5 to 7.5 fl oz	4 hrs	 1	For foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	dinotefuran, MOA 4A (Venom) 70 SG	 5 to 6 oz (soil)	12 hrs	 21	See comments under thrips for application instructions and restrictions.
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	See comments under Aphids.
	pyriproxyfen, MOA 7C Knack) 0.86 EC	 8 to 10 fl oz	12 hrs	 7	Do not make more than two applications per season, and do not make applications closer than 14 days apart.
	spiromesifen, MOA 23 (Oberon), 2 SC	 7 to 8.5 fl oz	12 hrs	 7	Do not make more than 3 applications per season.
	thiamethoxam, MOA 4A (Platinum) 75 SG	 1.66 to 3.67 oz	12 hrs	 30	Platinum is for soil applications. See comments under Aphids.
	(Actara) 25WDG	3 to 5.5 oz	12 hrs	0	Actara is for foliar applications

TABLE 2-11. INSECT CONTROL FOR EGGPLANT

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	acetamiprid, MOA 4A (Assail) 30 SG	2 to 4 oz	12 hrs	7	Thoroughly cover foliage to effectively control aphids. Do not apply more than once every 7 days, and do not exceed a total of 7 oz per season.
	clothianidin, MOA 4A (Belay) 50 WDG	4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	— 7 (foliar)	Soil application at planting only.
	flonicamid, MOA 9C (Beleaf) 50 SG	2 to 2.8 oz	12 hrs	0	
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	7 to 10.5 oz 16 to 24 fl oz	12 hrs	21 21	See label for soil application instructions. For short-term protection of transplants at planting, apply Admire Pro (0.44 oz/10,000 plants) not more than 7 days before transplanting by 1) uniformly spraying on transplants, followed immediately by sufficient overhead irrigation to wash product into potting media; or 2) injection into overhead irrigation system with adequate volume to thoroughly saturate soil media.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	1.3 to 2.2 fl oz 3.75 fl oz	12 hrs	0 0	
	pymetrozine, MOA 9B (Fulfill) 50 WDG	2.75 oz	12 hrs	14	Apply before aphids reach damaging levels. Do not exceed 5.5 oz per acre per season.
	spirotetramat, MOA 23 (Movento) 2 SC	4 to 5 fl oz	24 hrs	1	Do not exceed 10 fl oz per season. Requires surfactant.
	thiamethoxam, MOA 4A (Platinum) 75 SG	1.66 to 3.67 oz	12 hrs	30	Platinum may be applied to direct-seeded crops in-furrow at seed or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 8 oz per acre per season. Check label for plant-back restrictions for a number of plants.
	(Actara) 25 WDG	2 to 3 oz	12 hrs	0	Actara is for foliar application.
Blister beetle	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Colorado potato beetle	***Resistance too many insecticides are widespread in Colorado potato beetle (CPB). To reduce risk of resistance, scout fields and apply insecticides only when needed to prevent damage to the crop. Crop rotation will help prevent damaging CPB infestations. If control failures or reduced levels of control occur with a particular insecticide, do NOT make a second application of the same insecticide at the same or higher rate. If an additional insecticide application is necessary, a different insecticide representing a different MOA class should be used. Do NOT use insecticides belonging to the same class 2 years in a row for CPB control.***				
	abamectin, MOA 6 (Agri-Mek) 0.7 SC	1.75 to 3.5 fl oz	12 hrs	7	Apply when adults and small larvae are present but before large larvae appear. For resistance management, use the higher rate.
	acetamiprid, MOA 4A (Assail) 30 SG	2 to 4 oz	12 hrs	7	Do not apply more than once every 7 days, and do not exceed 7 oz of formulation per season.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	3.5 to 5 fl oz	4 hrs	1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	clothianidin, MOA 4A (Belay) 50WDG	4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	— 7 (foliar)	Soil application at planting only.
	dinotefuran, MOA 4A (Venom) 70 SG	1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	1 (soil) 1 (soli)	Do not follow soil applications with foliar applications on any neonicotinoid insecticide. Use only one application method. Do not apply more than 6 oz per acre per season using foliar applications, or 12 oz per acre per season using soil applications. Soil application may be applied by: 1) a narrow band below or above the seed line at planting; 2) a post-seeding or transplant drench with sufficient water to ensure incorporation to the root zone; or 3) drip irrigation.
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	21 21	See application methods under Aphids, Thrips.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	1.3 fl oz 3.75 fl oz	12 hrs	0 0	
	novaluron, MOA 15 (Rimon) 0.83 EC	9 to 12 fl oz	12 hrs	1	
	spinetoram, MOA 5 (Radiant) 1 SC	5 to 10 fl oz	4 hrs	1	

TABLE 2-11. INSECT CONTROL FOR EGGPLANT (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Colorado potato beetle (cont'd)	thiamethoxam, MOA 4A (Platinum) 75 SG	 1.66 to 3.67 oz	12 hrs	 30	See application methods under Aphids.
	(Actara) 25 WDG	2 to 3 oz	12 hrs	0	
Eggplant lace bug	imidacloprid, MOA 4A *Foliar treatment* (Admire Pro) 4.6 F (various) 1.6 F	 1.3 to 2.2 fl oz 3.8 to 6.2 fl oz	12 hrs	 0 0	
	malathion, MOA 1B (various brands) 57 EC	 3 pt	12 hrs	 3	
Flea beetle	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	carbaryl, MOA 1A (Sevin) 50 WP (Sevin) 80 S (Sevin) XLR Plus	 2 lb 1.25 lb 1 lb	12 hrs	 3 3 3	
	clothianidin, MOA 4A (Belay) 50WDG	 4.6 to 6.8 oz (soil) 1.6 to 2.1 fl oz (foliar)	12 hrs	 — 7 (foliar)	Soil application at planting only.
	dinotefuran, MOA 4A (Venom) 70 SG	 1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	 1 (foliar) —	Do not follow soil applications with foliar applications on any neonicotinoid insecticide. Use only one application method. Do not apply more than 6 oz per acre per season using foliar applications, or 12 oz per acre per season using soil applications. Soil application may be applied by: 1) a narrow band below or above the seed line at planting; 2) a post-seeding or transplant drench with sufficient water to ensure incorporation to the root zone; or 3) drip irrigation.
	thiamethoxam, MOA 4A (Platinum) 75 SG	 1.66 to 3.67 oz	12 hrs	 30	See application methods under Aphids.
	(Actara) 25 WDG	2 to 3 oz	12 hrs	0	
Hornworm, European corn borer, Beet army worm, Corn earworm	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 4 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	flubendiamide, MOA 28 (Belt) 4SC	 1.5 fl oz	12 hrs	 1	
	indoxacarb, MOA 22 (Avaunt) 30 WDG	 2.5 to 3.5 oz	12 hrs	 3	Do not apply more than 14 oz per acre per season.
	methomyl, MOA 1A (Lannate) 2.4 LV	 1.5 to 3 pt	48 hrs	 5	
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 16 fl oz	4 hrs	 1	Apply at rates of 4 to 8 fl oz early in season when plants are small. Apply at rates of 8 to 16 oz to large plants or when infestations are heavy. During periods of continuous moth flights, retreatments at 7 to 14 days may be required. Do not apply more than 16 fl oz per application or 64 fl oz of Intrepid 2F per acre per season.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Leafminer	abamectin, MOA 6 (Agri-Mek) 0.15 EC	 8 to 16 fl oz	12 hrs	 7	Use low rates for low to moderate infestations, and high rates for severe infestations
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 5 to 7.5 fl oz	4 hrs	 1	Foliar, soil, or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for application instructions.
	oxamyl, MOA 1A (Vydate) 2 L	 1 to 2 qt	48 hrs	 7	
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	
Stink bug, Leaffooted bug	pyrethroid MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	dinotefuran MOA 4A *Soil treatment* (Venom) 70 SG (Scorpion) 35 SL *Foliar treatment* Venom) 70 SG (Scorpion) 35 SL	 5 to 6 oz 9 to 10.5 fl oz 1 to 4 oz 2 to 7 fl oz	12 hrs	 21 21 1 1	
	Thiamethoxam, MOA 4A (Actara) 25 WDG	 3 to 5.5 oz	12 hrs	 0	Do not exceed 11 oz Actara per acre per season.

TABLE 2-11. INSECT CONTROL FOR EGGPLANT (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Spider mite	abamectin, MOA 6 (Agri-Mek) 0.7 SC	1.75 to 3.5 fl oz	12 hrs	7	Use low rates for low to moderate infestations, and high rates for severe infestations.
	acequinocyl, MOA 20B (Kanemite) 15SC	31 fl oz	12 hrs	1	
	bifenazate, MOA 25 (Acramite) 50 WS	0.75 to 1.0 lb	12 hrs	3	Do not make more than one application per season.
	etoxazole, MOA 10B (Zeal)	2 to 3 oz	12 hrs	7	Do not make more than one Zeal application per season.
	fenpyroximate MOA 21 (Portal) 0.4EC	2 pts	12 hrs	3	Do not make more than two applications per season.
	hexakis, MOA 12B (Vendex) 50 WP	2 to 3 lb	48 hrs	3	
	spiromesifen, MOA 23 (Oberon) 2 SG	7 to 8.5 fl oz	12 hrs	7	
Thrips	dinotefuran, MOA 4A (Venom) 70 SG	1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	1 (foliar) 21 (soil)	See Whitefly for application instructions. Soil applications are more effective against thrips than foliar applications are.
	imidacloprid, MOA 4A Admire Pro 4.6 F (various) 2 F	7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	21 21	See Aphids for application instructions.
	methomyl, MOA 1A (Lannate) 2.4 LV	1.5 to 3 pt	48 hrs	3	
	spinetoram, MOA 5 (Radiant) 1 SC	6 to 10 fl oz	4 hrs	1	
Whitefly	acetamiprid, MOA 4A (Assail) 30 SG	2.5 to 4 oz	12 hrs	7	Begin applications when significant populations of adults appear. Do not wait until heavy populations have become established. Do not apply more than once every 7 days, and do not exceed 4 applications per season. Do not apply more than 7 oz per season.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	5 to 7.5 fl oz	4 hrs	1	For foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	dinotefuran, MOA 4A (Venom) 70 SG	1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs 12 hrs	1 (foliar) 21 (soil)	Do not follow soil applications of other neonicotinoid insecticides (Assail or Venom). Use only one application method. Soil applications may be applied in a narrow band on the plant row in bedding operations, as a post-seeding or transplant drench, as a side-dress after planting and incorporated 1 or more inches, or through a drip irrigation system.
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	21 21	Do not follow soil applications with applications of other neonicotinoid insecticides (Assail or Venom). See Aphids for application methods and restrictions.
	pyriproxyfen, MOA 7C (Knack) 0.86 EC	8 to 10 fl oz	12 hrs	14	Knack prevents eggs from hatching. It does not kill whitefly adults. Applications should begin when 3 to 5 adults per leaf are present. Do not make more than 2 applications per season, and do not apply a second application within 14 days of the first application. Do not exceed 20 fl oz of Knack per acre per season. Check label for plant-back restrictions.
	spirotetramat, MOA 23 (Movento) 2SC	4 to 5 fl oz	24 hrs	1	Do not exceed 10 fl oz per season. Requires surfactant.
	spiromesifen, MOA 23 (Oberon) 2 SC	7 to 8.5 fl oz	12 hrs	7	Do not exceed 3 applications or 25.5 fl oz per season.
	thiamethoxam, MOA 4A (Platinum) 75 SG	1.66 to 3.67 oz	12 hrs	30	Platinum is for soil applications and may be applied to direct-seeded crops in furrow at seed or transplant depth, at post seeding or transplant as a drench, or through drip irrigation. Do not exceed 11 oz per acre per season. Check label for plant-back restrictions for a number of plants.
	(Actara) 25WDG	3 to 5.5 oz	12 hrs	0	Actara is for foliar application.

TABLE 2-12. INSECT CONTROL FOR LETTUCE

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	acetamiprid, MOA 4A (Assail) 30 SG	 2 to 4 oz	12 hrs	 7	Do not apply more than once every 7 days, and do not exceed 4 applications per season.
	clothianidin, MOA 4A (Belay) 2.13 SC	 4.8 to 6.8 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	 21 (days) 7 (foliar)	Soil application at planting only.
	dimethoate 4 EC, MOA 1B	0.5 pt	48 hrs	14	
	flonicamid, MOA 9C (Beleaf) 50 SG	 2 to 2.8 oz	12 hrs	 0	
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	 4.4 to 10.5 fl oz 10 to 24 fl oz	12 hrs	 21 21	Do not follow soil applications with foliar applications of any neonicotinoid insecticide. See label for soil application instructions.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	 1.3 fl oz 3.8 fl oz	12 hrs	 7 7	
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 oz	12 hrs	 7	Apply before aphids reach damaging levels. Do not exceed 5.5 oz per acre per season.
	spirotetramat, MOA 23 (Movento) 2SC	 4 to 5 fl oz	24 hrs	 3	Do not exceed 10 fl oz per season. Requires surfactant.
	thiamethoxam, MOA 4A (Platinum) 75 SG (Actara) 25 WDG	 1.66 to 3.67 oz 1.5 to 3 oz	12 hrs 12 hrs	 30 7	Do not follow applications of Platinum with foliar applications of any neonicotinoid insecticide. Platinum may be applied to direct-seeded crops in-furrow at the seeding or transplant depth, or as a narrow surface band above the seedling and followed by irrigation. Post seeding, it may be applied as a transplant or through drip irrigation. Actara is applied as a foliar spray.
Armyworm	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	Foliar or drip chemigation.
	emamectin benzoate, MOA 6 (Proclaim) 5 WDG	 2.4 to 4.8 oz	12 hrs	 7	Do not make more than two sequential applications without rotating to another product with a different mode of action.
	flubendiamide, MOA 28 (Belt) 4SC	 1.5 fl oz	12 hrs	 1	
	indoxacarb, MOA 22 (Avaunt) 30 WDG	 3.5 oz	12 hrs	 3	For control of low numbers of beet armyworm and not for corrective treatments of higher numbers of larvae. Do not apply more than 14 oz of Avaunt (0.26 lb ai) per acre per crop. The minimum interval between sprays is 3 days.
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 10 oz	4 hrs	 1	Use low rates for early-season applications when plants are small. For mid- and late-season applications, use 10 to 16 oz.
	spinetoram, MOA 5 (Radiant) 1 SC	 4 to 8 fl oz	4 hrs	 1	
Cabbage looper, Corn earworm, Tobacco budworm	*Bacillus thuringiensis,* MOA 11A (Crymax) WDG (Dipel) DF	 0.5 to 1.5 lb 8 oz	4 hrs	 0 0	
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	Foliar or drip chemigation.
	emamectin benzoate, MOA 6 (Proclaim) 5 WDG	 3.2 to 4.8 oz	12 hrs	 7	Do not make more than two sequential applications without rotating to another product with a different mode of action.
	flubendiamide, MOA 28 (Belt) 4SC	 1.5 fl oz	12 hrs	 1	
	indoxacarb, MOA 22 (Avaunt) 30 WDG	 2.5 to 3.5 oz	12 hrs	 3	Do not apply more than 14 oz of Avaunt (0.26 lb ai) per acre per crop. The minimum interval between sprays is 3 days.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	methomyl, MOA 1A (Lannate) 2.4 LV	 1.5 to 3 pt	48 hrs	 7 to 10	
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 10 fl oz	4 hrs	 1	Low rates for early-season applications to young or small plants. For mid- and late-season applications, use 6 to 10 oz.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	

TABLE 2-12. INSECT CONTROL FOR LETTUCE (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Leafhopper	dinotefuran, MOA 4A (Venom) 70 SG	1 to 3 oz (foliar) 5 to 6 oz (soil)	12 hrs	7 (foliar) 21 (soil)	Do not follow soil applications with foliar applications of any neonicotinoid insecticide. Use only one application method. Do not apply more than 6 oz per acre (foliar) or 12oz per acre (soil). Soil applications may be applied by: 1. Narrow band below or above the seed line at planting; 2. post seeding or transplant drench with sufficient water to ensure incorporation; or 3. drip irrigation.
	dimethoate 4 EC, MOA 1B	0.5 pt	48 hrs	14	14-day interval for leaf lettuce.
	imidacloprid, MOA 4A (various) 1.6 F	3.75 fl oz	12 hrs	7	There is a 12-month plant-back restriction for a number of crops. Check label for restrictions.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	thiamethoxam, MOA 4A (Actara) 25 WDG	1.5 to 3 oz	12 hrs	7	

TABLE 2-13. INSECT CONTROL FOR OKRA

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	imidacloprid, MOA 4A		12 hrs		See label for soil treatment instructions.
	Soil treatment				
	(Admire Pro) 4.6 F	7 to 10.5 fl oz		21	
	(various) 2 F	16 to 24 fl oz		21	
	Foliar treatment		12 hrs		
	(Admire Pro) 4.6 F	1.3 to 2.2 fl oz		0	
	(various) 1.6 F	3.8 fl oz		0	
	flonicamid, MOA 9C		12 hrs		
	(Beleaf) 50 SG	2 to 2.8 oz		0	
	spirotetramat, MOA 23		24 hrs		Do not exceed 10 fl oz per season. Not for flea beetle. Requires surfactant.
	(Movento) 2SC	4 to 5 fl oz		3	
	malathion, MOA 1B		12 hrs		
	(various brands) 8 F	1.5 pt		1	
	(various brands) 25 WP	6 lb		1	
Blister beetle, Flea beetle, Japanese beetle	carbaryl, MOA 1A		12 hrs		
	(Sevin) 50 WP	4 lb		3	On foliage as needed.
	(Sevin) 80 S	2.5 lb		3	
	(Sevin) XLR Plus	2 qt		3	
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Corn earworm, Tobacco budworm, European corn borer	carbaryl, MOA 1A		12 hrs		On foliage as needed.
	(Sevin) 50 WP	4 lb		3	
	(Sevin) 80 S	2.5 lb		3	
	(Sevin) XLR Plus	2 qt		3	
	chlorantraniliprole, MOA 28		4 hrs		Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	(Coragen) 1.67 SC	2 to 3.5 fl oz		1	
	flubendiamide, MOA 28		12 hrs		
	(Belt) 4SC	1.5 fl oz		1	
	methoxyfenozide, MOA 18		4 hrs		
	(Intrepid) 2 F	8 to 16 fl oz		1	
	novaluron, MOA 15		12 hrs		
	(Rimon) 0.83 EC	9 to 12 fl oz		1	
	spinetoram, MOA 5		4 hrs		For corn earworm only.
	(Radiant) 1 SC	5 to 10 fl oz		1	
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Spider mites	bifenazate, MOA 25		12 hrs		Do not make more than one application per season.
	(Acramite) 50 WP	0.75 to 1 lb		3	
	fenpyroximate MOA 21		12 hrs		Do not make more than two applications per season.
	(Portal) 0.4EC	2 pt		3	

TABLE 2-13. INSECT CONTROL FOR OKRA (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Stink bug, Leaffooted bug	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Whitefly	buprofezin, MOA 16 (Courier) 40 SC	 9 to 13.6 fl oz	12 hrs	 1	
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 2 to 3.5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F *Foliar treatment* (Admire Pro) 4.6 F (various) 1.6 F	 7 to 14 fl oz 16 to 32 fl oz 1.3 to 2.2 fl oz 3.8 oz	12 hrs 12 hrs	 21 21 0 0	See label for soil application instructions.
	pyriproxyfen, MOA 7C (Knack) 0.86 EC	 8 to 10 fl oz	12 hrs	 14	Do not make more than two applications per season.
	spirotetramat, MOA 23 (Movento) 2SC	 4 to 5 fl oz	24 hrs	 3	Do not exceed 10 fl oz per season. Not for flea beetle. Requires surfactant.

TABLE 2-14. INSECT CONTROL FOR ONION

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	dimethoate 400, MOA 1B	1 pt	48 hrs	180	Do not exceed 5 pt per acre per year.
	malathion, MOA 1B (various) 57 EC	 2 pt	12 hrs	 1	Aphid colonies appear by early September. The use of carbamates may result in aphid buildup.
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 oz	12 hrs	 —	For aphid control on ferns after harvest.
Armyworm, Cutworm	methoxyfenozide MOA 18 (Intrepid) 2F	 4 to 8 fl oz 8 to 12 fl oz	4 hrs	 1 1	Green onion only. Use lower rates in early season on small plants; use higher rates in late season and heavy infestations.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	
Leafminer	cryomazine, MOA 17 (Trigard) 75 WS	 2.66 oz	12 hrs	 7	
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 8 fl oz	4 hrs	 1	
Onion maggot, Seed corn maggot	***Onion seed pre-treated with cyromazine (Trigard) can be used to control onion and seed corn maggot.***				
	chlorpyrifos, MOA 1B (Lorsban) 4 E	 32 fl oz	24 hrs	 —	Apply as in-furrow drench at planting. Use a minimum of 40 gal per acre and incorporate to a depth of 1 to 2 in. Do not make more than one application per year.
	diazinon, MOA 1B (Diazinon) (AG 500)	 2 to 4 qt	3 days	 —	Furrow application; drench the seed furrow at planting time. Apply as a furrow treatment at time of planting. Use separate hoppers for seed and chemical.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Thrips	acetamiprid MOA 4A (Assail) 70 WP	 2.1 to 3.4 oz	12 hrs	 7	
	methomyl, MOA 1A (Lannate) 2.4 LV	 1.5 pt	48 hrs	 7	
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 8 fl oz	4 hrs	 1	
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.

TABLE 2-15. INSECT CONTROL FOR PEA, ENGLISH AND SNOW PEA (SUCCULENT AND DRIED)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	acetamiprid MOA 4A (Assail) 70 WP	 1 to 2.3 oz	12 hrs	 7	Also controls leafhoppers. **Succulent peas only.**
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	dimethoate, MOA 1B (Dimethoate) 400 (4E)	 0.33 pt	48 hrs	 0	Do not make more than one application per season, and do not feed or graze if a mobile viner is used, or for 21 days if a stationary viner is used. Re-entry interval is 48 hr.
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	See label for soil application instructions.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	 1.2 fl oz 3.5 fl oz	12 hrs	 7 7	
Armyworm, Cloverworm, Cutworm, Looper	chlorantraniliprole MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	spinetoram, MOA 5 (Radiant) 1 SC	 4 to 8 fl oz	4 hrs	 3 (succulent) 28 (dried)	Not for cutworm.
Leafhopper, Lygus bug, Stink bug	dimethoate, MOA 1B (Dimethoate) 400 (4E)	 0.33 to 1 pt	48 hrs	 See label	Do not make more than one application per season. Do not feed or graze if a mobile viner is used, or for 21 days if a stationary viner is used.
	methomyl, MOA 1A (Lannate) 2.4 LV	 1.5 to 3 pt	48 hrs	 3	Apply to foliage as needed.
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Seedcorn maggot	See ***BEANS*** section for control				

TABLE 2-15. INSECT CONTROL FOR PEA – COWPEA, SOUTHERNPEAS

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid, Thrips	acetamiprid MOA 4A (Assail) 70 WP	 1 to 2.3 oz	12 hrs	 7	Also controls leafhoppers. Succulent peas only.
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	See label for soil application instructions.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	 1.3 fl oz 3.5 fl oz	12 hrs	 7 7	
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 8 fl oz	4 hrs	 3 (succulent) 28 (dried)	Radiant is not effective against aphids.
Bean leaf beetle	carbaryl, MOA 1A (Sevin) 4 L (Sevin) 80 S	 0.5 to 1 qt 0.625 to 1.25 lb	12 hrs	 3 3	Do not feed treated foliage to livestock.
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Corn earworm, Loopers, European corn borer, Armyworm	chlorantraniliprole MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 16 fl oz	4 hrs	 7	Use lower rates on smaller plants and higher rates for mid- to late season applications, against corn earworm. Do not apply more than 16 fl oz (0.25 lb ai) per acre per season.
	spinetoram, MOA 5 (Radiant) 1 SC	 3 to 6 fl oz	4 hrs	 3 (succulent) 28 (dried)	Do not apply more than 12 fl oz (0.188 ai) per acre per season.

TABLE 2-15. INSECT CONTROL FOR PEA – COWPEA, SOUTHERNPEAS (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Corn earworm, Loopers, European corn borer, Armyworm (cont'd)	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	methomyl, MOA1A (Lannate) 90SP	0.5 to 1 lb	48 hrs	1	Re-entry interval is 48 hr.
Cowpea curculio, stink bug	pyrethroid, MOA 3A				See **Table 2-26** for a list of registered pyrethroids and pre-harvest intervals. Control may be poor in areas where resistant populations occur, primarily in the Gulf Coast areas.
	methomyl, MOA1A (Lannate) 90SP	0.5 to 1 lb	48 hrs	1	Re-entry interval is 48 hr.
Leafminer	spinetoram, MOA 5 (Radiant) 1 SC	5 to 8 fl oz	4 hrs	3 (succulent) 28 (dried)	

TABLE 2-16. INSECT CONTROL FOR PEPPER

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid, Flea beetle	acetamiprid, MOA 4A (Assail) 70 WP	0.8 to 1.2 oz	12 hrs	7	Do not apply more than once every 7 days, and do not exceed 4 applications per season.
	clothianidin, MOA 4A (Belay) 50WDG	4.8 to 6.4 oz (soil) 1.6 to 2.1oz (foliar)	12 hrs	21 (soil) 7 (foliar)	Soil application at planting only.
	dinotefuran, MOA 4A (Venom) 70 SG	1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	1 (foliar) 21 (soil)	Do not follow soil applications with foliar applications. Use only one application method. Do not apply more than 6 oz per acre per season using foliar applications, or 12 oz per acre per season using soil applications. Soil applications may be applied by 1) a narrow band below or above the seed line at planting; 2) a post-seeding or transplant drench with sufficient water to ensure incorporation to the root zone; or 3) drip irrigation. For flea beetle control only.
	flonicamid, MOA 9C (Beleaf) 50 SG	2 to 2.8 oz	12 hrs	0	
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	7 to 14 fl oz 16 to 32 fl oz	12 hrs	21 21	Do not follow soil applications with foliar applications of any neonicotinoid. See label for soil application instructions. For short-term protection of transplants at planting, apply Admire Pro (0.44 oz/10,000 plants) not more than 7 days before transplanting by 1) uniformly spraying on transplants, followed immediately by sufficient overhead irrigation to wash product into potting media; or 2) injection into overhead irrigation system using adequate volume to thoroughly saturate soil media.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	1.3 fl oz 3.8 fl oz	12 hrs	0 0	1.6 F formulation is applied as a foliar spray.
	oxamyl, MOA 1A (Vydate) 2 L	1 to 2 qt	48 hrs	7	
	pymetrozine, MOA 9B (Fulfill) 50 WDG	2.75 oz	12 hrs	0	Apply before aphids reach damaging levels. Do not exceed 5.5 oz per acre per season. Not for flea beetle.
	spirotetramat, MOA 23 (Movento) 2SC	4 to 5 fl oz	24 hrs	1	Do not exceed 10 fl oz per season. Requires surfactant. Will not control flea beetle.
	thiamethoxam, MOA 4A *Soil treatment* (Platinum) 75 SG	1.66 to 3.67 oz	12 hrs	30	Platinum may be applied to direct-seeded crops in-furrow seeding or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Actara is applied as a foliar spray. Do not exceed 11 oz per acre per season of Platinum or Actara. Check label for plant-back restrictions for a number of crops.
	Foliar treatment (Actara) 25 WDG	2 to 4 oz	12 hrs	0	

TABLE 2-16. INSECT CONTROL FOR PEPPER (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Armyworm, Corn earworm, Looper, Hornworm	*Bacillus thuringiensis,* MOA 11A (Dipel) DF (Xentari) WDG	 0.5 to 1.5 lb 0.5 to 1 lb	4 hrs	 0 0	
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 2 to 3.5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	emamectin benzoate, MOA 6 (Proclaim) 5 WDG	 2.4 to 4.8 oz	12 hrs	 7	Apply when larvae are first observed. Additional applications may be necessary to maintain control.
	flubendiamide, MOA 28 (Belt) 4 SC	 1.5 fl oz	12 hrs	 1	
	indoxacarb, MOA 22 (Avaunt) 30 WDG	 2.5 to 3.5 oz	12 hrs	 3	Use only higher rate for control of armyworm and corn earworm. Do not apply more than 14 oz of Avaunt (0.26 lb ai per acre per crop). Minimum interval between sprays is 5 days.
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 16 fl oz	4 hrs	 1	Apply at rates of 4 to 8 fl oz early in season when plants are small. Apply at rates of 8 to 16 oz to large plants or when infestations are heavy. During periods of continuous moth flights re-treatments at 7 to 14 days may be required. Do not apply more than 16 fl oz per application or 64 fl oz of Intrepid per acre per season.
	novaluron, MOA 15 (Rimon) 0.83 EC	 9 to 12 fl oz	12 hrs	 1	The use of a surfactant/adjuvant with Rimon is prohibited on pepper.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Blister beetle, Stink bug, Leaffooted bug	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	dinotefuran, MOA 4A (Venom) 70SG	 5 to 6 oz (soil) 1 to 4 oz (foliar)	12 hrs	 21 (soil) 1 (foliar)	Do not combine foliar applications with soil applications, or vice versa. Use only one application method.
	thiamethoxam, MOA 4A (Actara) 25WDG	 3 to 5.5 oz	12 hrs	 0	
European corn borer	***For all insecticides, begin applications at first fruit set when European corn borer moths are flying, as indicated by light trap catches. Applications should be made at 5- to 7-day intervals as long as moths continue to fly or egg masses are present on the plants.***				
	acephate, MOA 1B (Orthene) 97 PE	 0.75 to 1 lb	24 hrs	 7	Do not apply more than 2 lb ai per acre per season on bell peppers, or 1 lb ai on non-bell peppers.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 2 to 3.5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	emamectin benzoate (Proclaim) 5SG	 2.4 to 4.8 oz	12 hrs	 7	Do not allow animals to graze in treated areas.
	flubendiamide, MOA 28 (Belt) 4SC	 1.5 fl oz	12 hrs	 1	
	methomyl, MOA 1A (Lannate) 2.4 LV	 1.5 pt	48 hrs	 3	
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Leafminer	abamectin, MOA 6 (Agri-Mek) 0.7 SC	 1.75 to 3.5 fl oz	12 hrs	 7	
	cyromazine, MOA 17 (Trigard) 75 WP	 2.66 oz	12 hrs	 0	
	dimethoate 4 EC, MOA 1B	0.5 pt	48 hrs	0	Re-entry interval is 48 hr.
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 10 fl oz	4 hrs	 1	
Pepper maggot	acephate, MOA 1B (Orthene) 97 PE	 0.75 to 1 lb	24 hrs	 7	See comments under European corn borer.
	dimethoate 4 EC, MOA 1B	0.5 to 0.67 pt	48 hrs	0	
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.

TABLE 2-16. INSECT CONTROL FOR PEPPER (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Pepper weevil	acetamiprid, MOA 4A (Assail) 30 SG	4 oz	12 hrs	7	
	oxamyl, MOA 1A (Vydate) 2 L	2 to 4 pt	48 hrs	7	
	thiamethoxam, MOA 4A (Actara) 25 WP	3 to 4 oz	12 hrs	0	Do not exceed 8 oz of Actara per acre per season.
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Spider mite, Broad mite	abamectin, MOA 6 (Agri-Mek) 0.7 SC	1.75 to 3.5 fl oz	12 hrs	7	On foliage as needed. Effective against broad mite.
	acequinocyl, MOA 20B (Kanemite) 15SC	31 fl oz	12 hrs	1	Will not control broad mite.
	bifenazate, MOA 25 (Acramite) 50 WS	0.75 to 1 lb	12 hrs	3	Do not make more than one application per season. Will not control broad mite.
	etoxazole, MOA 10B (Zeal)	2 to 3 oz	12 hrs	7	Do not make more than one Zeal application per season. Will not control broad mite.
	fenpyroximate MOA 21 (Portal) 0.4EC	2 pt	12 hrs	3	Do not make more than two applications per season. Effective against broad mite.
	spiromesifen, MOA 23 (Oberon) 2 SG	7 to 8.5 fl oz	12 hrs	7	Do not exceed 3 applications per season. Effective against broad mite.
Thrips	dinotefuran, MOA 4A (Venom) 70 SG	1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	1 (foliar) 21 (soil)	See label for application instructions and restrictions.
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	7 to 14 fl oz 16 to 32 fl oz	12 hrs	21 21	See Aphids for application instructions. Treating transplants before setting in the field, followed by drip irrigation may suppress incidence of tomato spotted virus. Imidacloprid is ineffective against western flower thrips.
	methomyl, MOA 1A (Lannate) 2.4 LV	1.5 pt	48 hrs	3	
	spinetoram, MOA 5 (Radiant) 1 SC	6 to 10 fl oz	4 hrs	1	Do not exceed 29 fl oz per acre per season. Control of thrips may be improved by adding a spray adjuvant. See label for instructions.

TABLE 2-17. INSECT CONTROL FOR POTATO, IRISH

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	acetamiprid, MOA 4A (Assail) 30 SG	1.5 to 4 oz	12 hrs	7	Do not make more than 4 applications per season. Thorough coverage is important. Assail belongs to the same class of insecticides (neonicotinoid) as Admire Pro, Provado, Actara, and Platinum and Colorado potato beetle populations have the potential to become resistant to this class.
	clothianidin MOA 4A (Belay) 50 WDG	1.0 to 1.5 oz	12 hrs	7	Apply Belay 50 WDG as foliar spray when populations reach a threshold level. Do not apply more than 3 applications. Belay belongs to the same class of insecticides (neonicotinoid) as Admire Pro, Provado, Actara, and Platinum and Colorado potato beetle populations have the potential to become resistant to this class.
	flonicamid, MOA 9C (Beleaf) 50 SG	2 to 2.8 oz	12 hrs	7	
	dimethoate 4 EC, MOA 1B	0.5 to 1 pt	48 hrs	0	Do not apply more than 2 pints total per year.
	imidacloprid, MOA 4A (Admire Pro) 4.6F (various) 1.6 F	1.2 fl oz 3.75 fl oz	12 hrs	7 7	To minimize selection for resistance in Colorado potato beetle, do not use acetamiprid, imidacloprid, or thiamethoxam for aphid control if either of these compounds was applied to the crop for control of Colorado potato beetle. See comments on insecticide rotation under Colorado potato beetle.
	pymetrozine, MOA 9B (Fulfill) 50 WDG	2.75 oz	12 hrs	14	Allow at least 7 days between applications. Do not exceed a total of 5.5 oz (0.17 lb ai) per acre per season.
	thiamethoxam, MOA 4A (Actara) 25 WDG	3 oz	12 hr	14	To minimize selection for resistance in Colorado potato beetle, do not use imidacloprid or thiamethoxam for aphid control if either of these compounds was applied to the crop for control of Colorado potato beetle.
Colorado potato beetle	***Colorado potato beetle (CBP) populations in most commercial potato-growing areas have developed resistance to many insecticides. As a result, insecticides that are effective in some areas, or were effective in the past, may no longer provide control in particular areas. CBP readily develops resistance to insecticides. The following practices help to reduce the risk of resistance developing:*** ***CROP ROTATION AND INSECTICIDE ROTATION (the use of insecticides representing different modes of action IRAC MOA class number in different years and against different generations of potato beetle within a year) are essential if insecticide resistance is to be managed and the risks of control failures due to resistance minimized. If control failures or reduced levels of control are observed with a particular insecticide, do NOT make a second application of the same insecticide at the same or higher rate. If an additional insecticide application is necessary, a different insecticide representing a different IRAC MOA class number should be used.*** ***SCOUT FIELDS: All insecticide applications to the potato crop, regardless of the target insect pest, have the potential to increase the resistance of the Colorado potato beetle to insecticides. Unnecessary insecticide applications should be avoided by scouting fields for insect pests and applying insecticides only when potentially damaging insect populations are present.*** ***SPOT TREATMENTS: Because overwintered potato beetles invade rotated fields from sources outside the field, potato beetle infestations in rotated fields occur first along field edges early in the season. Limiting insecticide applications to infested portions of the field will provide effective control and reduce costs. Growers are advised to keep accurate records on which insecticides have been applied to their potato crop for control of CBP and on how effective those insecticides were at controlling infestations. This will make choosing an insecticide and maintaining insecticide rotations easier. Monitoring the insecticide resistance status of local populations will also make insecticide selection easier.***				
	Abamectin, MOA 6 (Agri-Mek) 0.7 SC	1.75 to 3.5 fl oz	12 hrs	14	Apply when adults and/or small larvae are present but before large larvae appear. Do not exceed two applications per season. Apply in at least 20 gal water per acre.
	Acetamiprid, MOA 4A (Assail) 70 WP	0.6 to 1.7 oz	12 hrs	7	Apply when most of the egg masses have hatched and many small but few large larvae are present. An additional application should be used only if defoliation increases. Allow at least 7 days between foliar applications. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any IRAC MOA class 4A insecticides were applied to the crop as soil or seed piece treatments. See comments on insect rotation under Colorado potato beetle.
	chlorantraniliprole, MOA 28 (Coragen) 1.67	3.5 to 5 oz	4 hrs	14	Do not apply more than 15.4 oz Coragen per acre per crop season.
	clothianidin MOA 4A (Belay) 50 WDG	1.9 to 2.8 fl oz	12 hrs	7	Apply Belay 50 WDG as foliar spray Apply when adults and/or small larvae are present but before large larvae appear. Do not apply more than 3 applications. Belay belongs to the same class of insecticides (neonicotinoid) as Admire Pro, Provado, Actara, and Platinum and Colorado potato beetle populations have the potential to become resistant to this class.
	dinotefuran, MOA 4A (Venom) 70 SG	1 to 1.5 oz (foliar) 6.5 to 7.5 oz (soil)	12 hrs	7 (foliar) 21 (soil)	Soil treatment for preplant, preemergence, or at ground crack only application only. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any IRAC MOA class 4A insecticides were applied to the crop as soil or seed piece treatments. See comments on insecticide rotation under Colorado potato beetle.

TABLE 2-17. INSECT CONTROL FOR POTATO, IRISH (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Colorado potato beetle (cont'd)	imidacloprid seed piece treatment, MOA 4A (Genesis) 240 g/L	0.4 to 0.6 fl oz/ 100 lb of seed tubers	—	—	See label for specific instructions. For early planted potatoes control may be marginal because of the prolonged time between application and Colorado potato beetle emergence. Limit use to locations where Colorado potato beetles were a problem in the same or adjacent fields during the previous year. Do not apply other IRAC MOA class 4A insecticides to a field if seed pieces were treated with Genesis. See product label for restrictions on rotational crops.
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2.0 F	0.74 fl oz/ 1,000 ft row	12 hrs	—	Admire Pro applied in-furrow at planting time may provide season-long control. However, for early planted potatoes control may be marginal due to the prolonged time between application and Colorado potato beetle emergence. Use only in potato fields that have a history of potato beetle infestations. If potatoes are rotated to a field adjacent to one planted in potato last year, a barrier treatment may be effective. (See Vegetable IPM Insect Note #45.) Admire Pro may also be applied as a seed treatment. Check label for instructions regarding this use. Check label for restrictions on planting crops following Admire Pro treated potatoes. There have been reports of low levels of resistance to imidacloprid. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any of these compounds were applied to the crop as soil or seed piece treatments. See comments on insecticide rotation under Colorado potato beetle.
	Foliar treatment (Admire Pro) 4.6 (various) 1.6 F	1.3 fl oz 3.75 fl oz	12 hrs	7 7	Apply when most of the egg masses have hatched and most larvae are small (1/8 to 3/16 in.). An additional application should be made only if defoliation increases. Allow at least 7 days between foliar applications. Do not exceed 5.6 fl oz of Admire Pro per field per acre per season. Regardless of formulation, do NOT apply more than a total of 0.31 lb imidacloprid per season. Foliar applications of imidacloprid should not be applied If soil application was used. There have been reports of resistance to imidacloprid. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any of these compounds were applied to the crop as soil or seed piece treatments. See comments on insecticide rotation under Colorado potato beetle.
	imidacloprid + cyfluthrin premix, MOA 4A and 3 (Leverage) 2.7 SE	3 to 3.75 fl oz	12 hrs	7	Apply when most of the egg masses have hatched and most larvae are small (1/8 to 3/16 in.). An additional application should be made only if defoliation increases. Leverage will control European corn borer if application coincides with egg hatch and presence of small corn borer larvae. Leverage should not be used in fields treated with Admire Pro. There have been reports of low levels of resistance to imidacloprid. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any of these compounds were applied to the crop as soil or seed piece treatments. See comments on insecticide rotation under Colorado potato beetle.
	novaluron, MOA 15 (Rimon) 0.83 EC	9 to 12 fl oz	12 hrs	14	
	spinosad, MOA 5 (Blackhawk) 36WG	1.7 to 3.3 oz		3	Apply when most egg masses have hatched and both small and large larvae are present. Thorough coverage is important. Do not apply more than a total of 0.33 lb ai (14.4 oz of Blackhawk or 21 oz of Radiant) per crop. Do not apply in consecutive generations of Colorado potato beetle and do not make more than two applications per single generation of Colorado potato beetle. Do not make successive applications less than 7 days apart. To minimize the potential for resistance, do NOT use spinosad or spinetoram if it either product was applied to a potato crop in the field or an adjacent field within the last year.
	spinetoram, MOA 5 (Radiant) 1 SC	6 to 8 fl oz	4 hrs	7	
	thiamethoxam seed piece treatment, MOA 4A (Cruiser) 5 FS	0.11 to 0.16 fl oz/100 lb	—	—	See label for specific instructions. For early planted potatoes control may be marginal because of the prolonged time between application and Colorado potato beetle emergence. Limit use to locations where Colorado potato beetles were a problem in the same or adjacent fields during the previous year. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any of these compounds were applied to the crop as soil or seed piece treatments. See comments on insecticide rotation under Colorado potato beetle.

TABLE 2-17. INSECT CONTROL FOR POTATO, IRISH (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Colorado potato beetle (cont'd)	thiamethoxam, MOA 4A (Platinum) 75 SG	1.66 to 2.67 oz	12 hrs	7	Platinum applied in-furrow at planting time may provide season-long control. For early planted potatoes control may be marginal because of the prolonged time between application and Colorado potato beetle emergence. Limit use to locations where Colorado potato beetles were a problem in the same or adjacent fields in the previous year. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any of these compounds were applied to the crop as soil or seed piece treatments. See comments on insecticide rotation under Colorado potato beetle. See product label for restrictions on rotational crops.
	(Actara) 25 WDG	3 oz	12 hrs	7	Actara is applied as foliar spray. Apply when most of the eggs have hatched and most of the larvae are small (1/8 to 3/16 in.). An additional application should be made only if defoliation increases. Allow at least 7 days between applications. Do not make more than 2 applications of Actara per crop per season. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any of these compounds were applied to the crop as soil or seed piece treatments. See label for rotational restrictions.
	thiamethoxam, MOA 4A + chlorantraniliprole, MOA 28 Premix (Voliam Flexi)	4 oz	12 hr	14	Voliam Flexi is applied as a foliar spray. Apply when most of the eggs have hatched and most of the larvae are small (1/8 to 3/16 in.). An additional application should be made only if defoliation increases. Allow at least 7 days between applications. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any of these compounds were applied to the crop as soil or seed piece treatments. Do not exceed 8 oz of Voliam Flexi. See label for rotational restrictions Voliam Flexi can be expected to provide control of European corn borer if application is timed correctly (see European corn borer for correct timing.
European corn borer	***The Atlantic variety of potato is very tolerant of injury by European corn borer larvae. Consequently, control is not recommended on Atlantic unless more than 30% of the stems are infested. Control on all other varieties is recommended when infestations reach 20% infested stems. Application timing is critical. Scout for eggs and treat when eggs hatch or at the first sign of larvae entering petioles. Several days of cool wet weather will kill larvae and may eliminate the need for insecticide applications. If this occurs, flag additional egg masses and apply insecticide at hatch.***				
	pyrethroid, MOA 3A		12 hrs		Apply when threshold is reached (usually during the first half of May). A second application may be needed if the percentage of infested stems increases substantially 7 to 10 days after the first application. Ground applications are usually more effective than aerial applications. See **Table 2-26** for a list of registered pyrethroids and pre-harvest intervals.
	chlorantraniliprole, MOA 28 (Coragen) 1.67	3.5 to 5 oz	4 hrs	14	Do not apply more than 15.4 oz Coragen per acre per crop season.
	thiamethoxam, MOA 4A + Chlorantraniliprole MOA 28 Premix (Voliam Flexi)	4 oz	12 hrs	14	Voliam Flexi is applied as a foliar spray. Apply when most of the eggs have hatched and most of the larvae are small (1/8 to 3/16 in.). An additional application should be made only if defoliation increases. Allow at least 7 days between applications. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any of these compounds were applied to the crop as soil or seed piece treatments. Do not exceed 8 oz of Voliam Flexi. See label for rotational restrictions Voliam Flexi can be expected to provide control of Colorado potato beetle if application is timed correctly (see Colorado potato beetle section for correct timing.
	indoxacarb, MOA 22 (Avaunt) 30 WDG	3.5 to 6.0 oz	12 hrs	7	Apply when threshold is reached (usually during the first half of May). A second application may be needed if the percentage of infested stems increases substantially 7 to 10 days after the first application. Ground applications are usually more effective than aerial applications. Do not apply more than 24 oz of Avaunt per acre per crop.
	spinetoram, MOA 5 (Radiant) 1 SC	6 to 8 fl oz	4 hrs	7	Do not apply more than a total of 0.25 lb ai (32 fl oz product) per crop.)
Flea beetle	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2.0 F	0.74 fl oz/ 1,000 ft row	12 hrs	—	Imidacloprid applied in-furrow at planting time may provide season-long control. However, for early planted potatoes control may be marginal due to the prolonged time between application and crop emergence. Check label for restrictions on planting crops following Admire Pro treated potatoes. See comments on resistance in Colorado potato beetle to imidacloprid. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any of these compounds were applied to the crop as soil or seed piece treatments.

TABLE 2-17. INSECT CONTROL FOR POTATO, IRISH (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Flea beetle (cont'd)	*Foliar treatment*		12 hrs		See comments for imidacloprid resistance in Colorado potato beetle.
	(Admire Pro) 4.6	1.3 fl oz		7	
	(various) 1.6 F	3.75 fl oz			
	thiamethoxam seed piece treatment, MOA 4A (Cruiser) 5 FS	0.11 to 0.16 fl oz/100 lb		—	See label for specific instructions. For early planted potatoes control may be marginal because of the prolonged time between application and flea beetle emergence. Limit use to locations where Colorado potato beetles were a problem in the same or adjacent fields during the previous year. To minimize selection for resistance, do not use foliar applications of any IRAC MOA class 4A insecticides if any of these compounds were applied to the crop as soil or seed piece treatments. See comments on insecticide rotation under Colorado potato beetle.
	thiamethoxam, MOA 4A (Platinum) 2 SC	5 to 8 fl oz	12 hrs	7	Platinum applied in-furrow at planting time may provide season-long control. However, for early planted potatoes control may be marginal due to the prolonged time between application and crop emergence. See product label for restrictions on rotational crops.
	(Actara) 25 WDG	3 oz	12 hrs	7	Actara is applied as foliar spray.
	thiamethoxam MOA 4A + chlorantraniliprole MOA 28 (Voliam Flexi)	4 fl oz	12 hrs	14	Do not exceed a total of 8.0 fl oz/acre Voliam Flexi or 0.094 lb a.i/acre of thiamethoxam-containing products or 0.2 lb a.i/acre of chlorantraniliprole-containing products per growing season.
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Leafhopper	carbaryl, MOA 1A		12 hrs		On foliage when leafhoppers first appear. Repeat every 10 days as needed. Often a problem in the mountains.
	(Sevin) 50 WP	1 to 2 lb		7	
	(Sevin) 80 S	0.625 to 1.25 lb		7	
	(Sevin) XLR Plus	1 pt		7	
	dimethoate 4 EC, MOA 1B	0.5 to 1 pt	48 hrs	0	Do not apply more than 2 pints total per acre per year.
	methomyl, MOA 1A (Lannate) 2.4 LV	1.5 pt	48 hrs	6	
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Leafminer	dimethoate 4 EC, MOA 1B	0.5 to 1 pt	48 hrs	0	Do not apply more than 2 pints total per acre per year.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	3.5 to 5 fl oz	4 hrs	14	
Blister beetle, Leaffooted bug, Plant bug, Stink bug, Vegetable weevil	carbaryl, MOA 1A		12 hrs		On foliage as needed.
	(Sevin) 50 WP	2 to 4 lb		7	
	(Sevin) XLR Plus	1 to 2 qt		7	
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Potato tuberworm	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	3.5 to 5 fl oz	4 hrs	14	Do not exceed 4 applications per acre per crop. Do not apply more than 15.4 oz Coragen per acre per crop season. Minimum interval between applications is 5 days.
	methomyl, MOA 1A (Lannate) 2.4 LV	1.5 to 3 pt	48 hrs	6	Prevent late-season injury by keeping potatoes covered with soil. To prevent damage in storage, practice sanitation.
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Thrips	dimethoate 4 EC, MOA 1B	0.5 pt	48 hrs	0	
	spinetoram, MOA 5 (Radiant) 1 SC	6 to 8 fl oz	4 hrs	7	
Wireworm	***Planting in fields previously in corn, soybean, or fallow may increase risk of wireworm.***				
	bifenthrin, MOA 3 (Capture LFR)	25.5 fl oz	12 hrs	—	In furrow at planting.
	clothianidin (Belay) 50 WDG	6 oz	12 hrs	—	In-furrow at planting.
	ethoprop, MOA 1B (Mocap) 15 G	1.4 lb per 1,000 row ft	48 hrs	90	In-furrow at planting.
	fipronil, MOA 2B (Regent) 4 SC	3.2 fl oz	none	90	In-furrow at planting.
	phorate, MOA 1B (Thimet) 20 G	Row Treatment: 10 to 20 oz (38 in. row spacing)	12 hrs	90	Can contribute to insecticide-resistance problems with Colorado potato beetle.

TABLE 2-18. INSECT CONTROL FOR PUMPKIN, SQUASH

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide applications in cucurbits should be made in late evening to protect pollinating insects. Refer to the pollination section of the general production recommendations in this publication for more information about protecting pollinators.					
Aphid	acetamiprid, MOA 4A (Assail) 30SG	 2.5 to 4 oz	12 hrs	 0	
	clothianidin, MOA 4A (Belay) 50WDG	 4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	At planting 7 (foliar)	Soil applications may only be applied at planting. Will also control cucumber beetle. Do not apply Belay during bloom or if bees are actively foraging.
	flonicamid, MOA 9C (Beleaf) 50 SG	 2 to 2.8 oz	12 hrs	 0	
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	Must be applied to the soil. May be applied preplant; at planting; as a post-seeding drench, transplant water drench, or hill drench; subsurface sidedress or by chemigation using low-pressure drip or trickle irrigation. See label for approved application methods. Will also control whitefly and cucumber beetles.
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 oz	12 hrs	 14	Apply before populations reach damaging levels. Do not exceed 5.5 oz per acre per season.
	thiamethoxam, MOA 4A *Soil treatment* (Platinum) 75 SG	 1.66 to 3.67 oz	12 hrs	 30	Platinum may be applied to direct-seeded crops in-furrow seeding or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 11 oz per acre per season of Platinum. Check label for plant-back restrictions for a number of crops.
	Foliar treatment (Actara) 25 WDG	 1.5 to 3.0 oz	12 hrs	 0	
Armyworm	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 2 to 3.5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	flubendiamide, MOA 28 (Belt) 4SC	 1.5 fl oz	12 hrs	 1	
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 10 fl oz	4 hrs	 3	Do not exceed 4 applications per season, and do not reapply in less than 7 days.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 3	
Cucumber beetle	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	carbaryl, MOA 1A (Sevin) 50 WP (Sevin) 80 S (Sevin) XLR Plus	 2 lb 1.25 lb 1 qt	12 hrs	 3 3 3	Phytotoxicity may occur following application of carbaryl during hot, humid weather.
	acetamiprid, MOA 4A (Assail) 30SG	 2.5 to 5.3 oz	12 hrs	 0	
	clothianidin, MOA 4A (Belay) 50WDG	 4.8 to 6.8oz (soil) 1.6 to 2.1oz (foliar)	12 hrs	At planting 7 (foliar)	See application instructions and precautionary bee statement under above under aphids.
	dinotefuran, MOA 4A (Venom) 70 SG	 3 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	 1 (foliar) 21 (soil)	Do not follow soil applications with foliar applications. Use only one application method. Do not apply more than 6 oz per acre per season using foliar applications, or 12 oz per acre per season using soil applications. Soil applications may be applied by 1) a narrow band below or above the seed line at planting; 2) a post-seeding or transplant drench with sufficient water to ensure incorporation to the root zone; or 3) drip irrigation.
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	See application methods under Aphid.
Cutworm	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Corn earworm, Looper, Pickleworm, Melonworm	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	flubendiamide, MOA 28 (Belt) 4SC	 1.5 fl oz	12 hrs	 1	

TABLE 2-18. INSECT CONTROL FOR PUMPKIN, SQUASH (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide applications in cucurbits should be made in late evening to protect pollinating insects. Refer to the pollination section of the general production recommendations in this publication for more information about protecting pollinators.					
Corn earworm, Looper, Pickleworm, Melonworm (cont'd)	indoxacarb, MOA 22 (Avaunt) 30 WDG	2.5 to 6 oz	12 hrs	3	
	methoxyfenozide, MOA 18 (Intrepid) 2 F	4 to 10 fl oz	4 hrs	3	Do not exceed 4 applications per season, and do not reapply in less than 7 days.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	spinetoram, MOA 5 (Radiant) 1 SC	5 to 10 fl oz	4 hrs	3	
Spider mite	abamectin, MOA 6 (Agri-Mek) 0.7 SC	1.75 to 3.5 fl oz	12 hrs	7	
	bifenazate, MOA 25 (Acramite) 50 WS	0.75 to 1.0 lb	12 hrs	3	Do not make more than one application per season.
	etoxazole, MOA 10B (Zeal)	2 to 3 oz	12 hrs	7	Do not make more than one Zeal application per season.
	spiromesifen, MOA 23 (Oberon) 2 SG	7 to 8.5 oz	12 hrs	7	Do not exceed 3 applications per season.
Squash bug	acetamiprid, MOA 4A (Assail) 30 SG	5.3 oz	12 hrs	0	Assail is most effective against newly laid eggs and nymphs.
	clothianidin, MOA 4A (Belay) 50SDG	4.8 to 6.8oz (soil) 1.6 to 2.1oz (foliar)	12 hrs	At planting 7 (foliar)	See application instructions and precautionary bee statement above under aphid.
	dinotefuran, MOA 4A (Venom) 70 SG	3 to 4 oz	12 hrs	1	Do not exceed 6 oz Venom per acre per season.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Squash vine borer	acetamiprid, MOA 4A (Assail) 30 SG	5.3 oz	12 hrs	0	
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	3.5 to 5 fl oz	4 hrs	1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	flubendiamide, MOA 28 (Belt) 4SC	1.5 fl oz	12 hrs	1	
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Thrips	dinotefuran, MOA 4A (Venom) 70 SG	1 to 4 oz	12 hrs	1	
	spinetoram, MOA 5 (Radiant) 1 SC	6 to 10 fl oz	4 hrs	3	
Whitefly	acetamiprid, MOA 4A (Assail) 30 SG	5.3 oz	12 hrs	0	
	buprofezin, MOA 16 (Courier) 40 WP	9 to 13.6 oz	12 hrs	7	Use sufficient water to ensure good coverage. Do not apply more than twice per crop cycle or 4 applications per year total.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	5 to 7.5 fl oz	4 hrs	1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	dinotefuran, MOA 4A (Venom) 70 SG	1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	1 (foliar) 21 (soil)	See comments under cucumber beetle for application instructions and restrictions.
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	21 21	Admire Pro must be applied to the soil. May be applied preplant; at planting; as a post-seeding drench, transplant water drench, or hill drench; subsurface sidedress or by chemigation using low-pressure drip or trickle irrigation. See label for information on approved application methods. Will also control aphids and cucumber beetle.
	pyriproxyfen, MOA 7C (Knack) 0.86 EC	8 to 10 fl oz	12 hrs	7	Do not make more than two applications per season, and do not make applications closer than 14 days apart.
	spiromesifen, MOA 23 (Oberon) 2 SC	7 to 8.5 fl oz	12 hrs	7	
	thiamethoxam, MOA 4A (Platinum) 75 SG	1.66 to 3.67 oz	12 hrs	30	Platinum may be applied to direct-seeded crops in-furrow at seed or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 11 oz per acre per season. Check label for plant-back restrictions for a number of crops.
	(Actara) 25 WDG	1.5 to 3.0 oz	12 hrs	0	

TABLE 2-19. INSECT CONTROL FOR RADISH

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid, Flea beetle, Leafminer	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	Imidacloprid, MOA 4A *Foliar treatment* (Admire Pro) 4.6 F (various) 1.6 F	 1.2 fl oz 3.5 fl oz	12 hrs	 7 7	Will not control leafminer.
	thiamethoxam, MOA 4A (Platinum) 75SG (Actara) 25WDG	 1.7 to 2.17 oz 1.5 to 3 oz	12 hrs	 30 7	See label for soil application instructions.
Root maggot, Wireworm	chlorpyrifos, MOA 1B (Lorsban) 4E	 1 fl oz/1,000 linear ft	24 hrs	 —	Water-based drench in-furrow planting. Use a minimum of 40 gal of water per acre.
	diazinon, MOA 1B (AG 500) 50 WP	 3 to 4 qt 6 to 8 lb	3 days	 — —	Broadcast just before planting and immediately incorporate into the upper 4 to 8 inches of soil.

TABLE 2-20. INSECT CONTROL FOR SPINACH

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	acetamiprid, MOA 4A (Assail) 30SG	 2 to 4 oz	12 hrs	 7	Do not apply more than once every 7 days, and do not exceed 5 applications per season.
	clothianidin, MOA 4A (Belay) 50 WDG	 4.8 to 6.0 oz (soil) 1.6 to 2.1 fl oz (foliar)	12 hrs	 — 7 (foliar)	Soil application at planting only.
	flonicamid, MOA 9C (Beleaf) 50 SG	 2 to 2.8	12 hrs	 0	
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	 4.4 to 10.5 fl oz 10 to 24 fl oz	12 hrs	 21 21	Do not follow soil applications with foliar applications of any neonicotinoid insecticides. See label for soil application instructions.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	 1.2 fl oz 3.8 fl oz	12 hrs	 7 7	
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 oz	12 hrs	 7	Apply before aphids reach damaging levels. Use sufficient water to ensure good coverage.
	spirotetramat, MOA 23 (Movento) 2SC	 4 to 5 fl oz	24 hrs	 3	Do not exceed 10 fl oz per season. Requires surfactant.
	thiamethoxam, MOA 4A (Platinum) 75SG (Actara) 25WDG	 1.7 to 2.17 oz 1.5 to 3 oz	12 hrs	 30 7	See label for soil application instructions.
Leafminer	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 5 to 7.5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	cryomazine, MOA 17 (Trigard) 75 WP	 2.66 oz	12 hrs	 7	
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 10 fl oz	4 hrs	 1	Spray adjuvants may enhance efficacy against leafminers. See label for information on adjuvants.
Armyworm, Beet webworm, Corn earworm, Cutworm, Looper	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 3	
	emamectin benzoate, MOA 6 (Proclaim) 5 SG	 2.4 to 4.8 oz	12 hrs	 7	
	flubendiamide, MOA 28 (Belt) 4SC	 1.5 fl oz	12 hrs	 1	
	indoxacarb, MOA 22 (Avaunt) 30 SG	 2.5 to 3.5 oz	12 hrs	 3	
	methomyl, MOA 1A (Lannate) 90 SP (Lannate) 2.4 LV	 0.5 lb 1.5 pt	48 hrs	 7 7	Air temperature should be well above 32 degrees F. Do not apply to seedlings less than 3 in. in diameter.
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 10 fl oz	4 hrs	 1	Use low rates for early-season applications to young or small plants and 6 to 10 oz for mid- to late-season applications.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.

TABLE 2-21. INSECT CONTROL FOR SWEETPOTATO

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphids, Leafhopper, Whitefly	***Aphids, leafhoppers, and whiteflies are rarely a problem.***				
	acetamiprid, MOA 4A (Assail) 30SG	 1.5 to 4 oz	12 hrs	 7	Do not make more than 4 applications per season. Do not apply more frequently than once every 7 days. Use 2.5 to 4 oz for aphids.
	clothianidin, MOA 4A (Belay) 2.13 SC	 9 to 12 oz (soil)	12 hrs	 21	Soil application as an in-furrow or sidedress application. For sidedress applications, immediately cover with soil.
	flonicamid, MOA 9C (Beleaf) 50 SG	 2 to 2.8 oz	12 hrs	 7	
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 1.6 F	 1.2 fl oz 3.5 fl oz	12 hrs	 7 7	Two applications may be needed to control heavy populations. Allow 5 to 7 days between applications.
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 to 5.5 oz	12 hrs	 14	
	spirotetramat MOA 23 (Movento) 2 SC	 4 to 5 fl oz	24 hrs	 7	Will not control leafhopper. Requires surfactant.
	thiamethoxam, MOA 4A (Actara) 25 WDG	 3 oz	12 hrs	 14	Two applications of Actara may be needed to control heavy populations. Allow 7 to 10 days between applications. Do not exceed a total of 6 oz of Actara per crop per season.
Armyworm, Looper, Corn earworm, Hornworm	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	Foliar application only on sweetpotato.
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 6 to 10 fl oz	4 hrs	 7	Damaging earworm infestations may occur in August or September. If significant infestations are present on foliage during harvest, larvae may feed on exposed root. Do not make more than 3 applications or apply more than 30 fl oz of Intrepid per acre per season.
	novaluron, MOA 15 (Rimon) 0.83 EC	 9 to 12 fl oz	12 hrs	 14	Do not make more than 2 applications per crop per season.
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 8 fl oz	4 hrs	 7	
Cucumber beetle (adults), Japanese beetle (adults), Tortoise beetle	***Cucumber beetle larvae (diabrotica) are a serious pest of sweetpotato in Louisiana and Mississippi. Controlling adult cucumber beetles in areas with a history of diabrotica damage can reduce damage to roots. Foliage feeding by beetles rarely causes economic loss, and control is not warranted unless defoliation is severe.***				
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	carbaryl, MOA 1A (Sevin) 50 WP (Sevin) 80 S, WSB (Sevin) XLR Plus	 4 lb 2.5 lb 2 qt	12 hrs	 7 7 7	Treat for tortoise beetles only if significant defoliation is observed. Tortoise beetles are frequently present but rarely reach levels requiring treatment.
	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 8 fl oz	4 hrs	 7	
Flea beetle, Wireworm, White grub	bifenthrin, MOA 3 (various) 2 EC	 9.6 to 19.2 fl oz	12 hrs	 21	Apply as broadcast, preplant application to the soil and incorporate 4 to 6 in. prior to bed formation. This use has been demonstrated to control overwintered wireworm populations and reduce damage to roots at harvest. Chlorpyrifos will not control whitefringed beetle or other grubs that attack sweetpotato. Research has shown that best control is achieved when chlorpyrifos is applied as a preplant application incorporated 4 to 6 in. deep prior to bed formation, followed by 1 or more soil-directed, incorporations of bifenthrin during routine cultivation. Bifenthrin should be directed onto each side of the bed from the drill to the middle of the furrow and incorporated with cultivating equipment set to throw soil toward the drill. The objective is to provide a barrier of treated soil that covers the bed and furrows. Foliar sprays of various insecticides that target adults to prevent egg laying have not been shown to provide any reduction in damage to roots by wireworm larvae at harvest.
	chlorpyrifos, MOA 1B (Lorsban) 15 G (Lorsban) 4 E (Lorsban Advance)	 13.5 lb 4 pt	24 hrs	 125 125 60 (Lorsban Advanced for use in NC only)	
Fruit fly (vinegar fly)	pyrethrins, MOA 3 (Pyrenone)	 1 gal/100,000 cu ft	12 hrs	 —	Postharvest application in storage. Apply as a space fog with a mechanical or thermal generator. Do not make more than 10 applications.
Sweetpotato weevil	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	phosmet, MOA 1B (Imidan) 70 W	 1.33 lb		 7	
Thrips	spinetoram, MOA 5 (Radiant) 1 SC	 6 to 8 fl oz	4 hrs	 7	
Whitefringed beetle	phosmet, MOA 1B (Imidan) 70 W	 1.33 lb		 7	Do not make more than five applications per season. Whitefringed beetle adults are active in July and August. Do not plant in fields with a recent history of whitefringed beetles.

TABLE 2-22. INSECT CONTROL FOR TOMATO

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid	dimethoate 400, MOA 1B	1 pt	48 hrs	180	Do not exceed 5 pt per acre per year.
Aphid, Flea beetle	acetamiprid, MOA 4A (Assail) 30 SG	 2 to 4 oz	12 hrs	 7	Do not apply more than once every 7 days, and do not exceed 5 applications per season.
	clothianidin, MOA 4A (Belay) 50 WDG	 4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	 — 7 (foliar)	Soil applications at planting only.
	dimethoate 4 EC, MOA 1B	0.5 to 1 pt	48 hrs	7	Do not exceed rate with dimethoate as leaf injury may result.
	flonicamid, MOA 9C (Beleaf) 50 SG	 2 to 2.8 oz	12 hrs	0	Will not control flea beetle.
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F *Foliar treatment* (Admire Pro) 4.6 F (various) 1.6 F	 7 to 10.5 fl oz 16 to 24 fl oz 1.2 fl oz 3.75 fl oz	12 hrs 12 hrs	 21 21 0 0	For short-term protection at planting. Admire Pro may also be applied to transplants in the planthouse not more than 7 days before planting at the rate of 0.44 (4.6 F formulation) or 1 oz (2 F formulation) per 10,000 plants. See label for soil application instructions.
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 oz	12 hrs	 0	For aphids only.
	spirotetramat, MOA 23 (Movento) 2SC	 4 to 5 fl oz	24 hrs	 1	Do not exceed 10 fl oz per season. Requires surfactant.
	thiamethoxam, MOA 4A (Platinum) 75 SG	 1.66 to 3.67 oz	12 hrs	 30	Platinum may be applied to direct-seeded crops in-furrow seeding or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 11 oz per acre per season of Platinum. Check label for plant-back restrictions for a number of crops.
	(Actara) 25 WDG	2 to 3 oz	12 hrs	0	Actara is for foliar applications.
Armyworm	*Bacillus thuringiensis,* MOA 11A (Crymax) WDG (Dipel) 2X (Xentari)	 0.5 to 1.5 lb 0.5 to 1 lb 0.5 to 1 lb	4 hrs	 0 0 0	Start applications when larvae are small, and continue at 5- to 7-day intervals during periods of infestation.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 4 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	emamectin benzoate, MOA 6 (Proclaim) 5 WDG	 2.4 to 4.8 oz	12 hrs	 7	Apply when larvae are first observed.
	flubendiamide, MOA 28 (Belt) 4SC	 1.5 fl oz	12 hrs	 1	
	indoxacarb, MOA 22 (Avaunt) 30 DG	 3.5 oz	12 hrs	 3	Do not apply more than 14 oz of Avaunt (0.26 lb ai) per acre per crop. The minimum interval between sprays is 5 days.
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 10 fl oz	4 hrs	 1	Use low rates for early-season applications to young or small plants and 6 to 10 oz for mid- and late-season applications.
	novaluron, MOA 15 (Rimon) 0.83 EC	 9 to 12 fl oz	12 hrs	 1	Do not make more than 3 applications per season.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	
Colorado potato beetle	acetamiprid, MOA 4A (Assail) 30 SG	 1.5 to 2.5 oz	12 hrs	 7	
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F *Foliar treatment* (Admire Pro) 4.6 F (various) 1.6 F	 7 fl oz 16 fl oz 1.2 fl oz 3.75 fl oz	12 hrs 12 hrs	 21 21 0 0	Use Admire Pro for soil or transplant drench treatment and 1.6 F formulation for foliar applications.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 1	
	thiamethoxam, MOA 4A (Platinum) 75 SG	 1.66 to 3.67 oz	12 hrs	 30	Platinum may be applied to direct-seeded crops in-furrow seeding or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 11 oz per acre per season of Platinum. Check label for plant-back restrictions for a number of crops.
	(Actara) 25 WDG	2 to 3 oz	12 hrs	0	Actara is for foliar applications.

TABLE 2-22. INSECT CONTROL FOR TOMATO (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Cabbage looper, Hornworm, Tomato fruitworm, Pinworm	*Bacillus thuringiensis,* MOA 11A		4 hrs		
	(Dipel) DF, MOA	0.5 to 1 lb		0	
	(Crymax) WDG	0.5 to 1.5 lb		0	
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	chlorantraniliprole, MOA 28		4 hrs		Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	(Coragen) 1.67 SC	3.5 to 5 fl oz		1	
	emamectin benzoate, MOA 6		12 hrs		
	(Proclaim) 5 WDG	2.4 to 4.8 oz		7	
	flubendiamide, MOA 28		12 hrs		
	(Belt) 4 SC	1.5 fl oz		1	
	indoxacarb, MOA 22		12 hrs		Do not apply more than 14 oz of Avaunt (0.26 lb ai) per acre per crop. The minimum interval between sprays is 5 days.
	(Avaunt) 30 WDG	2.5 to 3.5 oz		3	
	methomyl, MOA 1A		48 hrs		Methomyl may induce leafminer infestation.
	(Lannate) 2.4 LV	1.5 to 3 pt		1	
	methoxyfenozide, MOA 18		4 hrs		Use low rates for early-season applications to young or small plants and 6 to 10 oz for mid- and late-season applications. Intrepid provides suppression of pinworm only.
	(Intrepid) 2 F	4 to 10 fl oz		1	
	novaluron, MOA 15		12 hrs		Do not make more than 3 applications per season.
	(Rimon) 0.83 EC	9 to12 fl oz		1	
	spinetoram, MOA 5		4 hrs		
	(Radiant) 1 SC	5 to 10 fl oz		1	
Cutworm	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Leafminer	abamectin, MOA 6		12 hrs		Do not exceed 48 fl oz per acre per season, or more than two sequential applications.
	(Agri-Mek) 0.7 SC	1.75 to 3.5 fl oz		7	
	chlorantraniliprole, MOA 28		4 hrs		Foliar or soil chemigation. Drip chemigation must be applied uniformly to the root zone. See label for soil application instructions.
	(Coragen) 1.67 SC	5 to 7.5 fl oz		1	
	cryomazine, MOA 17		12 hrs		See label for plant-back restrictions.
	(Trigard) 75 WP	2.66 oz		0	
	spinetoram, MOA 5		4 hrs		Do not exceed 29 fl oz per acre per season.
	(Radiant) 1 SC	6 to 8 fl oz		1	
Spider mite	abamectin, MOA 6		12 hrs		Do not exceed 48 fl oz per acre per season, or more than two sequential applications.
	(Agri-Mek) 0.7 SC	1.75 to 3.5 fl oz		7	
	acequinocyl, MOA 20B		12 hrs		The use of a surfactant/adjuvant with Kanemite on tomatoes is prohibited.
	(Kanemite) 15SC	31 fl oz		1	
	bifenazate, MOA 25		12 hrs		Do not make more than one application per season.
	(Acramite) 50 WS	0.75 to 1.0 lb		3	
	fenpyroximate MOA 21		12 hrs		Do not make more than two applications per season.
	(Portal) 0.4EC	2 pts		3	
	spiromesifen, MOA 23		12 hrs		Do not exceed 3 applications per season.
	(Oberon) 2 SG	7 to 8.5 fl oz		7	
Stink bug	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	dinotefuran MOA 4A		12 hrs		
	Soil treatment				
	(Venom) 70 SG	5 to 6 oz		21	
	(Scorpion) 35 SL	9 to 10.5 fl oz		21	
	Foliar treatment		12 hrs		
	(Venom) 70 SG	1 to 4 oz		1	
	(Scorpion) 35 SL	2 to 7 fl oz		1	
	thiamethoxam, MOA 4A				Do not exceed 11 oz Actara per acre per season.
	(Actara) 25 WDG	3 to 5.5 oz		0	
Thrips	dimethoate 4 EC, MOA 1B	0.5 to 1 pt	48 hrs	7	
	dinotefuran, MOA 4A		12 hrs		See comments under Whitefly for application instructions and restrictions.
	(Venom) 70 SG	1 to 4 oz (foliar) 5 to 6 oz (soil)		1 (foliar) 21 (soil)	

TABLE 2-22. INSECT CONTROL FOR TOMATO (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Thrips (cont'd)	(Scorpion) 35SL	2 to 7 fl oz (foliar) 9 to 10.5 fl oz (soil)	12 hrs	1 (foliar) 21 (soil)	
	methamidophos, MOA 1B (Monitor) 4 E	1.5 to 2 pt		7	Check 24(c) label for state registration.
	methomyl, MOA 1A (Lannate) 2.4 LV	1.5 to 3 pt	48 hrs	1	On foliage as needed.
	novaluron, MOA 15 (Rimon) 0.83 EC	9 to12 fl oz	12 hrs	1	Do not make more than 3 applications per season.
	spinetoram, MOA 5 (Radiant) 1 SC	6 to 10 fl oz	4 hrs	1	Will control thrips on foliage, not in flowers.
Whitefly	***For resistance management of whiteflies, do not follow a soil application of a neonicotinoid (MOA 4A's) with a foliar application of any neonicotinoid.***				
	acetamiprid, MOA 4A (Assail) 30 SG	2.5 to 4 oz	12 hrs	7	Do not apply more than once every 7 days, and do not exceed 5 applications per season.
	buprofezin, MOA 16 (Courier) 40 SC	9 to 13.6 fl oz	12 hrs	7	Use sufficient water to ensure good coverage. Do not apply more than twice per crop cycle, and allow 28 days between applications.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	5 to 7.5 fl oz	4 hrs	1	Foliar or soil application. Drip chemigation must be applied uniformly to the root zone. See label for soil application instructions.
	dinotefuran MOA 4A *Soil treatment* (Venom) 70 SG (Scorpion) 35 SL	 5 to 6 oz 9 to 10.5 fl oz	12 hrs	 21 21	Soil applications of Venom or Scorpion may be made in a narrow band under the plant row, as a post-transplant drench, as a soil incorporated sidedress after plants are established, or in drip irrigation water. See label for instructions.
	Foliar treatment (Venom) 70 SG (Scorpion) 35 SL	 1 to 4 oz 2 to 7 fl oz	12 hrs	 1 1	
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	16 to 24 fl oz 7 to 10.5 fl oz	12 hrs	21 21	Apply through a drip irrigation system or as a transplant drench with sufficient water to reach root zone. As a sidedress, apply 2 to 4 in. to the side of the row and incorporate 1 or more in. Residual activity will increase with increasing rates applied. Use higher rate for late-season or continuous infestations. Trickle irrigation applications will also control aphids and stinkbugs.
	pyriproxyfen, MOA 7C (Knack) 0.86EC	8 to 10 fl oz	12 hrs	14	Do not apply more than two applications per growing season, and do not make applications closer than 14 days.
	spiromesifen, MOA 23 (Oberon) 2 SC	7 to 8.5 fl oz	12 hrs	7	Do not make more than 3 applications per season.
	spirotetramat, MOA 23 (Movento) 2SC	4 to 5 fl oz	24 hrs	1	Do not exceed 10 fl oz per season. Requires surfactant.
	thiamethoxam, MOA 4A (Platinum) 75 SG (Actara) 25 WDG	1.66 to 3.67 oz 3 to 5.5 oz	12 hrs 12 hrs	30 0	Platinum may be applied to direct-seeded crops in-furrow seeding or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 11 oz per acre per season of Platinum. Check label for plant-back restrictions for a number of crops. Actara is for foliar applications.
Wireworm	diazinon, MOA 1B (Diazinon) AG 500 or 50 WP	2 to 4 qt	48 hrs	—	Broadcast before planting and incorporate. Wireworms may be a problem in fields previously in pasture, corn, or soybean.

TABLE 2-23. INSECT CONTROL FOR TURNIP

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Aphid, Flea beetle	clothianidin, MOA 4A (Belay) 50 WDG	 4.8 to 6.4 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	 — 7 (foliar)	Soil application at planting only as in-furrow or side dress application, seed or transplant drench, or chemigation. See label for application instructions.
	dimethoate 4 EC, MOA 1B	0.5 pt	48 hrs	14	
	imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6 F (various) 2 F	 4.4 to 10.5 fl oz 10 to 24 fl oz	12 hrs	 21 21	See label for soil application instructions.
	Foliar treatment (Admire Pro) 4.6 F (various) 1.6 F	 1.2 fl oz 3.8 fl oz	12 hrs	 7 7	
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 oz	12 hrs	 7	Will not control flea beetle.
	thiamethoxam, MOA 4A (Platinum) 75 SG (Actara) 25 WDG	 1.7 to 4.01 oz 1.5 to 3 oz	12 hrs 12 hrs	 Apply at plant 7	Platinum is for soil application and Actara for foliar application.
Harlequin bug, Vegetable weevil, Yellow margined leaf beetle	clothianidin, MOA 4A (Belay) 50 WDG	 4.8 to 6.0 oz (soil) 1.6 to 2.1 oz (foliar)	12 hrs	 — 7 (foliar)	Soil application at planting only as in-furrow or side dress application, seed or transplant drench, or chemigation. See label for application instructions.
	Imidacloprid, MOA 4A *Soil treatment* (Admire Pro) 4.6F (Various) 2F	 4.4 to 10.5 fl oz 10 to 24 fl oz	12 hrs	 21 21	Soil applications of imidacloprid will not control harlequin bug past 20 days after application.
	Foliar treatment (Admire Pro) 4.6F (Various) 2F	 1.2 fl oz 2.8 fl oz	12 hrs	 7 7	
	thiamethoxam, MOA 4A (Platinum) 75 SG (Actara) 25 WDG	 1.7 to 4.01 oz 1.5 to 3 oz	12 hrs	 Apply at plant 7 (foliar)	Platinum is for soil application and Actara for foliar application.
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Cabbage looper, Diamondback moth	***Insecticide-resistant populations, widespread in the Southeast, may not be controlled with some registered insecticides. To manage resistance, avoid transplants from Georgia and Florida, and avoid the repeated use of the same materials for extended periods of time. Repeated use of pyrethroid insecticides often aggravates diamondback moth problems. Do not allow populations to increase to large densities before treatments are initiated.***				
	Bacillus thuringiensis, MOA 11A (Crymax) WDG (Dipel) 2 X (Dipel) 4 L (Xentari) WDG	 0.5 to 1.5 lb 8 oz 1 to 2 pt 0.5 to 1 lb	4 hrs	 0 0 0 0	On foliage every 7 days as needed.
	chlorantraniliprole, MOA 28 (Coragen)	 3.5 to 5.0 fl oz	4 hrs	 1	For turnip greens or root turnips.
	emamectin benzoate, MOA 6 (Proclaim) 5 WDG	 2.4 to 4.8 oz	12 hrs	 14	For turnip greens only.
	flubendiamide, MOA 28 (Belt) 4 SC	 2 to 2.4 fl oz	12 hrs	 8	For turnip greens only
	indoxacarb, MOA 22 (Avaunt) 30 WDG	 2.5 to 3.5 oz	12 hrs	 3	Avaunt may be applied only to turnip greens, not root turnips.
	spinetoram, MOA 5 (Radiant) 1 SC	 3 to 6 fl oz	4 hrs	 1	
Root maggot	chlorpyrifos, MOA 1B (Lorsban) 4 E (Lorsban) 75 WDG	 1 to 2 pt 1.1 to 1.8 oz/ 1,000 ft row	24 hrs	 21 21	Irrigation or rainfall after application will enhance activity.

TABLE 2-24. INSECT CONTROL FOR WATERMELON

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide applications in cucurbits should be made in late evening to protect pollinating insects. Refer to the pollination section of the general production recommendations in this publication for more information about protecting pollinators.					
Aphid	acetamiprid, MOA 4A (Assail) 30 SG	 2.5 to 4 oz	12 hrs	0	
	clothianidin, MOA 4A (Belay) 50WDG	 4.8 to 6.4oz (soil) 1.6 to 2.1oz (foliar)	12 hrs	 At planting 7 (foliar)	Soil application at planting only.
	dimethoate, MOA 1B 2 E 2.67 E	 2 pt 1.5 pt	48 hrs	 3 3	
	flonicamid, MOA 9C (Beleaf) 50 SG	 2 to 2.8 oz	12 hrs	 0	
	pymetrozine, MOA 9B (Fulfill) 50 WDG	 2.75 oz	12 hrs	 0	Apply before populations reach damaging levels. Do not exceed 5.5 oz per acre per season.
	thiamethoxam, MOA 4A (Platinum) 75 SG	 1.66 to 3.67 oz	12 hrs	 30	Platinum may be applied to direct-seeded crops in-furrow seeding or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 11 oz per acre per season of Platinum. Check label for plant-back restrictions for a number of crops.
	(Actara) 25 WDG	1.5 to 3 oz	12 hrs	0	Actara is for foliar applications.
Armyworm, Cabbage looper	*Bacillus thuringiensis, MOA 11A and 11B2* (Xentari) DF (Dipel) DF	 0.5 to 2 lb 0.5 to 2 lb	4 hrs	 0 0	On foliage as needed.
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	 3.5 to 5 fl oz	4 hrs	 1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	flubendiamide, MOA 28 (Belt) 4 SC	 1.5 fl oz	12 hrs	 1	
	methoxyfenozide, MOA 18 (Intrepid) 2 F	 4 to 10 fl oz	4 hrs	 3	Use higher rates against large larvae.
	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	spinetoram, MOA 5 (Radiant) 1 SC	 5 to 10 fl oz	4 hrs	 3	
Cucumber beetle	acetamiprid, MOA 4A (Assail) 30 SG	 2.5 to 5.3 oz	12 hrs	 0	
	dinotefuran MOA 4A (Venom) 70 SG	 1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	 1 (foliar) 21 (soil)	
	(Scorpion) 35 SL	2 to 7 fl oz (foliar) 9 to 10.5 fl oz (soil)		1 (foliar) 21 (soil)	
	clothianidin, MOA 4A (Belay) 50WDG	 4.8 to 6.4 oz (soil) 1.6 to 2.1oz (foliar)	12 hrs	 At planting 21 (foliar)	Soil application at planting only.
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	 7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	 21 21	Admire Pro must be applied to the soil. May be applied pre-plant; at planting; as a post-seeding drench, transplant water drench, or hill drench; subsurface sidedress or by chemigation using low-pressure drip or trickle irrigation. See label for information on approved application method. Will also control aphids and whiteflies.

TABLE 2-24. INSECT CONTROL FOR WATERMELON (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide applications in cucurbits should be made in late evening to protect pollinating insects. Refer to the pollination section of the general production recommendations in this publication for more information about protecting pollinators.					
Cucumber beetle (cont'd)	pyrethroid, MOA 3A				See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
	thiamethoxam, MOA 4A *Soil treatment* (Platinum) 75 SG	1.66 to 3.67 oz	12 hrs	30	
	Foliar treatment (Actara) 25 WDG	3 to 5.5 oz	12 hrs	0	
Cutworm	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Thrips	dimethoate, MOA 1B (various brands & formulations)	See label	48 hrs	3	
	dinotefuran, MOA 4A (Venom) 70 SG	1 to 4 oz	12 hrs	1	
	spinetoram, MOA 5 (Radiant) 1 SC	6 to 10 fl oz	4 hrs	3	
Leafminer	abamectin, MOA 6 (Agri-Mek) 0.7 SC	1.75 to 3.5 fl oz	12 hrs	7	
	chlorantraniliprole, MOA 28 (Coragen) 1.67 SC	3.5 to 5 fl oz	4 hrs	1	Foliar or drip chemigation. Drip chemigation must be applied uniformly to the root zone. See label for instructions.
	cyromazine, MOA 17 (Trigard) 75 WP	2.66 oz	12 hrs	0	
	spinetoram, MOA 5 (Radiant) 1 SC	8 fl oz	4 hrs	3	
Spider mite	abamectin, MOA 6 (Agri-Mek) 0.7 SC	1.75 to 3.5 fl oz	12 hrs	7	Do not feed or graze vines.
	bifenazate, MOA 25 (Acramite) 50 WS	0.75 to 1.0 lb	12 hrs	3	Do not make more than one application per season.
	etoxazole, MOA 10B (Zeal) 72 WSP	2 to 3 oz	12 hrs	7	
	fenpyroximate MOA 21 (Portal) 0.4EC	2 pts	12 hrs	3	Do not make more than two applications per season.
	spiromesifen, MOA 23 (Oberon) 2 SG	7 to 8.5 fl oz	12 hrs	7	Do not exceed 3 applications per season.
Squash bug, Leaffooted bug	acetamiprid, MOA 4A (Assail) 30 SG	5.3 oz	12 hrs	0	
	dinotefuran MOA 4A (Venom) 70 SG	1 to 4 oz (foliar)	12 hrs	1 (foliar)	Foliar use only.
	(Scorpion) 35 SL	2 to 7 fl oz (foliar)		1 (foliar)	
	pyrethroid, MOA 3A		12 hrs		See **Table 2-26** for list of registered pyrethroids & pre-harvest intervals.
Whitefly	acetamiprid, MOA 4A (Assail) 30 SG	2.5 to 5.3 oz	12 hrs	0	
	buprofezin, MOA 16 (Courier) 40 SC	9 to 12.5 fl oz	12 hrs	7	Allow at least 7 days between applications.
	pyriproxyfen, MOA 7D (Knack) 0.86EC	8 to 10 fl oz	12 hrs	7	Do not make more than two applications per growing season.
	dinotefuran, MOA 4A (Venom) 70 SG	1 to 4 oz (foliar) 5 to 6 oz (soil)	12 hrs	1 (foliar) 21 (soil)	Do not follow soil applications with foliar applications of any neonicotinoid insecticide. Use only one application method. Do not apply more than 6 oz per acre per season using soil applications. Soil applications may be applied by a narrow band below or above the seed line at planting, by a post-seeding or transplant drench with sufficient water to ensure incorporation into the soil, or by drip irrigation.
	imidacloprid, MOA 4A (Admire Pro) 4.6 F (various) 2 F	7 to 10.5 fl oz 16 to 24 fl oz	12 hrs	21 21	Do not follow soil applications with foliar applications of any neonicotinoid insecticides. Must be applied to the soil. Do not use a foliar application of any neonicotinoid insecticide if using Admire Pro. May apply preplant; at planting; as a post-seeding drench, transplant water drench, or hill drench; subsurface sidedress or by chemigation using low-pressure drip or trickle irrigation. See label for information on approved application method. Will also control aphids and cucumber beetles.

TABLE 2-24. INSECT CONTROL FOR WATERMELON (cont'd)

Insect	Insecticide, Mode of Action Code, and Formulation	Amount of Formulation Per Acre	Restricted Entry Interval (REI)	Pre harvest Interval (PHI) (Days)	Precautions and Remarks
Insecticide applications in cucurbits should be made in late evening to protect pollinating insects. Refer to the pollination section of the general production recommendations in this publication for more information about protecting pollinators.					
Whitefly (cont'd)	spiromesifen, MOA 23 (Oberon) 70 SC	7 to 8.5 fl oz	12 hrs	7	
	thiamethoxam, MOA 4A (Platinum) 75 SG	1.66 to 3.67 oz	12 hrs	30	Apply Platinum to direct-seeded crops in-furrow at seed or transplant depth, post seeding or transplant as a drench, or through drip irrigation. Do not exceed 11 oz per acre per season. Check label for plant-back restrictions for a number of crops.
	(Actara) 25 WDG	3 to 5.5 oz	12 hrs	0	Actara is for foliar applications. Do not use a foliar application of any neonicotinoid insecticide if using Admire Pro.
Wireworm	diazinon, MOA 1B (Diazinon) AG 500	3 to 4 qt	3 days	—	Broadcast on soil before planting and thoroughly work into upper 6 in.

TABLE 2-25. RELATIVE EFFECTIVENESS OF INSECTICIDES AND MITICIDES FOR INSECT AND MITE CONTROL ON VEGETABLES.

Not all insecticides listed below are registered on all vegetable crops. Refer to the label before applying to a specific crop. Ratings are based on a consensus of vegetable entomologists in the southeastern United States.

"+++" very effective; "++" effective; "+" somewhat effective; "—" ineffective or insufficient data

Chemical class (IRAC)	Common name	Example Product	Flea Beetle	Colorado potato beetle*	Cucumber beetles	Corn earworm*	European corn borer	Fall armyworm	Cabbage looper	Imported cabbageworm	Diamondback moth*	Squash vine borer	Beet armyworm*	Stinkbugs/Harlequin bug	Squash bug	Aphids*	Thrips	Western Flower Thrips*	Leafminer	Maggots	Whiteflies*	Cutworms	Wireworms	White grubs	Spider mites*
1A	carbaryl	Sevin	+++	+	++	+	++	+	+	++	+	+	-	-	-	-	+	-	-	-	-	+	-	-	-
	methamidophos	Monitor	+	-	-	++	+	+	++	-	-	-	+	++	-	+++	+++	++	++	-	-	-	-	-	-
	methomyl	Lannate	+	-	-	++	++	++	++	++	++	-	+	++	++	+	+++	++	+	-	+	-	-	-	-
	oxamyl	Vydate	+	+	+	-	-	-	-	-	-	-	-	+	+	++	++	+	-	-	+	-	-	-	-
1B	malathion	Malathion	++	+	++	+	+	+	+	++	+	+	-	+	+	+	+	-	-	+	-	+	-	-	-
	chlorpyrifos	Lorsban	-	-	-	+	+	+	+	++	+	-	-	-	-	-	+	-	-	+++	-	++	++	++	-
	acephate	Orthene	-	-	-	+	+++	++	+	++	-	-	-	-	-	++	++	-	+	-	+	++	-	-	-
	diazinon	Diazinon	-	-	-	-	-	-	-		-	-	-		-	-	-	-	-	++	-	+	++	+	-
	dimethoate	Dimethoate	++	-	+	-	-	-	-	-	-	-	-	++	+	+++	+++	+	++	-	-	-	-	-	-
3	permethrin	Pounce	++	+	++	++	++	+	++	+++	+	+++	-	+	++	+	+	-	+	-	-	++	-	-	-
	zeta cypermethrin	Mustang Max	+++	+	+++	++	+++	++	++	+++	+	+++	-	+	++	+	++	-	+	-	-	+++	-	-	-
	cyfluthrin	Baythroid/Renounce	++	+	++	++	++	+	++	+++	+	+++	-	+	++	+	+	-	+	-	-	+++	-	-	-
	lambda cyhalothrin	Karate	+++	+	+++	++	+++	++	++	+++	+	+++	-	+	++	+	++	-	+	-	-	+++	-	-	-
	esfenvalerate	Asana XL	++	++	++	++	++	+	++	+++	+	++	-	+	+	+	+	-	+	-	-	++	-	-	-
	gamma cyhalothrin	Proaxis	+++	+	+++	++	+++	++	++	+++	+	+++	-	+	++	+	++	-	+	-	-	+++	-	-	-
	fenpropathrin	Danitol	++	-	++	++	++	+	+	+++	+	++	-	+	++	+	+	-	+	-	+	++	-	-	+
	bifenthrin	Brigade	+++	+	+++	++	++	+	+	+++	+	+++	-	++	++	+	++	-	+	+	+	+++	++	+	+
4A	imidacloprid	Admire	+++	++	+++	-	-	-	-	-	-	-	-	+	++	+++	++	-	-	++	++	-	+	++	-
	acetamiprid	Assail	++	+++	++	-	-	-	-	-	-	+	-	+	+	+++	++	-	-	-	++	-	-	-	-
	clothianidin	Belay	+++	+++	++	-	-	-	-	-	-	-	-	-	-	++	-	-	+	++	-	-	+	++	-
	thiamethoxam	Platinum/Actara	+++	++	++	-	-	-	-	-	-	-	-	++	++	+++	+	-	+	++	++	-	+	+	-
	dinotefuran	Venom/Scorpion	+++	+++	++	-	-	-	-	-	-	-	-	++	++	+	++	-	+	-	++	-	-	-	-
5	spinosad	Blackhawk/Entrust	-	+++	-	++	++	++	++	+++	++	++	++	-	-	-	++	++	+++	-	-	+	-	-	-
	spinetoram	Radiant	-	+++	-	+++	+++	++	++	+++	++	++	++	-	-	-	+++	++	+++	-	-	+	-	-	-
6	emamectin benzoate	Proclaim	-	-	-	++	++	++	+++	+++	+++	++	+++	-	-	-	-	-	+	-	-	+	-	-	-
	abamectin	Agri-Mek	-	+++	-	-	-	-	-	-	-	-	-	-	-	-	++	+	+++	-	-	-	-	-	+++
7C	pyriproxyfen	Knack/Distance	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	-	-
9B	pymetrozine	Fulfill	-	-	-	-	-	-	-	-	-	-	-	-	-	+++	-	-	-	-	+	-	-	-	-
9C	flonicamid	Beleaf	-	-	-	-	-	-	-	-	-	-	-	-	-	+++	-	-	-	-	-	-	-	-	-
10	etoxazole	Zeal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++
11	Bt	Dipel, various	-	-	-	+	+	+	++	+++	++	+	+	-	-	-	-	-	-	-	-	-	-	-	-
15	novaluron	Rimon	-	+++	-	+++	+++	+++	++	+++	+	++	+++	+	+	-	++	++	++	-	++	-	-	-	-
16	buprofezin	Courier	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	-	-
17	cyromazine	Trigard	-	++	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+++	-	-	-	-	-	-
-	methoxyfenozide	Intrepid	-	-	-	++	++	+++	+++	+++	+	++	+++	-	-	-	-	-	-	-	-	-	-	-	-
20B	acequinocyl	Kanemite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+++
21	fenpyroximate	Portal		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	++
22	indoxacarb	Avaunt	+	++	+	+++	++	++	+++	+++	++	++	+++	-	-	-	-	-	+	-	-	+	-	-	-
23	spiromesifen	Oberon	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	++
	spirotetramat	Movento	-	-	-	-	-	-	-	-	-	-	-	-	-	++	-	-	-	-	++	-	-	-	-
25	bifenazate	Acramite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+++
28	chlorantraniliprole	Coragen	-	+++	-	+++	+++	+++	+++	+++	+++	++	+++	-	-	-	+	-	+++	-	++	-	-	-	-
	flubendiamide	Belt	-	++	-	+++	+++	++	+++	+++	+++	++	+++	-	-	-	-	-	+	-	-	-	-	-	-

* Denotes that insecticide-resistant populations may occur in some areas and can affect the performance of insecticides.

TABLE 2-26. PREHARVEST INTERVALS (*IN DAYS*) FOR PYRETHROID INSECTICIDES IN VEGETABLE CROPS.

See Table 2-25 to compare relative efficacy of these products against specific insect pests. Read the pesticide label for specific rates and application instructions.

		Common Name/Example Product — IRAC Class (MOA) 3									
		beta cyfluthrin/ Baythroid XL	*bifenthrin/ Brigade*	*cypermethrin/ Ammo*	*cyfluthrin/ Tombstone*	*esfenvalerate/ Asana XL*	*fenpropathrin/ Danitol*	*gamma cyhalothrin/ Proaxis*	*lambda cyhalothrin/ Karate*	*permethrin/ Pounce*	*zeta cypermethrin/ Mustang Max*
	Asparagus	NR	NR	NR	NR	NR	NR	NR	NR	1	NR
Bulb Vegetables	Onions, Green	NR	NR	7	NR	NR	NR	NR	NR	NR	7
	Onions, Dry Bulb	NR	NR	7	NR	NR	NR	14	14	1	7
Brassica Leafy Vegetables	Broccoli, Brussels Sprout, Cabbage, Cauliflower, Kohlrabi	0	7	1	0	3	7	1	1	1	1
	Collard, Mustard Green	0	7	1	0	7	NR	NR	NR	1	1
Cereal Grain	Sweet Corn	0	1	NR	0	1	NR	1	1	1	3
Cucurbits	Cantaloupe, Watermelon	0	3	NR	0	3	7	NR	1	0	1
	Cucumber, Pumpkin, Summer Squash, Winter Squash	0	3	NR	0	3	7	NR	1	0	1
Fruiting Vegetables	Eggplant, Pepper	7	7	NR	0	7	3	5	5	3	1
	Tomato	0	1	NR	7	1	3	5	5	0	1
	Okra	NR	7	NR	NR	NR	NR	NR	NR	NR	1
Fruiting Vegetables	Edible-podded	NR	3	NR	NR	3	NR	7	7	NR	1
	Succulent Shelled Pea and Bean	3[A]	3	NR	3[A]	3	7[D]	7	7	NR	1
	Dried Shelled Pea and Bean	7	14	NR	7	21	NR	21	21	NR	21
Leafy Vegetables, Except Brassica	Head and Leaf Lettuce, Spinach	0	7[B]	5[C]	0	NR	NR	1	1	1	1
	Celery	0	NR	NR	0	NR	NR	NR	NR	3	1
Root and Tuber Vegetables	Beet, Carrot, Radish. Turnip	0	21	NR	0	7	NR	NR	NR	1	1
	Potato	0	21	NR	0	NR	NR	NR	7	14	1
	Sweet Potato	0	21	NR	0	NR	NR	NR	7	NR	1

NR Not registered
[A] Southern pea only
[B] 40 day PHI for Spinach
[C] Head lettuce only
[D] Succulent peas only

TABLE 2-27. LIST OF GENERIC INSECTICIDES BY ACTIVE INGREDIENT.

Active Ingredient	*Original Product and Formulation (Manufacturer)*	*Generics and Formulation (Manufacturer)*	
abamectin	**Agri-Mek 0.15 EC (Syngenta)**	*Abba 0.15 EC (Makhteshim)*	Reaper 0.15 EC (Loveland)
		Abba Ultra 0.3 EC (Makhteshim)	Reaper Advance 0.15 EC (Loveland)
		Agri-Mek 0.7 EC (Syngenta)	Temprano 0.15 EC (Chemtura)
		Epi-Mek 0.15 EC (Syngenta)	Timectin 0.15 EC (Tide Intl.)
		Nufarm Abamectin 0.15 EC (Nufarm)	Zoro 0.15 EC (Cheminova)
acephate	**Orthene 90 SP (Valent)**	*Acephate 90 Prill (Makhteshim)*	Acephate 97 UP (United Phosphorous)
		Acephate 90 WDG (Loveland)	Bracket 90 WDG (Winfield)
		Acephate 90 WSP (Loveland)	Orthene 97 (Amvac)
bifenthrin	**Brigade 2 EC, Capture 2 EC (FMC)**	*Bifen 2AG Gold (Direct AG Source)*	Sniper 2 EC (Loveland)
		Bifenture 2 EC (United Phosphorous)	Tailgunner 2 EC (Makhteshim)
		Discipline 2 EC (Amvac)	Tundra 2 EC (Winfield)
		Fanefare 2 EC (Makhteshim)	
carbaryl	**Sevin 4L, 80 S, SL, XLR (Bayer)**	*Carbaryl 4 L (Drexel, Loveland)*	Prokoz Sevin SL (Prokoz)
chlorpyrifos	**Lorsban 4 E, 15 G, 75 WDG, Advanced 3.76 E (Dow AgroSciences)**	Chlorpyrifos 4 E (Makhteshim, Drexel)	Vulcan 3.76 E (Makhteshim)
		Govern 4 E (Tenkos)	Warhawk 4 E (Loveland)
		Hatchet 4 E (Dow AgroSciences)	Yuma 4 E (Winfeild)
		Nufos 4E (Tenkos)	Whirlwind 4 E (Helena)
		Saurus 15 G (Helena)	
cyfluthrin	**Baythroid XL 1 EC, Renounce 20 WP (Bayer)**	*Tombstone 2 E (Loveland)*	Tombstone Helios 2 E (Loveland)
esfenvalerate	**Asana XL 0.66 EC (DuPont)**	S-FenvaloStar 0.66 EC (LG Life Sciences)	
gamma-cyhalothrin	**Proaxis 0.5 EC (Loveland)**	*Declare Insecticide 0.5 EC (Cheminova)*	Proaxis Insecticide 0.5 EC (Cheminova)
Imidacloprid	**Admire 2 F, Pro 4.6 F, Provado1.6 F (Bayer)**	*Advise 2 FL (Winfield)*	Montana 2 F, 4 F (Rotam NA)
		Mana Alias 2 F, 4 F (Makhteshim)	NuPrid 2 F, 2 SC, 4 F Max, 4.6 F, (Nufarm)
		Amtide Imidacloprid 2 F (AmTide)	Pasada 1.6 F (Makhteshim)
		Couraze 2 F, 4 F (Cheminova)	Prey 1.6 F (Loveland)
		Macho 2 FL, 4 F (Albaugh)	Sherpa 1.6 F (Loveland)
		Malice 75 WSP (Loveland)	Widow 2 F (Loveland)
		Midash 2 SC (Sharda USA)	Wrangler 4 F (Loveland)
lambda-cyhalothrin	**Karate 1 EC, Warrior T 1 ME, II 2 ME (Syngenta)**	Grizzly Z 1 CS (Winfield)	Lamcap 1 CS (Syngenta)
		Kiaso 24 WG (Nufarm)	Paradigm 1 EC (Makhteshim)
		Lambda T 1 CS (Helena)	Province 1 SC (TENKoz)
		Lambda CY 1 EC (United Phosphorous)	Silencer 1 EC (Makhteshim)
		Lambda-Cyhalothrin 1 EC (Nufarm)	Willowood Lambda-Cy 1 EC (Willowood)
		LambdaStar 1 EC, 1 CS (LG Life Sciences)	
permethrin	**Pounce 3.2 EC (FMC)**	*Arctic 3.2 EC (Winfield)*	PermaStar 3.2 EC (LG Life Sciences)
		Perm-Up 3.2 EC (United Phosphorous)	Permethrin 3.2 EC (Loveland, TENKoz, Helena)
zeta-cypermethrin	**Mustang Max 1.5 EW (FMC)**	*Respect 0.8 EC (BASF)*	

TABLE 2-28. COMPONENTS OF INSECTICIDE MIXTURES.

Premix Trade Name	*Components (Legacy trade name)*
Athena	abamectin (Agri-Mek) + bifenthrin (Brigade)
Agri-Flex	abamectin (Agri-Mek) + thiamethoxam (Actara)
Gladiator	avermectin B1 (Agri-Mek) + zeta-cypermethrin (Mustang Max)
Hero, Steed	bifenthrin (Brigade) + zeta-cypermethrin (Mustang Max)
Voliam Xpress, Besiege	chlorantraniliprole (Coragen) + lambda-cyhalothrin (Warrior, Karate)
Cobalt, Bolton	chlorpyrifos (Lorsban) + gamma-cyhalothrin (Proaxis)
Kilter	imidacloprid (Admire) + lambda-cyhalothrin (Warrior, Karate)
Endigo ZC	lambda-cyhalothrin (Warrior, Karate) + thiamethoxam (Actara)
Leverage 360	imidacloprid (Admire) + beta-cyfluthrin (Baythroid XL)
Leverage 2.7	imidacloprid (Admire) + cyfluthrin (Baythroid)
Brigadier, Swagger	bifenthrin (Brigade) + imidacloprid (Admire)
Durivo, Voliam Flexi	chlorantraniliprole (Coragen) + thiamethoxam (Actara, Platinum)
Vetica	flubendiamide (Belt) + buprofezin (Applaud)

TABLE 2-29. ALTERNATIVE (NON-INSECTICIDAL) INSECT PEST CONTROL STRATEGIES IN VEGETABLE CROPS.

NOTE: Results of many specific control tactics listed below are highly variable. Many have not been tested thoroughly in commercial vegetable systems.

Target Pest	Cropping System	Systems-based Practices (for pest prevention)	Mechanical & Physical tactics (for pest prevention)	Biorational Insecticides (before pests reach outbreak status)	Natural Enemies (NE)†
Aphid	Multiple crops	Timely planting and harvest. Reduce water stress; trap crop of okra, sorghum, etc.; removal of alternative hosts	Use of reflective mulches to protect transplants or use row covers after transplanting; use water jet or frequent irrigation to dislodge aphids & reduce plant stress	Insecticidal soap & oil, neem, Pyrethrin, *Chromobacterium* (Grandevo), Azera (insecticide premix)	Lady beetles, Lacewings†, Midges, Parasitic wasps†, Predatory stink bugs, Syrphid fly larvae†
Asparagus beetle	Asparagus	Use some portion of field as trap crops; use insecticides on trap crops (repeated sprays)	Manually remove beetles from trap crops	Pyrethrin, Spinosad, *Chromobacterium* (Grandevo)	Lady beetles, Eulophid wasps
Bean leaf beetle	Snap, lima, pole beans	Sanitation (removal of crop debris), site selection (away from wooded areas), delayed planting date.	Hand-pick beetles off the leaves	Insecticidal soap, Pyrethrin, Neem	Tiphidae (parasitoids)
Beet armyworm	Multiple crops	Timely harvest	Destroy egg masses and caterpillars	*Bacillus thuringiensis* (Xentari, Dipel), Spinosad, *Chromobacterium* (Grandevo), viruses (Spod-X)	Lady beetles, Lacewing larvae, Soldier bugs
Blister beetle	Multiple crops	—	Hand-picking, insect netting	Spinosad	—
Cabbage looper	Multiple crops	—	Sanitation (remove crop debris). Remove alternate host plants (wild mustard, shepherd's purse)	*Bacillus thuringiensis kurstaki*, Insecticidal soap & oil, Spinosad, Neem, *Chromobacterium* (Grandevo)	Trichogramma, Encyrtid & Pteromalid parasitoids, Lacewings
Colorado potato beetle	Multiple crops	Crop rotation, tolerant varieties	Hand-picking	Insecticidal soap, Neem, Pyrethrin (use for larval control)	Lacewing, Ichneumonid wasp
Corn earworm/Tomato fruitworm	Multiple crops	—	Hand-picking	*Bacillus thruringiensis*, Insecticidal soap & oil, spinosad, Neem, *Chromobacterium* (Grandevo)	Flower bugs, Lacewings, Ichneumonid and Pteromalid parasitoids
Cowpea curculio	Snap, lima, pole beans	Crop rotation, sanitation	Timely or early harvest of crop	Insecticidal soap & oil, Pyrethrin, Neem (adults are difficult to kill)	Soldier beetle, Braconid wasps
Cucumber beetle	Multiple crops	Trap crop of Hubbard squash	Insect netting to block beetles (early season protection)	Pyrethrin, neem, parasitic nematodes (weekly soil drench)	Braconid wasps
Cutworm	Multiple crops	Vigorously growing plant varieties; timely planting	Plant collars, floating row covers.	*Bacillus thuringiensis* (Xentari, DiPel) directed spray to plant base. Spinosad foliar and stem spray; Seduce bait (spinosad)	Lady beetle, Ground beetles
Diamondback moth & Imported cabbageworm	Collard & Mustard greens	Use pheromone traps to monitor moths	Destroy caterpillar clusters on leaves; pheromone mating disruption	*Bacillus thuringiensis kurstaki*, insecticidal soap, Neem, Pyrethrin, *Chromobacterium* (Grandevo), Azera (insecticide premix)	*Trichogramma brassicae* Parasitic wasp†, *Macrolophus caliginosus* (Predatory beetle†)
European corn borer	Multiple crops	Use tolerant cultivars when possible	Remove caterpillars on foliage	*Bacillus thuringiensis kurstaki*, insecticidal soap, Neem, Pyrethrin, *Chromobacterium* (Grandevo)	*Trichogramma* wasps encourage native Parasitic flies and Wasps

† **Denotes natural enemies that can be purchased from commercial insectaries.**

TABLE 2-29. ALTERNATIVE (NON-INSECTICIDAL) INSECT PEST CONTROL STRATEGIES IN VEGETABLE CROPS (cont'd).

NOTE: Results of many specific control tactics listed below are highly variable. Many have not been tested thoroughly in commercial vegetable systems.

Target Pest	Cropping System	Systems-based Practices (for pest prevention)	Mechanical & Physical tactics (for pest prevention)	Biorational Insecticides (before pests reach outbreak status)	Natural Enemies (NE)†
Flea beetle	Multiple crops	Timely planting of crops, trap crops	Use row covers to protect transplants	Insecticidal oil, Neem, Spinosad, Parasitic nematodes (drench in soil), Azera (insecticide premix)	Braconid wasps
Grasshopper	Multiple crops	Maintain a grassy patch away from main crop and use insecticidal bait	Hand-picking, sweep netting	Pyrethrin (multiple applications), Nolo Bait (*Nosema locustae*)	Nematode bait (Semaspore)
Hornworm	Tomato	—	Hand-picking	Spinosad, *Bacillus thuringiensis kurstaki,* Pyrethrin, Neem, *Chromobacterium* (Grandevo)	Lacewings, Lady beetles, Trichogramma and Braconid wasps
Japanese beetle	Multiple crops	Timely harvest; trap crops to deter feeding on main crop	Manual removal of beetles by sweep netting or other means.	Pyrethrin, Neem (multiple sprays), Milky spore disease	Tiphid parasitoids
Lace bug	Eggplant	—	—	Parasitic nematodes (drench in soil weekly)	Braconid
Leaffooted bug	Fruiting vegetables (tomato, okra, eggplant)	Timely planting of main crops, trap crop of *Peredovik* sunflower & silage sorghum *NK300* provides significant reduction	Hand-pick and destroy adults; bug vacuum may be used for removing nymphs	Pyrethrin	—
Leafhopper	Multiple crops	—	—	Insecticidal soap & oil, Pyrethrin, Neem	Flower bugs, Lacewings
Leafminer	Multiple crops	—	Pick and destroy mined leaves; remove egg clusters	Neem, spinosad, *Chromobacterium* (Grandevo)	Eulophid wasps (*Diglyphus, Dacnusa*)†
Mealy bugs	Multiple crops	—	Hand-picking	Insecticidal soap and oil	*Leptomastix* parasite†, *Cryptolaemus montrouzieri* predatory beetle†
Onion maggot	Onion	Use well-composted manure; soil tillage exposes maggots	—	—	Braconid parasitoid
Parsleyworm (black swallowtail)	Parsley, dill, carrot	—	Hand-pick and destroy caterpillars	*Bacillus thuringiensis kurstaki*	Trichogramma wasps
Pepper weevil	Pepper	Crop rotation	Hand-pick insects	Insecticidal soap, Neem, Pyrethrin, Parasitic nematodes (drench in soil weekly)	Lady beetles, Predatory mites, Lacewings
Pickleworm	Cantaloupe, muskmelon	—	—	—	Lady beetles, Predatory mites, Lacewings
Seedcorn maggot	Snap, lima, pole beans	Reduce organic matter	—	—	Parasitoid, Parasitic nematodes
Spider mite	Multiple crops	Plant and harvest timely; provide irrigation; problem could be severe in drought years; tolerant varieties	—	Paraffinic oil, Neem oil, Sulfur dust or spray (check label before use); do not use pyrethrin	*Amblyseius californicus*† & *Phytoseiulus persimilis*† (Predatory mites), *Feltiella acarisuga* gall midge
Squash vine borer	Pumpkin, squash	Timely planting, tolerant varieties, sanitation (remove crop debris)	Practice de-worming, insect netting at plant base (early season)	Pyrethrin, Spinosad (early season spray after detecting moths or eggs at plant base)	—
Squash bug	Pumpkin, squash	Trap cropping with Hubbard squash; plant tolerant varieties, sanitation (remove crop debris)	Insect netting early in season	Pyrethrin weekly spray at low population levels	—
Stink bug & Harlequin bug	Multiple crops	Trap crop of sorghum, okra	Hand-picking	Insecticidal oil, Pyrethrin	Eucoliid & Scelionid parasitoids
Thrips	Multiple crops	Trap crops	—	Spinosad, Insecticidal soap, Paraffinic oil	*Orius insidiosus*† & *O. majusculus* (flower bugs), Lacewings, *Hypoaspis miles* & *Amblyseius swirskii* (predatory mites)†
Target Pest	Cropping System	Systems-based Practices (for pest prevention)	Mechanical & Physical Tactics (for pest prevention)	*Biorational Insecticides (before pests reach outbreak status)*	*Natural Enemies (NE)†*
Whitefly	Multiple crops	Crop rotation	—	Insecticidal soap, Neem oil, *Chromobacterium* (Grandevo)	Lacewings, *Encarsia formosa*† & *Eretmocerus eremicus* (parasitoids), *Amblyseius swirskii* (Predatory mite) †
Wireworms	Multiple crops	Crop rotation is a major IPM strategy	—	None	—
Yellow-striped armyworm	Multiple crops	Sanitation (remove crop debris after harvest)	Hand-picking eggs and larvae	*Bacillus thuringiensis* (Xentari, Dipel), Neem (azadirachtin), Spinosad, *Chromobacterium* (Grandevo), Azera (insecticide premix)	Spined soldier bugs

† **Denotes natural enemies that can be purchased from commercial insectaries.**

INSECT CONTROL FOR GREENHOUSE VEGETABLES

Sound cultural practices, such as sanitation and insect-free transplants, help prevent insect establishment and subsequent damage. Separate plant production houses, use of yellow sticky traps, and timely sprays will help prevent whitefly buildup. Use of Encarsia parasites for whitefly and other biological control agents in conjunction with use of pesticides is encouraged. Unless a pesticide label specifically states that a product cannot be used in a greenhouse vegetable crop, the product can be used on those crops for which it is registered. However, pesticides behave differently in the field and the greenhouse, and for many products, information is not available on greenhouse crop phytotoxicity and residue retention. If unsure of the safety of a product to a crop, apply to a small area before treating the entire crop.

TABLE 2-30. INSECT CONTROL FOR GREENHOUSE VEGETABLES

CROP Insect	Insecticide and Formulation	Amount of Formulation	Re Entry Interval	Pre Harvest Interval (PHI) (Days)	Precautions and Remarks
INSECT CONTROL FOR CUCUMBER					
Aphid	malathion, MOA 1B (various) 10 A 57 EC 25 WP	 1 lb/50,000 cu ft 1 qt/100 gal water 4 lb/100 gal water	24 hrs	 1 1 1	Apply as needed in the closed greenhouse in air above the plants. Spray when the temperature is 70 to 85 degrees F. Keep ventilator closed for 2 hr or overnight. Ventilate before reentry. Hazardous to honey bees.
	imidacloprid, MOA 4A (Admire Pro) 4.6 F	 0.6 fl oz/1,000 plants	12 hrs	 0	Apply in a minimum of 21 gal water using soil drenches, micro-irrigation, or drip irrigation. Do not apply to immature plants as phytotoxicity may occur. Make only one application per crop per season.
	insecticidal soap (M-Pede) 49 EC	 2 tbsp/gal water	12 hrs	 0	
Cabbage looper	*Bacillus thuringiensis,* MOA 11 (various)	 0.5 to 1 lb OR 3 pt/100 gal water		 0	
	spinosad, MOA 5 (Entrust) SC	 3 fl oz/100 gal	4 hrs	 1	Do not make more than two consecutive applications.
Spider mite	insecticidal soap (M-Pede) 49 EC	 2 tbsp/gal water	12 hrs	 0	Can cause phytotoxicity under slow drying conditions. Apply to a small area before treating an entire crop.
	mineral oil (TriTek)	 1 to 2 gal/100 gal		 0	Begin applications when mite populations are low, and repeat at weekly intervals.
Whitefly, Leafminer	malathion, MOA 1B (various) 10 A 50 WP 25 WP	 1 lb/50,000 cu ft 1 qt/100 gal water 4 lb/100 gal water	24 hrs	 1 1 1	For details see CUCUMBER — Aphid
	imidacloprid, MOA 4A (Admire Pro) 4.6 F	 0.6 fl oz/1,000 plants	12 hrs	 0	Apply in a minimum of 21 gal water using soil drenches, micro-irrigation, or drip irrigation. Do not apply to immature plants as phytotoxicity may occur. Make only one application per crop per season.
	insecticidal soap (M-Pede) 49 EC	 2 tbsp/gal water	12 hrs	 0	May be used alone or in combination. Acts as an exciter.
	Beauveria bassiana (Mycotrol WP)	 0.25 lb/20 gal water		 0	Apply when whiteflies observed. Repeat in 4- to 5-day intervals.
INSECT CONTROL FOR LETTUCE					
Aphid, Leafminer, Whitefly	pyrethrins and PBO, MOA 3 (Pyrenone)	 12 oz/20 gal water		 0	May be used alone or tank mixed with a companion insecticide (see label for details).
	malathion, MOA 1B (various) 10 A 57 EC 25 WP	 1 lb/50,000 cu ft 1 qt/100 gal water 4 lb/100 gal water	24 hrs	 10 14 14	
	insecticidal soap (M-Pede) 49 EC	 2 tbsp/gal water	12 hrs	 0	May be used alone or in combination. Acts as an exciter. Insecticidal soaps can cause phytotoxicity under high temperatures or slow drying conditions. If unsure, apply to a small area before treating the entire crop.
	Beauveria bassiana (Mycotrol WP)	 0.25 lb/20 gal water		 0	Under high aphid or whitely pressure, apply at 2 to 5 day intervals.

TABLE 2-30. INSECT CONTROL FOR GREENHOUSE VEGETABLES (cont'd)

CROP Insect	Insecticide and Formulation	Amount of Formulation	Re Entry Interval	Pre Harvest Interval (PHI) (Days)	Precautions and Remarks
INSECT CONTROL FOR LETTUCE (cont'd)					
Cabbage looper	malathion, MOA 1B (various) 10 A 57 EC 25 WP	 1 lb/50,000 cu ft 1 qt/100 gal water 4 lb/100 gal water	24 hrs	 10 14 14	
	Bacillus thuringiensis, MOA 11 (Javelin) WG	0.5 to 1.25/100 gal water		0	
	spinosad, MOA 5 Entrust SC	 3 fl oz/100 gal	4 hrs	 1	Do not make more than two consecutive applications.
Slugs	iron phosphate + spinosad (Sluggo)	0.5 to 1 lb/1,000 sq ft		1	Scatter the bait around the perimeter of the greenhouse to provide a protective barrier. If slugs are within the crop, then scatter the bait on the ground around the plants. Do not make more than 3 applications within 21 days. Will also control earwigs, cutworms, sowbugs and pillbugs.
Spider mite	insecticidal soap (M-Pede) 49 EC	 2 tbsp/gal water	12 hrs	 0	
	mineral oil (TriTek)	 1 to 2 gal/100 gal		 0	Begin applications when mite populations are low, and repeat at weekly intervals.
INSECT CONTROL FOR TOMATO and PEPPER					
Aphid	imidacloprid, MOA 4A (Admire Pro) 4.6 F	 0.6 fl oz/1,000 plants	12 hrs	 0	Apply in a minimum of 21 gal water using soil drenches, micro-irrigation, or drip irrigation. Do not apply to immature plants as phytotoxicity may occur. Make only one application per crop per season. Also controls whiteflies.
	malathion, MOA 1B (various) 10 A 57 EC 25 WP	 1 lb/50,000 cu ft 1 qt/100 gal water 4 lb/100 gal water	12 hrs	 15 hr 1 1	
	insecticidal soap (M-Pede) 49 EC	 2 tbsp/gal water	12 hrs	 0	May be used alone or in combination. Acts as an exciter.
	Beauveria bassiana (Mycotrol WP)	 0.25 lb/20 gal water		 0	Apply when whiteflies are observed. Repeat in 4-to 5-day intervals.
Armyworm, Fruitworm, Cabbage looper, Cutworm, Pinworm	malathion, MOA 1B (various) 10 A 57 EC 25 WP	 1 lb/50,000 cu ft 1 qt/100 gal water 4 qt/100 gal water	12 hrs	 15 hr 1 1	See instructions for Aphids (above). Hazardous to Honey bees.
	Bacillus thuringiensis, MOA 11 (Javelin) WG (Agree) WP (Dipel) DF Xentari DF	 0.5 lb to 1.25 lb/100 gal water 1 to 2 lb 0.5 to 1.25 0.5 to 1.5	4 hrs	 0 0 0 0	
	chlorfenapyr, MOA 13 (Pylon) 2SC	 6.5 to 13 fl oz/100 gal water or per acre area		 0	For use on tomatoes more than 1 inch in diameter at maturity. Do not make more than two applications at 5 to 10 day intervals before rotating to an insecticide with a different mode of action.
	spinosad, MOA 5 Entrust SC	 3 fl oz/100 gal	4 hrs	 1	Do not make more than two consecutive applications. Do not apply to seedling tomatoes or peppers grown for transplants.
Leafminer	malathion, MOA 1B (various) 10 A	 1 lb/50,000 cu ft	12 hrs	 15 hr	See TOMATO—Aphid
	diazinon, MOA 1B (Diazinon, Spectracide) (AG 500) 50 WP	 4 to 8 oz/100 gal water	48 hrs	 3	Keep ventilators closed for 2 hr or overnight. Plant injury may result if labeling directions are not followed. **For use by members of N.C. Greenhouse Vegetable Growers Association only.**
	spinosad, MOA 5 (Entrust) SC	 10 fl oz/100 gal	4 hrs	 1	Do not apply to seedlings grown for transplants.
Millipede, Cricket	malathion, MOA 1B (various) 5 D	Follow label directions	12 hrs		Apply to soil at base of plants. Do not contaminate fruit.

TABLE 2-30. INSECT CONTROL FOR GREENHOUSE VEGETABLES (cont'd)

CROP Insect	Insecticide and Formulation	Amount of Formulation	Re Entry Interval	Pre Harvest Interval (PHI) (Days)	Precautions and Remarks
INSECT CONTROL FOR TOMATO and PEPPER (cont'd)					
Slug	metaldehyde (various baits)	Follow label directions			Apply to soil surface around plants. Do not contaminate fruit.
Spider mite, broad mite	Bifenazate (Floramite) SC	4 to 8 fl oz/100 gal of water 1/4 to 1/2 tsp/gal of water		3 3	For use on tomatoes >1" in diameter at maturity. Not registered on pepper.
	mineral oil (TriTek)	1 to 2 gal/100 gal		0	Begin applications when mite populations are low, and repeat at weekly intervals.
	Chlorfenapyr, MOA 13 (Pylon) 2SC	9.8 to 13 fl oz/100 gal water or per acre area		0	For use on tomatoes more than1 inch in diameter at maturity. Do not make more than two applications at 5 to 10 day intervals before rotating to an insecticide with a different mode of action.
	insecticidal soap (M-Pede) 49 EC	2 tbsp/gal water	12 hrs	0	
Thrips, including western flower	*Beauveria bassiana* (Mycotrol WP)	0.25 lb/20 gal water		0	Use screens on intake vents. Apply when whiteflies observed. Repeat in 4- to 5-day intervals.
	Chlorfenapyr, MOA 13 (Pylon) 2SC	9.8 to 13 fl oz/100 gal water or per acre area		0	For use on tomatoes more than1 inch in diameter at maturity. Do not make more than two applications at 5 to 10 day intervals before rotating to an insecticide with a different mode of action.
	spinosad, MOA 5 (Entrust) SC	5.5 fl oz/100 gal	4 hrs	1	Do not make more than two consecutive applications, and do not apply more than 6 times in a 12 month period against thrips. Do not apply to seedlings grown for transplants.
Whitefly	imidacloprid, MOA 4A (Admire Pro) 4.6 F	0.6 fl oz/1,000 plants	12 hrs	0	Apply in a minimum of 21 gal water using soil drenches, micro-irrigation, or drip irrigation. Do not apply to immature plants as phytotoxicity may occur. Make only one application per crop per season. Also controls aphids.
	insecticidal soap (M-Pede) 49 EC	2 tbsp/gal water	12 hrs	0	
	pyrethrins and PBO, MOA 3 (Pyrenone)	12 oz/ 20 gal water		0	May be used alone or tank mixed with a companion insecticide. (See label for details.)
	Beauveria bassiana (Mycotrol WP)	0.25 lb/20 gal water		0	Apply when whiteflies are observed. Repeat in 4- to 5-day intervals.
	buprofezin, MOA 16 (Talus) 40SC	9 to 13.6 oz/100 gal water or per acre area		1	Insect growth regulator that affects immature stages of whiteflies. Will not kill adults. For use on tomatoes only.
	pyriproxyfen, MOA 7C (Distance) 0.86EC	6 fl oz/100 gal water		14	Insect growth regulator that affects immature stages of whiteflies. Will not kill adults.

Disease Control for Commercial Vegetables

Caution: At the time this table was prepared, the entries were believed to be useful and accurate. However, labels change rapidly and errors are possible, so the user must follow all directions on the pesticide label. For example, federal tolerances for fungicides may be canceled or changed at any time.

Information in the following table must be used in the context of a total disease control program. For example, many diseases are controlled by combining various practices—resistant varieties, crop rotation, deep-turn plowing, sanitation, seed treatment, cultural practices, and fungicides. Always use top-quality seed and plants obtained from reliable, commercial sources. Seed are ordinarily treated by the commercial seed producer for the control of seed decay and damping-off.

Nematode control chemicals and Greenhouse Diseases are given in separate tables following the crop tables. Relative efficacy tables will help you select the appropriate disease control materials for bean, brassica, cucurbit, onion, pepper, and tomato diseases, respectively. These tables are located at the end of each crop table.

Rates: Some foliar rates given in the table are based on mixing a specified amount of product in 100 gal of water and applying the finished spray for complete coverage of foliage just to the point of run-off with high pressure (over 250 psi) drop nozzle sprayers. Actual amount of product and water applied per acre will vary depending on plant size and row spacing. Typically 25 to 75 gal per acre of finished spray are used. Concentrate spray (air blast, aircraft, etc.) rates are based on amount of product per acre. Caution: With concentrate sprays, it is easy to apply too much product. Some fungicides are adversely affected by pH of water; adjust pH of water if specified on label.

Do not feed treated foliage to livestock unless allowed by the label. Do not reenter fields until sprays have dried; some fungicides may have a reentry requirement of one to several days. Read the label. Do not exceed maximum number of applications on label. Do not exceed maximum limit of fungicide per acre per application or per year as stated on the label. See label for rotational crops. In all cases, follow directions on label.

TABLE 3-1. DISEASE CONTROL FOR ALL VEGETABLES

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Sanitize wash water and/or use as a vegetable wash	chlorine (Chlorine Gas, 99.5%) (Chlorine Liquid, 99.5%) (Compressed Chlorine Gas, 99.5%)		available chlorine 100 to 150 ppm	–	–	**DANGER!** Inhalation hazard. To be used only by trained personnel. Allow a contact time of 2 to 3 min.
	chlorine dioxide (Oxine, 2%) (Anthium Dioxcide, 5%) (MaxKlor, 5%) (CDG Solution 3000, 0.3%)	 1/3 fl oz/10 gal 1/3 fl oz/25 gal 1/3 fl oz/25 gal 2.13 fl oz/10 gal	Available ClO_2 5 ppm 5 ppm 5 ppm 5 ppm	–	–	To control buildup of bacteria in process water. Make up fresh solutions daily. After treatment, vegetables must be rinsed with potable water. For heavy use of rinse water or if bacterial buildup is extreme, an activated solution may be used. Activate prior to use by the addition of activator crystals or a suitable acid (see label instructions). Prepare activated solution in a well-ventilated area and avoid breathing fumes.
	(CDG Solution 3000, 0.3%)	2.13 fl oz/10 gal	5 ppm			For use as a vegetable wash, immerse previously cleaned vegetables and allow to soak for at least 5 minutes.
	hydrogen dioxide (StorOx, 27%)	To sanitize wash water, use 1.5 fl. oz/10 gal As a vegetable wash, use 0.5 to 1.25 fl oz/gal		–	–	Works best in clean water with a pH of 7. Dilution rates vary based on method of application and use. See label for specific rates.
	peroxyacetic acid + hydrogen peroxide (VigorOx 15 F&V, 15% + 10%) (Zeprolong VF, 15% + 10%)	 1 fl oz/16 gal 1 fl oz/16 gal	 85 ppm + 57 ppm 85 ppm + 57 ppm	–	–	Use as a vegetable wash. Allow a contact time of at least 45 sec. A post-treatment potable water rinse is not necessary.
	(Tsunami 100, 15.2% + 11.2%)	1 fl oz/16.4 gal	80 ppm peroxyacetic acid	–	–	Allow contact time of at least 45 sec.
	(Keystone Fruit and Vegetable Wash, 15% + 11%) (Victory, 15% + 11%)	1 fl oz/16.4 gal 1 fl oz/16.4 gal	80 ppm + 59 ppm 80 ppm + 59 ppm	–	–	Allow contact time of at least 30 sec for spray application and 1 min for submersion. Adjust the solution as necessary to maintain a concentration of no more than 80 ppm.

TABLE 3-1. DISEASE CONTROL FOR ALL VEGETABLES (cont'd)

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Sanitize wash water and/or use as a vegetable wash (cont'd)	(PAA Sanitizer FP, 4.9% + 26.5%)	3 to 3.5 fl oz/16 gal	88 to 100 ppm peroxyacetic acid	–	–	Allow a contact time of at least 45 sec.
	(Perasan A , 5.6% + 26.5%)	1 oz/20 gal	25 ppm peroxyacetic acid	–	–	Adjust the solution as necessary to maintain a concentration of no more than 25 ppm.
	sodium hypochlorite		available chlorine	–	–	Mix only with water. Change solution when visibly dirty. Do not allow available chlorine level to fall below 25 ppm. Submerge vegetables in sanitizing solution (2 min.) then rinse with tap or other potable water. See label for commodity-specific recommendations.
	(Clean Force Fruit and Vegetable Wash, 3.25%)	1 oz/10 gal	25 ppm			
	(Vegi Wash, 3.25%)	4 oz/40 gal	25 ppm			
	(JP Optimum CRS, 4%)	0.75 oz/10 gal	25 ppm			
	(Clorox Commercial Solutions Clorox Ultra Germicidal Bleach, 6.15%)	0.5 fl oz/9 gal	25 ppm			
	(Pristine, 8.4%)	8 oz/200 gal	25 ppm			
	(Maxxum 700, 8.4%)	8 oz/200 gal	25 ppm			
	(Dibac, 9.2%)	1 oz/20 gal	25 ppm			
	(Chemland Extract-2, 12.5%)	5 oz/200 gal	25 ppm			
	(ChemStation 3030, 12.5%)	5 fl. oz/100 gal	25 ppm			
	(Dynachlor, 12.5%)	5 oz/200 gal	25 ppm			
	(Zep FS Formula 4665, 12.5%)	5 oz/200 gal	25 ppm			
	(Agclor 310, 12.5%)	0.65 to 4 fl oz/10 gal	65 to 400 ppm			
Sanitize conveyors, packinghouses, field equipment, etc.	hydrogen dioxide (StorOx, 27%)	For pre-cleaned surfaces: 0.5 to 1.25 fl oz/gal For uncleaned surfaces: 2.5 fl oz/gal	–	–	–	Works best in clean water with a pH of 7. Follow treatment of any food contact surface with a potable water rinse.
	peroxyacetic acid + hydrogen peroxide			–	–	Allow a contact time of at least 1 min. Allow to dry prior to use; no rinse is necessary.
	(VigorOx 15 F&V, 15% + 10%)	3.1 to 5 fl oz/50 gal	85 to 135 ppm + 57 to 90 ppm			
	(Zeprolong VF, 15% + 10%)	3.1 fl oz/50 gal	85 ppm + 57 ppm			
	(Perasan A , 5.6% + 26.5%)	1 to 2.4 oz/6 gal	82 to 197 ppm peroxyacetic acid			
	(SaniDate 5.0, 5.3% + 23%)	1.6 to 1.7 fl oz/5 gal	145 to 154 ppm + 631 to 670 ppm			
	(Divosan Activ, 5.1% + 21.7%)	1 to 1.7 fl oz/5 gal	87.7 to 149 ppm + 373 to 635 ppm			
	(VigorOx Liquid Sanitizer and Disinfectant, 5.1% + 21.7%)	1 to 1.7 fl oz/5 gal	87.7 to 149 ppm + 373 to 635 ppm			
	sodium hypochlorite (Clorox Commercial Solutions Clorox Ultra Germicidal Bleach, 6.15%)	5 oz/10 gal	available chlorine 200 ppm	–	–	Allow a contact time of at least 1 min. Allow to dry prior to use; no rinse is necessary.
	(Pristine, 8.4%)	4 oz/13 gal	200 ppm			
	(Maxxum 700, 8.4%)	4 oz/13 gal	200 ppm			

TABLE 3-2. DISEASE CONTROL FOR ASPARAGUS

E. Sikora, Plant Pathologist, Auburn University

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Crown rot	mancozeb* 80W	1 lb/100 gal	0.8 lb/100 gal	—	—	Soak crowns 5 min in burlap bag with gentle agitation, drain, and plant.
Phytophthora crown rot, spear rot	mefenoxam (Ridomil Gold) SL	1 pt/acre	0.5 lb/A	1	2	Apply over beds after seeding or covering crowns, 30 to 60 days before first cutting, and just before harvest.
	fosetyl-AL (Alliette)	5 lb/A	4 lb a.i.	110	0.5	
Rust	myclobutanil (Rally 40W)	5 oz/A	2.0 oz a.i.	180	1	Begin applications to developing ferns after harvest has taken place. Repeat on a schedule not to exceed 14 days. Do not supply to harvestable spears.
	sulfur*	See label		0	1	
	tebuconazole (Folicur) 3.6F (Orius 3.6F) (Toled o 3.6F)	4 to 6 fl oz/A	0.11 to 0.17 lb	180	0.5	Apply to developing ferns at first sign of rust and repeat on a 14-day interval; no more than 3 applications per season.
Rust, *Cercospora* leaf spot	chlorothalonil (Bravo Weather Stik)	2 to 4 lb/A	1.5 to 3.0 lb a.i.	190	0.5	Repeat applications at 14 to 28 day intervals depending on disease pressure. Do not apply more than 12 pints/aces during each growing season.
	mancozeb* 80W	2 lb/A	1.6 lb/A	180	1	Apply to ferns after harvest; spray first appearance, 7- to 10-day intervals. Do not exceed 8 lb product per acre per crop.
Purple spot	azoxystrobin (Quadris)	6 to 15.5 fl oz	0.10 to 0.25 lb a.i.	100	4 hr	Do not apply more than 1 foliar application of Quadris (or other group-11 fungicide) before alternating with a fungicide that has a different mode of action.
	chlorothalonil (Bravo Weather Stik)	2 to 4 lb/A	1.5 to 3.0 lb a.i.	190	0.5	Repeat applications at 14 to 28 day intervals depending on disease pressure. Do not apply more than 12 pints/aces during each growing season.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-3. RELATIVE IMPORTANCE OF ALTERNATIVE MANAGEMENT PRACTICES FOR DISEASE CONTROL IN ASPARAGUS

E. Sikora, Plant Pathologist, Auburn University; and A. Keinath, Plant Pathologist, Clemson University

Scale: "0" not important/does not impact disease, "5" = very important practice to implement/impacts disease greatly; "-" = not applicable; "?" = unknown.

Management tactic	Disease				
	Rust	Cercospora blight	Stemphylium blight	*Fusarium* root rot	*Phytophthora* crown/ spear rot
Avoid overhead irrigation	3	3	3	0	0
Crop rotation (5 years or more)	0	0	0	3	1
Clip and bury infected ferns	4	4	4	0	0
Destroy infected ferns	5	5	5	0	0
Encourage air movement/wider row spacing	1	1	4	0	0
Plant in well-drained soil	0	0	0	2	3
Destroy volunteer asparagus	2	0	0	0	0
Pathogen-free planting material	0	0	0	5	5
Resistant/tolerant cultivars	4	4	0	4	0

TABLE 3-4. DISEASE CONTROL FOR BEAN

D. Langston, Plant Pathologist, UGA; and S. Rideout, Plant Pathologist, Virginia Polytechnic Institute

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
BEAN, DRY (catjang, chickpea, fava, garbanzo, lentil, lima, lupine, mung, may pea, southern, soybean)						
Anthracnose, *Alternaria* leaf spot and blight, *Ascochyta* leaf and pod spot, rust (*Phakopsora*)	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz	0.10 to 0.25 lb	0	4 hr	Do not apply more than three sequential applications.
Anthracnose, *Botrytis* gray mold, white mold (*Sclerotinia*)	boscalid (Endura) 70 WG	8 to 11 oz	5.6 to 7.7 oz	21	0.5	Use 6-oz rate for chickpeas and lentils. Many other dried and succulent beans on label.
	pyraclostrobin + boscalid (Pristine) 38 WG	15 to 25 oz	5.7 to 9.5 oz	21	1	All dry beans except soybeans. Make no more than 2 applications per season.
Pythium damping-off	mefenoxam (Ridomil Gold) 4 SL	0.5 to 1 pt/trt acre	0.25 to 0.5 lb/trt acre	—	2	Preplant incorporate. See label for row rates.
	azoxystrobin + mefenoxam (Uniform)	0.34 fl oz/1,000 row ft	0.0071 + 0.0028 lb/ acre	—		In-furrow spray. See label directions.
Rhizoctonia root rot	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/ 1,000 row feet	0.006 to 0.013 lb	—	4 hr	Make in-furrow or banded applications shortly after plant emergence.
	azoxystrobin + mefenoxam (Uniform)	0.34 fl oz/1,000 row ft	0.0071 + 0.0028 lb/ acre	—		In-furrow spray. See label directions.
Rust *(Uromyces)*	azoxystrobin (Quadris) 2.08 F	6.2 fl oz	0.10 lb	0	4 hr	Do not apply more than three sequential applications.
	boscalid (Endura) 70 WG	8 to 11 oz	5.6 to 7.7 oz	21	0.5	Use 6-oz rate for chickpeas and lentils. Many other dried and succulent beans on label.
	pyraclostrobin (Headline) 2.09 F	5.5 to 8 fl oz	1.5 to 2.4 lb	30	0.5	All dry beans except soybeans. Make no more than 2 applications per season
	pyraclostrobin + boscalid (Pristine) 38WG	10 to 15 oz	3.8 to 5.7 oz	21	1	All dry beans except soybeans. Make no more than 2 applications per season.
	tebuconazole (Folicur) 3.6F	4 to 6 fl oz/acre	1.5 to 2 lb/acre	14	0.5	Apply before disease appears when conditions favor rust development and repeat at 14-day intervals; maximum 12 fl oz per season.
BEAN, POLE (snap)						
Anthracnose, *Botrytis*, *Sclerotinia*	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz	0.10 to 0.25 lb	0	4 hr	For anthracnose only. Do not apply more than three sequential applications.
	chlorothalonil* (Bravo Ultrex) 82.5 WDG	2.7 lb/acre	2.2 lb/acre	7	2	Spray first appearance, 11 lb limit per acre per crop, 7-day intervals. Not for *Sclerotinia* control.
	dicloran (Botran) 75 W	2.25 to 4 lb/acre	1.7 to 3 lb/acre	2	0.5	For *Sclerotinia* only. Use low rate for bush varieties and high rate for pole varieties.
	thiophanate-methyl (Topsin M) 70 WP	1 to 2 lb/acre	0.7 to 1.4 lb/acre	14	1	Spray at 25% bloom, repeat at full bloom. Do not exceed 4 lb product per season.
	fluazinam (Omega 500)	0.5 to 0.85 pts	0.26 to 0.44	14	3	Apply at 10-30% bloom.
Ascochyta blight, *Botrytis* gray mold, white mold	boscalid (Endura) 70 WG	8 to 11 oz	5.6 to 7.7 oz	7	0.5	Many other dried and succulent beans on label.
	penthiopyrad (Fontelis)	14 to 30 fl oz/acre	0.18 to 0.4 oz/acre	0	12 hr	Begin sprays prior to disease development.
Bacterial blights	fixed copper*	See label	—	1	1	Spray first appearance, 10-day intervals.
Damping-off, *Pythium*, *Rhizoctonia*	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/ 1,000 row feet	0.006 to 0.013 lb	—	4 hr	For *Rhizoctonia* only. Make in-furrow or banded applications shortly after plant emergence.
	mefenoxam + PCNB (Ridomil Gold) PCGR	0.75 lb/ 100 linear ft row	0.08 lb/100 linear ft row	—	2	Do not allow feeding of vines or grazing of foliage by livestock.
Powdery mildew	sulfur*	See label		0	1	Spray at first appearance, 10- to 14-day intervals. Avoid days over 90°F.
Rhizoctonia root rot	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/ 1,000 row feet	0.006 to 0.013lb/ 1,000 row feet	--	4 hr	Apply in-furrow or banded applications shortly after plant emergence.
Root and stem rot *(Rhizoctonia* and *Sclerotium)*	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/ 1,000 row feet	0.006 to 0.013lb/ 1,000 row feet	--	4 hr	For *Rhizoctonia* only. Make in-furrow or banded applications shortly after plant emergence.
	PCNB (Terraclor) 75 WP	1.3 to 2 lb/acre row	1 to 1.5 lb/acre row	45	0.5	Mix in 10 gal of water/acre. Spray in furrow and cover soil at seeding at the rate of 8.8 fl oz per 100 ft of row. 10 G formulation available. Do not exceed 10 lb a.i. PCNB per acre per season. Based on 36-in. rows. After emergence, direct spray to base of stem and soil.
	myclobutanil Rally 40 WSP	4 to 5 oz/acre	1.6 to 2 oz/acre	0	1	For *Rhizoctonia* only.
	dichoropropene (Telone) C-17 C-35	10.8 to 17.1 gal/acre 13 to 20.5 gal/acre	107 to 169 lb/acre 139 to 220 lb/acre	—	5	Rate is based on soil type; see label for in-row rates.
	metam-sodium (Vapam) 42 HL	37.5 to 75 gal/trt acre	160 to 320 lb/trt acre	—	—	Rate is based on soil properties and depth of soil to be treated; apply 14 to 21 days before planting.

TABLE 3-4. DISEASE CONTROL FOR BEAN (cont'd)

D. Langston, Plant Pathologist, UGA; and S. Rideout, Plant Pathologist, Virginia Polytechnic Institute

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
BEAN, POLE (snap) (cont'd)						
Rust *(Uromyces)*	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz/acre	0.10 to 0.25 lb/acre	0	4 hr	Make no more than three sequential applications.
	boscalid (Endura) 70 WG	8 to 11 oz/acre	5.6 to 7.7 oz/acre	7	0.5	Many other dried and succulent beans on label.
	chlorothalonil* (Bravo Ultrex) 82.5 WDG	1.25 to 2.7 lb/acre	1.1 to 2.2 lb/acre	7	2	Spray first appearance, 11 lb limit per acre per crop, 7-day intervals;
	myclobutanil Rally 40 WSP	4 to 5 oz/acre	1.6 to 2 oz/acre	0	1	Spray at first appearance.
	sulfur*	See label	2 to 4 lb/100 gal	0	1	Spray at 7- to 10-day intervals.
	tebuconazole (Folicur) 3.6F	4 to 6 fl oz/acre	1.5 to 2 lb/acre	7	0.5	Apply before disease appears when conditions favor rust development and repeat at 14-day intervals; maximum 24 fl oz per season.
White mold *(Sclerotinia)*	Botran 75 W	2.5 to 4 lb/acre	1.9 to 3 lb/acre	2	0.5	Use low rate for bush varieties and high rate for pole varieties.
	thiophanate-methyl (Topsin M) 70 WP	1 to 2 lb/acre	0.7 to 1.4 lb/acre	14	1	Spray at 25% bloom, repeat at full bloom. Do not exceed 4 lb product per season.
BEAN, LIMA						
Botrytis, *Sclerotinia*, leaf spots	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz/acre	0.10 to 0.25 lb/acre	0	4 hr	Leaf spots only; do not make more than three sequential applications.
	thiophanate-methyl (Topsin M) 70 WP	1.5 to 2 lb/acre	1.05 to 1.4 lb/acre	14	1	4 lb limit per acre per crop.
	iprodione (Rovral) 50 WP 4 F	1.5 to 2 lb/acre 1.5 to 2 pt/acre	0.75 to 1 lb/acre	0	1	
	fluazinam (Omega 500)	0.5 to 0.85 pts	0.26 to 0.44	30	3	Apply at 10-30% bloom.
	penthiopyrad (Fontelis)	14 to 30 fl oz/acre	0.18 to 0.4	0	12 hr	Begin sprays prior to disease development.
Damping-off, *Pythium*, *Rhizoctonia*	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/ 1,000 row feet	0.006 to 0.013 lb/1,000 row feet	—	4 hr	*Rhizoctonia* only. Make in-furrow or banded applications shortly after plant emergence.
	mefenoxam (Ridomil Gold) 4 SL	0.5 to 2 pt/trt acre	0.25 to 0.5 lb/trt acre	—	2	For *Pythium* only. Soil incorporate. See label for row rates. Use proportionally less for band rates.
	mefenoxam + PCNB (Ridomil Gold) PCGR	0.75 lb/100 linear ft row	0.08/100 linear ft row	—	2	
	azoxystrobin + mefenoxam (Uniform)	0.34 fl oz/1,000 row ft	0.0071 + 0.0028 lb/ acre	—		In-furrow spray. See label directions.

* See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-5. RELATIVE EFFECTIVENESS OF VARIOUS CHEMICALS FOR FOLIAR DISEASE CONTROL IN BEANS[1]

D. Langston, Plant Pathologist, UGA; and S. Rideout, Plant Pathologist, Virginia Polytechnic Institute

Scale: "—" = ineffective; "+" .... "++++" = very effective; "?" = unknown efficacy.

Fungicide/Bactericide	Aerial *Rhizoctonia*	Anthracnose	Brown Spot (*Pseudomonas*)	*Cercospora*	Common Bacterial Blight	Common Rust	Downy Mildew	Gray Mold (*Botrytis*)	Halo Blight	Powdery Mildew	*Pythium* Cottony Leak	*Pythium* Damping-off	*Rhizoctonia* Sore Shin	*Sclerotinia* Blight	Southern Blight (*S. rolfsii*)
azoxystrobin (Quadris)	+++++	++++	—	?	—	+++++	?	+	—	?	++	?	++++	—	+++++
azoxystrobin + mefenoxam (Uniform)	?	?	—	?	—	?	?	—	—	—	+	++++	++++	—	—
boscalid (Endura)	?	?	—	?	—	?	—	++++	—	?	—	—	?	+++++	+
penthiopyrad (Fontelis)	?	?	—	?	—	?	—	++++	—	?	—	—	?	+++++	+++
dicloran (Botran)	—	—	—	—	—	—	—	+++	—	—	—	—	—	+++	—
fluazinam (Omega 500)	?	?	—	—	—	—	?	++++	—	—	—	—	?	++++	+++
chlorothalonil (Bravo, Echo, Equus)	+	++	—	++++	—	++++	++	—	—	?	—	—	—	—	—
cyprodonil + fludioxonil (Switch)	?	?	—	?	—	?	—	++++	—	?	—	—	?	+++++	+
fixed copper[2]	—	+	++	+	++	+	+++	+	++	+	—	—	—	—	—
iprodione (Rovral)	+	—	—	—	—	—	—	++++	—	—	—	—	++	++++	—
mefenoxam (Ridomil)	—	—	—	—	—	—	++++	—	—	—	+++	++++	—	—	—
myclobutanil (Nova)	++	—	—	+++	—	+++++	—	—	—	++++	—	—	?	—	—
PCNB (Terraclor)	+	—	—	—	—	—	—	—	—	—	—	—	++++	—	+++
pyraclostrobin (Cabrio, Headline)	++++	++++	—	++++	—	+++++	?	+	—	?	+++	?	++	—	+++
sulfur	—	++	—	++	—	+++	+	+	—	+++	—	—	—	—	—
tebuconazole (Folicur)	—	—	—	+++	—	++++	—	+++	—	—	—	—	+	—	++++
thiophanate-methyl (Topsin M)	+	+++	—	++++	—	?	—	—	—	?	—	—	+	++	—

[1] Products were rated at the 2011 Southeast Extension Vegetable Workshop in Fletcher, NC. Efficacy ratings do not necessarily indicate a labeled use.

[2] Fixed coppers include: Basicop, Champ, Champion, Citcop, Copper-Count-N, Kocide, Nu-Cop, Super Cu, Tenn-Cop, Top Cop with Sulfur, and Tri-basic copper sulfate.

TABLE 3-6. RELATIVE IMPORTANCE OF ALTERNATIVE MANAGEMENT PRACTICES FOR DISEASE CONTROL IN BEANS

E. Sikora, Plant Pathologist, Auburn University; and S. Rideout, Plant Pathologist, Virginia Polytechnic Institute

Scale: "0" = not important/does not impact disease, "5" = very important practice to implement/impacts disease greatly; "-" = not applicable; "?" = unknown. Explanatory notes: * = plant earlier; ** = tolerant.

	Disease													
Management Tactic	**Anthracnose**	**Ashy stem blight**	***Botrytis* gray mold**	***Cercospora***	**Common bacterial blight and halo blight**	***Fusarium* root rot**	**Mosaic viruses**	**Powdery mildew**	***Pythium* damping-off**	***Rhizoctonia* root rot**	**Root knot**	**Rust (more on pole beans)**	**Southern blight (*Sclerotium rolfsii*)**	**White mold (*Sclerotini*)**
Avoid field operations when leaves are wet	5	0	5	3	5	0	0	0	0	0	0	5	0	0
Avoid overhead irrigation	5	0	5	5	5	0	0	0	1	0	0	5	0	4
Change planting date	2	2	0	1	2	4	3	1	5	5	1	4*	0	0
Cover cropping with antagonist	0	?	0	0	0	0	0	0	0	0	4	0	0	0
Crop rotation	4	1	2	2	4	3	1	1	3	2	4	0	2	5
Deep plowing	5	3	5	1	5	2	0	0	2	3	5	0	5	5
Destroy crop residue	5	2	5	2	5	0	0	0	1	1	2	3	4	5
Encourage air movement	5	0	5	2	5	0	0	5	1	0	0	3	0	4
Increase between-plant spacing	1	0	1	2	1	1	1	1	3	2	0	1	2	4
Increase soil organic matter	0	3	0	0	0	2	0	0	0	0	3	0	0	0
Insecticidal oils	0	0	0	0	0	0	2	0	0	0	0	0	0	0
pH management	0	0	0	0	0	3	0	0	0	0	0	0	0	0
Plant in well-drained soil	2	2	2	0	2	5	0	0	5	5	0	0	1	3
Plant on raised beds	2	1	2	0	2	5	0	0	5	5	0	0	1	3
Plastic mulch bed covers	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Postharvest temperature control	0	0	0	0	0	0	0	0	0	0	0	0	0	5
Reflective mulch	0	0	0	0	0	0	4	0	0	0	0	0	0	1
Reduce mechanical injury	0	0	0	0	0	3	1	0	0	0	0	0	1	0
Rogue diseased plants	0	0	1	0	0	0	2	0	0	0	0	0	1	2
Row covers	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Soil solarization	0	0	1	0	0	3	0	0	2	4	3	0	3	4
Pathogen-free planting material	5	4	0	2	5	0	4	0	0	0	0	0	0	0
Resistant cultivars	5	4	0	5	5	4	5	5	0	0	0	5**	0	2
Weed control	2	0	2	0	3	2	5	2	0	0	2	2	1	3

TABLE 3-7. DISEASE CONTROL FOR BROCCOLI, BRUSSEL SPROUT, CABBAGE, CAULIFLOWER

N. Dufault, Plant Pathologist, UF; and G. Vallad, Plant Pathologist, UF

Disease	Material	Rate Of Material To Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Alternaria leaf spot, black rot, downy mildew	fixed copper*	see label	—	0	1-2	Apply on 7- to 10-day intervals after transplanting or shortly after seeds have emerged. Some reddening on older broccoli leaves and flecking of cabbage wrapper leaves may occur. Certain Kocide formulations are also registered for use on collard, mustard, and turnip greens. Check label carefully for recommended rates for each disease on each crop.
Alternaria leaf spot	azoxystrobin + difenoconazole (Quadris Top) 29.6 SC	14 fl oz/acre	0.3 lb/acre	1	0.5	Apply prior to disease, but when conditions are favorable, on 7- to 14-day schedule. Alternate to a non-QoI fungicide after 1 application. No more than 4 applications per season.
	boscalid (Endura) 70 WG	6 to 9 oz/acre	4.2 to 6.3 oz/acre	0	0.5	Begin applications prior to disease development, and continue on a 7- to 14-day interval. Make no more than 2 applications per season.
	cyprodinil + difenoconazole (Inspire Super) 32.5 SC	16 to 20 fl oz/acre	5.6 to 7.1 oz/acre	7	0.5	Begin applications prior to disease development, and continue on a 7 – 10 day interval. Make no more than 2 sequential applications before rotating to another effective fungicide with a different mode of action. Do not exceed 80 fl oz per season.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.7 oz/acre	7	0.5	Apply when disease first appears, and continue on 7- to 10-day intervals. Do not exceed 56 oz of product per acre per year.
	triflumizole (Procure) 480 EC	6 to 8 fl oz/acre	3 to 4 oz/acre	1	0.5	Apply when disease first appears and continue on 14 day interval. Do not exceed 18 fl oz per season.
Alternaria and gray mold	penthiopyrad (Fontelis)	14 to 30 fl oz/acre	0.18 to 0.39 lb/acre	0	0.5	Do not exceed 72 fl oz of product per year. Make no more than 2 sequential applications per season before rotating to another effective product with a different mode of action.
Black leg (for broccoli only)	iprodione (Rovral) 50 W 4 F	2 lb/acre 2 pt/acre	1 lb/acre 1 lb/acre	0	—	Apply to base of plant at two- to four-leaf stage. A second application may be made up to the harvest date. Do not use as a soil drench.
Black rot, downy mildew	acibenzolar-*S*-methyl (Actigard) 50WG	0.5 to 1 oz/acre	0.25 to 0.5 oz/acre	7	0.5	Begin applications 7-10 days after thinning, not to exceed four applications per a season.
Clubroot	cyazofamid (Ranman) 34.5 SC	*Transplant:* 12.9 to 25.75 fl oz/100 gal water *Banded:* 20 fl oz/acre	0.333 to 0.665 lb/100 gal water 0.52 lb/acre	0.5	0	Either apply immediately after transplanting with 1.7 fl oz of solution per transplant, or as a banded application with soil incorporation of 6-8 inches prior to transplanting. Do not apply more than 39.5 fl oz/acre/season; or six (1 soil + 5 foliar) applications per season. Do not make more than 3 consecutive applications without rotating to another fungicide with a different mode of action for 3 subsequent applications.
	PCNB (Terraclor) FL	*Transplant*: 3 pt/100 gal water *Banded*: 5.6 gal/25 gal water *Broadcast:* 7.5 gal/30 gal water	0.02 lb/gal water 0.9 lb/ gal water 1 lb/ gal water	—	0.5	Apply to transplants (3 pt of flowable or 2 lb of 75WP per 100 gal of water) or as a banded or broadcast treatment directly to soil prior to planting. See label for row spacing rates. Terraclor FL, 10G, and 75WP formulations can also be used on Chinese broccoli and Chinese cabbage.
	(Terraclor) 75 WP	*Transplant:* 2 lb/100 gal water *Banded*: 30 lb/25 gal water	0.02 lb/gal water 0.9 lb/gal water			
	(Terraclor) 10 G (Terraclor) 15 G	*Broadcast:* 40 lb/30 gal water 200 to 300 lb/acre 125 to 200 lb/acre	1 lb/gal water 20 to 30 lb/acre 18.8 to 30 lb/acre			
	(Fluazinam) Omega 500F	*Transplant*: 6.45 fl oz/100gal water *Banded*: 2.6 pts/acre	0.002 lb/gal water 1.36 lb/acre	50	2	Either apply directly as a drench to transplants or as a banded application with soil incorporation of 6-8 inches prior to transplanting. Use of product can delay harvest and cause some stunting without adverse effects on final yields

TABLE 3-7. DISEASE CONTROL FOR BROCCOLI, BRUSSEL SPROUT, CABBAGE, CAULIFLOWER (cont'd)

N. Dufault, Plant Pathologist, UF; and G. Vallad, Plant Pathologist, UF

Disease	Material	Rate Of Material To Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Downy mildew	cyazofamid (Ranman) 34.5 SC	2.75 fl oz/acre	0.072 lb/acre	0	0.5	Begin applications on a 7- to 10-day schedule when disease first appears or weather is conducive. Do not apply more than 39.5 fl oz/acre/season; or six (1 soil + 5 foliar) applications per season. Do not make more than 3 consecutive applications without rotating to another fungicide with a different mode of action for 3 subsequent applications.
	fluopicolide (Presidio) 39.5 SC	3 to 4 fl oz/acre	0.09 to 0.125 lb/acre	2	0.5	No more than 2 sequential applications before rotating to another effective product of a different mode of action. Limited to 4 applications, 12 fl oz/ acre per season,
	fosetyl-AL (Aliette) 80 WDG	2 to 5 lb/acre	1.6 to 4 lb/acre	3	1	Apply when disease first appears; then repeat on 7- to 21-day intervals. Do not tank mix with copper fungicides. A maximum of seven applications can be made per season. Also for loose-heading Chinese cabbage, kale, kohlrabi, and greens (collard, mustard, and rape).
	mandipropamid (Revus) 2.08F	8 fl oz/acre	0.13 lb/acre	1	0.5	Apply prior to disease development and continue throughout season at 7- to 10-day intervals; maximum 32 fl oz per season.
Downy mildew, *Alternaria* leaf spot	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz	0.1 to 0.25 lb	0	4 hr	
	chlorothalonil			7	2	Apply after transplanting, seedling emergence, or when conditions favor disease development. Repeat as needed on a 7- to 10-day interval.
	(Bravo Ultrex) 82.5 WDG	1.4 pt/acre	1.2 lb/acre			
	(Bravo Weatherstik) 6 F	1.5 pt/acre	1.1 lb/acre			
	(Bravo 500)	2.25 lb/acre	1.2 lb/acre			
	(Bravo S)	4.5 pt/acre	1.2 lb/acre			
	(Equus) DF	1.4 to 1.8 lb/acre	1.2 to 1.5 lb/acre			
	(Equus) 720	0.75 to 1.5 pt/acre	0.6 to 1.1 lb/acre			
	cyprodinil + difenoconazole (Inspire Super) 32.5 SC	16 to 20 fl oz/acre	5.6 to 7.1 oz/acre	7	0.5	Begin applications prior to disease development, and continue on a 7 – 10 day interval. Make no more than 2 sequential applications before rotating to another effective fungicide with a different mode of action. Do not exceed 80 fl oz per season.
	fenamidone (Reason) 500 SC	5.5 to 8.2 fl oz/acre	0.178 to 0.267 lb/ acre	2	0.5	Begin applications on a 5 to 10 day schedule when disease first appears or weather is conducive. Do not apply more than 24.6 fl oz/acre/season. Do not make more than 1 application without rotating to another fungicide with a different mode of action.
	mancozeb (Manzate Pro-Stick) 75 WDG	1.6 to 2.1 lb/acre	1.2 to 1.6 lb/acre	10	1	Spray at first appearance of disease and continue on a 7- to 10-day interval. No more than 12.8 lbs/acre per season.
	mefenoxam + chlorothalonil (Ridomil Gold/Bravo)	1.5 lb/acre	—	7	2	Begin applications when conditions favor disease but prior to symptoms. Under severe disease pressure use additional fungicides between 14-day intervals. Do not make more than four applications per crop.
Powdery mildew	azoxystrobin + difenoconazole (Quadris Top) 29.6 SC	14 fl oz/acre	0.3 lb/acre	1	0.5	Apply prior to disease, but when conditions are favorable, on 7 to 14 day schedule. Alternate to a non-QoI fungicide after 1 application. No more than 4 applications per season.
	boscalid (Endura) 70 WG	6 to 9 oz/acre	4.2 to 6.3 oz/acre	0	0.5	Begin applications prior to disease development, and continue on a 7- to 14-day interval. Make no more than 2 applications per season; disease suppression only.
	cyprodinil + difenoconazole (Inspire Super) 32.5 SC	16 to 20 fl oz/acre	5.6 to 7.1 oz/acre	7	0.5	Begin applications prior to disease development, and continue on a 7 – 10 day interval. Make no more than 2 sequential applications before rotating to another effective fungicide with a different mode of action. Do not exceed 80 fl oz per season.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 10 to 14 12 oz/ acre	6.94.3 to 8.7.5 oz/ acre	7	0.5	Apply when disease first appears, and continue on 7- to 10-day intervals. Do not exceed 56 oz of product per acre per year.
	penthiopyrad (Fontelis)	14 to 30 fl oz/acre	0.18 to 0.39 lb/acre	0	0.5	Do not exceed 72 fl oz of product per year. Make no more than 2 sequential applications per season before rotating to another effective product with a different mode of action.
	sulfur (Microthiol Disperss) 80 MWS	3 to 10 lb/acre	2.4 to 8 lb/acre	0	1	Apply when disease first appears; then repeat as needed on 14-day intervals. Avoid applying on days over 90°F. Also for use on greens (collard, kale, and mustard), rutabaga, and turnip.
	triflumizole (Procure) 480 EC	6 to 8 fl oz/acre	3 to 4 oz/acre	1	0.5	Apply when disease first appears and continue on 14 day interval. Do not exceed 18 fl oz per season.

TABLE 3-7. DISEASE CONTROL FOR BROCCOLI, BRUSSEL SPROUT, CABBAGE, CAULIFLOWER (cont'd)

N. Dufault, Plant Pathologist, UF; and G. Vallad, Plant Pathologist, UF

Disease	Material	Rate Of Material To Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Pythium damping-off, *Phytophthora* basal stem rot	fluopicolide (Presidio) 39.5 SC	3 to 4 fl oz/acre	0.09 to 0.125 lb/acre	2	0.5	Apply as a soil drench at transplant. As plants enlarge, use apply directly to soil by chemigation on a 7-10 day schedule as conditions favor disease, but prior to disease development. No more than 2 sequential applications before rotating to another effective product of a different mode of action. Limited to 4 applications, 12 fl oz/ acre per season,
	mefenoxam (Ridomil Gold) 4 SL	0.25 to 2 pt/acre	0.12 to 1.0 lb/acre	—	2	Apply 1 to 2 pt per acre as a broadcast, preplant application to soil and incorporate in top 2 in. of soil. For *Pythium* control, use only 0.25 to 0.5 pt per acre.
	metalaxyl (MetaStar) 2 E	4 to 8 pt/ trt acre	0.5 to 1 lb/acre	—	2	Preplant incorporated or surface application.
Rhizoctonia bottom rot	boscalid (Endura) 70 WG	6 to 9 oz/acre	4.2 to 6.3 oz/acre	0	0.5	Begin applications prior to disease development, and continue on a 7- to 14-day interval. Make no more than 2 applications per season; disease suppression only.
Rhizoctonia stem (wirestem) and root rot	PCNB (Terraclor) FL	*Broadcast drench:* 2.8 to 3.8 gal/50 gal water *Row drench:* 1.9 to 2.8 gal/35 gal water *Broadcast drench:* 15 to 20 lb/50 gal water	0.2 to 0.3 lb/gal water	—	0.5	Apply to soil as a broadcast or row drench treatment at the time of or immediately after seeding. See label for row spacing rates.
	(Terraclor) 75 WP	*Row drench:* 10 to 15 lb/35 gal water				
	(Terraclor) 10 G	110 to 150 lb/acre	11 to 15 lb/acre			
	(Terraclor) 15 G	75 to 100 lb/acre	11 to 15 lb/acre			
Sclerotinia stem rot (white mold)	boscalid (Endura) 70 WG	6 to 9 oz/acre	4.2 to 6.3 oz/acre	0	0.5	Begin applications prior to disease development, and continue on a 7- to 14-day interval. Make no more than 2 applications per season.
	penthiopyrad (Fontelis)	16 to 30 fl oz/acre	0.21 to 0.39 lb/acre	0	0.5	Do not exceed 72 fl oz of product per year. Make no more than 2 sequential applications per season before rotating to another effective product with a different mode of action.

* See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-8. RELATIVE EFFECTIVENESS OF VARIOUS CHEMICALS FOR BRASSICA DISEASE CONTROL[1]

D. Langston, Plant Pathologist, UGA; and G. Vallad, Plant Pathologist, UF

Scale: "—" = ineffective; "+++++" = very effective; "?" = unknown efficacy.

Fungicides[2]	Fungicide Group[3]	Preharvest Interval (Days)	Relative Control Rating											
			Alternaria Leaf Spot	Bacterial Soft Rot	Black Rot	Black Leg	Bottom Rot (*Rhizoctonia*)	*Cercospora* & *Cercosporella*	Clubroot	Downy Mildew	Powdery Mildew	*Pythium* damping-off	*Sclerotinia*/Raisin Head	Wirestem (*Rhizoctonia*)
azoxystrobin (Amistar, Quadris)	11	—	+++++	—	—	?	?	+++	—	+++	+++	—	—	+
boscalid (Endura)	7	0-14	++++	—	—	++	—	—	—	+	+	—	+++	++
chlorothalonil (Bravo, Echo, Equus)	M	7	+++	—	—	—	+	++	—	+++	++	—	—	—
tebuconazole (Folicur, Tebuzol, Tegrol)	3	7	++	—	—	?	—	+++	—	—	?	—	—	—
cyprodinil + fludioxonil (Switch)	9+12	7	+++	—	—	—	—	++	—	—	++	—	—	—
dimethomorph (Forum)	40	0	—	—	—	—	—	—	—	++	—	—	—	—
fenamidone (Reason)	11	2	++	—	—	—	—	+++	—	+++++	—	—	—	—
fluopicolide (Presidio)	43	2	—	—	—	—	—	—	—	+++++	—	—	—	—
amectoctradin + dimethomorph (Zampro)	45+40	0-7	—	—	—	—	—	—	—	+++++	—	—	—	—
fixed copper[4]	M	0	+	—	++	—	—	+	—	++	++	—	—	—
fosteyl-Al[4] (Aliette)	33	3	—	—	—	—	—	—	—	+++[5]	—	—	—	—
iprodione (Rovral)[6]	2	—	—[6]	—	—	+++[6]	—	—	—	—	—	—	+[6]	+[6]
difenoconazole + cyprodinil (Inspire Super)	3 + 9	7	++++	—	—	?	—	++++	—	—	+++	—	+	—
penthiopyrad (Fontelis)	7	0	+++++	—	—	?	—	?	—	—	++++	—	++++	—
mandipropamid (Revus)	40	1	—	—	—	—	—	—	—	+++++	—	—	—	—
mancozeb (Manzate, Penncozeb, Dithane)	M	7	++	—	+	—	—	++	—	+++ [5]	+	—	—	—
mefenoxam (Ridomil Gold EC) pre-plant	4	NA	—	—	—	—	—	—	—	+++	—	+++	—	—
mefenoxam + chlorothalonil (Ridomil Gold Bravo)	4 + M	7	+++	—	—	—	+	++	—	+++	++	—	—	—
PCNB (Terraclor)	14	NA	—	—	—	—	+	—	++	—	—	—	—	+++
fluazinam (Omega 500)	29	20-50[7]	—	—	—	—	—	—	+++	—	—	—	—	—
pyraclostrobin (Cabrio)	11	—	+++++	—	—	?	—	+++++	—	+++	+++	—	—	—
sulfur	M	0	+	—	—	—	—	+	—	+	+++	—	—	—

[1] Product ratings are based on current field research. Efficacy ratings do not necessarily indicate a labeled use.

[2] Fungicides registered specifically on Cole crops (cabbage, cauliflower, broccoli) include chlorothalonil, iprodione, maneb, and mefenoxam + chlorothalonil. Pyraclostrobin is labeled only on turnip tops. Fosteyl-Al is not labeled on turnips. Always refer to product labels prior to use.

[3] **Key to Fungicide Groups:** 2: dicarboxamides; 3: demethylation inhibitors; 4: phenylamides; 7: carboxamides, 9: anilonopyrimidines; 11: quinone outside inhibitors; 12: phenylpyrroles; 14: aromatic hydrocarbons; 15: cinnamic acids; 33: phosphonates; 40: carboxylic acid amine; 45: complex III, cytochrome bc1 (ubiquitone reductase); M: multi-site activity.

[4] Phytotoxicity is seen when fosteyl-Al is tank-mixed with copper.

[5] When used in combination with fosteyl-Al or maneb.

[6] Applications of iprodione made for black leg may suppress *Alternaria*, *Sclerotinia*, and wirestem on broccoli.

[7] Use a 20 day PHI for Omega 500 on leafy greens and a 50 day PHI for Cole brassicas. Use a zero day PHI for Zampro on leafy greens and a 7 day PHI on Cole crops.

TABLE 3-9. RELATIVE IMPORTANCE OF ALTERNATIVE MANAGEMENT PRACTICES FOR DISEASE CONTROL IN BRASSICA CROPS

E.J. SIKORA, Plant Pathology, Auburn University

Scale: "0" = not important/does not impact disease, "5" = very important practice to implement/impacts disease greatly.

	Disease											
Management Tactic	***Alternaria* leaf spot**	**Bacterial soft rot**	**Black rot**	**Black leg**	**Bottom rot (*Rhizoctonia*)**	**Cercospora**	**Clubroot**	**Downy mildew**	**Powdery mildew**	**Pythium**	**Sclerotinia head**	**Wirestem (*Rhizoctonia*)**
Avoid field operations when leaves are wet	1	3	4	2	2	1	0	1	0	0	0	0
Avoid overhead irrigation	5	5	5	5	3	5	0	4	1	0	0	0
Change planting date	1	1	0	0	1	0	0	0	0	1	0	2
Cover cropping with antagonist	0	0	0	0	0	0	1	0	0	1	0	0
Crop rotation	2	2	4	4	1	3	0	3	0	0	1	1
Deep plowing	3	3	4	4	2	3	0	3	0	0	3	2
Destroy crop residue	3	3	4	4	2	3	0	3	0	0	1	1
Encourage air movement	3	1	1	1	2	3	0	3	0	1	2	0
Increase between-plant spacing	3	1	1	1	2	3	0	2	0	1	2	0
Increase soil organic matter	0	0	0	0	1	0	1	0	0	0	0	1
Hot water seed treatment	1	0	5	4	0	0	0	0	0	0	0	0
pH management	0	0	0	0	0	0	5	0	0	0	0	0
Plant in well-drained soil	1	2	1	1	4	1	5	1	0	3	2	4
Plant on raised beds	0	2	1	0	4	0	5	1	0	3	2	4
Plastic mulch bed covers	1	0	0	0	2	0	0	0	0	0	0	0
Postharvest temperature control	0	5	0	0	0	0	0	0	0	0	0	0
Reflective mulch	0	0	0	0	0	0	0	0	0	0	0	0
Reduce mechanical injury	0	5	4	0	0	0	0	0	0	0	2	1
Rogue diseased plants	1	0	0	2	1	0	0	0	0	0	0	0
Row covers	0	1	0	0	0	0	0	0	0	0	0	0
Soil solarization	0	0	0	?	3	0	0	0	0	1	1	2
Pathogen-free planting material	3	0	5	5	3	0	4	0	0	0	1	3
Resistant cultivars	0	0	5	0	0	0	1	3	3	0	0	1
Weed control	2	0	3	2	0	2	2	2	2	0	2	0

CANTALOUPE SEE CUBURBITS — TABLE 3-12.

TABLE 3-10. DISEASE CONTROL FOR CORN, SWEET

N. Dufault, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Seedling and soilborne diseases	fluoxastrobin	0.16 to 0.24 fl oz/ 1000 row feet	0.07 to 0.10 oz/ 1000 row feet	7	0.5	May be applied as a banded or in-furrow spray. Consult label for specifics.
Common Rust, *Helminthosporium* Leaf blight, gray leaf spot	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz	0.1 to 0.25 lb	7	4 hr	Use lower rate for rust. Make no more than two sequential applicationsbefore alternating with fungicides that have a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	azoxystrobin + propiconazole (Quilt) 1.66 F	10.5 to 14 fl oz/acre	0.14 to 0.18 lb/acre	14	1	Apply when disease first appears; continue to apply on a 14-day interval if favorable conditions persist.
	chlorothalonil 7 (Bravo Ultrex) 82.5 WDG	0.75 to 2 pt/acre	0.6 to 1.5 lb/acre	14	2	Spray at first appearance, 4- to 14-day intervals.
	mancozeb 80W*	1 to 1.5 lb/acre	0.8 to 1.2 lb/acre	7	1	Start applications when disease first appears and repeat at 4-7 day intervals.
	Koverall 75% W	1.5 lb/acre	1.2 lb/acre	7	1	
	Roper DF	1.5 lb/acre	1.2 lb/acre	7	1	
	propiconazole (Tilt)	2 to 4 fl oz/acre	—	14	1	16 fl oz per acre per crop maximum.
	tebuconazole (Folicur) 3.6 F	4 to 6 oz/acre	1.5-2.3 oz/acre	7	19	For optimum results use as a preventative treatment. Folicur 3.6 F must have 2-4 hours of drying time on foliage for the active ingredient to move systemically into plant tissue before rain or irrigation occurs.
	propiconazole + trifloxystrobin (Stratego)	10 oz/acre	2.28 oz/acre	14	1	Apply Stratego when disease first appears and continue on a 7-14 day interval. Alternate applications of Stratego with another product with a different mode of action than Group 11 fungicides.
	pyraclostrobin (Headline) 2.09 F	6 to 9 fl oz/acre	0.1to 0.15 lb/acre	7	0.5	
Anthracnose, gray leaf spot, Northern and southern corn leaf blight, southern rust, common rust	fluxapyroxad + pyraclostrobin (Priaxor)	4 to 8 fl oz/acre	1.7 to 3.4 oz/acre	7	0.5	Do not make more than two sequential applications of Priaxor before switching to a fungicide with a different mode of action. May be used with adjuvants (consult label for specifics).

* See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-11. ALTERNATIVE MANAGEMENT TOOLS–CORN, SWEET

N. Dufault, Plant Pathologist, UF

Disease	Resistant Varieties	Non-chemical Controls
Blights	Yes	
Pythium damping-off		Use raised beds to dry soil surface.
Rust	Yes	

CUCUMBERS SEE CUCURBITS - TABLE 3.12.

TABLE 3-12. DISEASE CONTROL FOR CUCURBITS *(FOR RELATIVE EFFICACY SEE TABLE 3-13)*

L. M. Quesada-Ocampo, Plant Pathologist, NCSU; S. C. Bost, Plant Pathologist, UT; A. P. Keinath, Plant Pathologist, Clemson University; D. Langston, Plant Pathologist, UGA

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Angular leaf spot, Bacterial leaf spot	fixed copper*	See label	—	0	0	Repeated use may cause leaf yellowing.
	acibenzolar-*S*-methyl (Actigard) 50 WP	0.5 to 1 oz/acre	0.25 to 0.5 oz/acre	0	0.5	Apply to healthy, actively growing plants. Do not apply to stressed plants. Apply no more than 8 oz per acre per season.
Bacterial fruit blotch	fixed copper*	See label	—	0	0	Start applications at first bloom; ineffective once fruit reaches full size. Repeated use may cause leaf yellowing.
	acibenzolar-*S*-methyl (Actigard) 50 WP	0.5 to 1 oz/acre	0.25 to 0.5 oz/acre	0	0.5	Apply to healthy, actively growing plants. Do not apply to stressed plants. Apply no more than 8 oz per acre per season.
Bacterial wilt	—	—	—	—	—	See Insect Control section for Cucumber Beetles.
Belly (fruit) rot, *Rhizoctonia*	azoxystrobin (Quadris) 2.08 F	See label	See label	1	4 hr	Make banded application to soil surface or in-furrow application just before seed are covered.
	fluopyram + tebuconazole (Luna Experience) 3.3 F	17 fl oz/acre	0.27 to 0.44 lb/acre	7	0.5	**APPLY ONLY TO WATERMELON**. Make no more than 2 applications before alternating to a fungicide with different active ingredients. Do not rotate with tebuconazole.
	thiophanate-methyl (Topsin M) 70 WP	0.5 lb/acre	0.35 lb/acre	0	0.5	Apply in sufficient water to obtain runoff to soil surface.
Cottony leak (*Pythium*)	metalaxyl (MetaStar) 2 E	4 to 8 pt/treated acre	0.5 to 1 lb/treated acre	0	2	Soil surface application in 7-in. band.
Damping-off *(Pythium)* and fruit rot	mefenoxam (Ridomil Gold) 4 SL (Ultra Flourish) 2 EL	1 to 2 pt/treated acre 2 to 4 pt/treated acre	0.5 to 1 lb/acre	0	2	Preplant incorporated (broadcast or band); soil spray (broadcast or band); or injection (drip irrigation).
	metalaxyl (MetaStar) 2 E	4 to 8 pt/treated acre	0.5 to 1 lb/acre	0	2	Preplant incorporated or surface application.
	propamocarb (Previcur Flex) 6 F	12.8 fl oz/100 gal	0.6 lb/100 gal	2	0.5	Rates based on rock wool cube saturation in the greenhouse. See label for use in seed beds, drip system, and soil drench.
Downy mildew	ametoctradin + dimethomorph (Zampro) 4.38 SC	14 oz/A	0.48 lb/acre	0	0.5	Make no more than 2 applications before alternating to a fungicide with different active ingredients. Do not rotate with Forum. Maximum of 3 applications per crop per season.
	azoxystrobin (Quadris) 2.08 F	11 to 15.4 fl oz/acre	0.18 to 0.25 lb/acre	1	4 hr	Make no more than one application before alternating with a fungicide with a different mode of action. Apply no more than 2.88 qt per crop per acre per season. Resistance reported.
	chlorothalonil 6 F *	1.5 to 3 pt/acre	0.8 to 1.6 pt/acre	0	2	Spray at first appearance and then at 7- to 14-day interval. Avoid late-season application after plants have reached full maturity.
	chlorothalonil + potassium phosphite (Catamaran) 5.27 SC	6 pints/acre	3.3 pints/acre	0	0.5	Apply no more than 50 pints per crop per acre per season.
	cyazofamid (Ranman) 400 SC	2.1 to 2.75 fl oz/acre	0.054 to 0.071 lb/ acre	0	0.5	Do not apply more than 6 sprays per crop. Make no more than 3 consecutive applications followed by 3 applications of fungicides from a different resistance management group.
	cymoxanil (Curzate) 60 DF	3.2 oz/acre	1.9 oz/acre	3	0.5	Use only in combination with labeled rate of protectant fungicide (e.g., mancozeb or chlorothalonil).
	dimethomorph (Forum) 4.17SC	6 fl oz/acre	3.13 oz/acre	0	0.5	Must be applied as a tank mix with another fungicide with a different mode of action. Do not make more than two sequential applications.
	famoxadone + cymoxanil (Tanos) 50WP	8 oz/acre	4 oz/acre	3	0.5	Do not make more than one application before alternating with a fungicide that has a different mode of action. Must be tank-mixed with contact fungicide with a different mode of action.
	fenamidone (Reason) 500 SC	5.5 fl oz/acre	0.178 lb/acre	14	0.5	Begin applications when conditions favor disease development, and continue on 5- to 10-day interval. Do not apply more than 22 fl oz per growing season. Alternate with fungicide from different resistance management group, and make no more than 4 total applications of Group 11 fungicides per season.
	fixed copper*	See label	—	0	1	Repeated use may cause leaf yellowing.
	fluopicolide (Presidio) 4F	3 to 4 fl oz/acre	0.09 to 0.125 lb/acre	2	0.5	Tank mix with another downy mildew fungicide with a different mode of action.

TABLE 3-12. DISEASE CONTROL FOR CUCURBITS *(FOR RELATIVE EFFICACY SEE TABLE 3-13)* (cont'd)

L. M. Quesada-Ocampo, Plant Pathologist, NCSU; S. C. Bost, Plant Pathologist, UT; A. P. Keinath, Plant Pathologist, Clemson University; D. Langston, Plant Pathologist, UGA

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Downy mildew (cont'd)	fosetyl-AL (Aliette) 80 WDG	2 to 5 lb/acre	1.6 to 4 lb/acre	0.5	0.5	Do not tank mix with copper-containing products. Mixing with surfactants or foliar fertilizers is not recommended.
	mandipropamid (Revus) 2.08F	8 fl oz/acre	0.13 lb/acre	1	0.5	For disease suppression only. Resistance reported.
	mancozeb*	2 to 3 lb/acre	1.6 to 2.4 lb/acre	5	1	Labeled on all cucurbits. Apply no more than 24 lb. per acre per season.
	mefenoxam + chlorothalonil (Ridomil Gold Bravo, Flouronil) 76.5 WP	2 to 3 lb/acre	1.5 lb/acre	7	2	Spray at first appearance and repeat at 14-day intervals. Apply full rate of protectant fungicide between applications. Avoid late-season application when plants reach full maturity. Resistance reported.
	propamocarb (Previcur Flex) 6 F	1.2 pt/acre	0.9 lb/acre	2	0.5	Begin applications before infection; continue on a 7- to 14- day interval. Do not apply more than 6 pt per growing season. Always tank mix with another Downy mildew product.
	pyraclostrobin (Cabrio) 20 WG	8 to 12 oz/acre	1.6 to 2.4 oz/acre	0	0.5	Make no more than one application before alternating to a fungicide with a different mode of action. Resistance reported.
	pyraclostrobin + boscalid (Pristine) 38 WG	12.5 to 18.5 oz/acre	4.8 to 7 oz/acre	0	1	Make no more than 4 applications per season. Resistance reported.
	trifloxystrobin (Flint) 50 WDG	4 oz/acre	2 oz/acre	0	0.5	Begin applications preventatively and continue as needed alternating applications of Ridomil Gold Bravo on a 7- to14-day interval. Resistance reported.
	zoxamide + mancozeb (Gavel) 75 DF	1.5 to 2 lb	1.13 to 1.5 lb	5	2	Begin applications when plants are in 2-leaf stage, and repeat at 7- to 10- day intervals. Now labeled on all cucurbits. Maximum 8 applications per season.
Gummy stem blight, Black rot	tebuconazole (Monsoon) 3.6 F	8 oz/acre	2 lb/acre	7	0.5	Maximum 3 applications per season. Apply as a protective spray at 10-14 day intervals. Add a surfactant.
Leaf spots: *Alternaria*, Anthracnose (*Colletotrichum*), *Cercospora*, Gummy stem blight (*Didymella*), Target spot (*Corynespora*)	azoxystrobin (Quadris) 2.08 F	11 to 15.4 fl oz/acre	0.18 to 0.25 lb/acre	1	4 hr	Make no more than one application before alternating with a fungicide with a different mode of action. Apply no more than 2.88 qt per crop per acre per season. Do not use for Gummy stem blight where resistance to group 11(QoI) fungicides exists.
	azoxystrobin + difenoconazole (Quadris Top) 1.67 SC	12 to 14 fl oz/acre	3.6 to 4.2 fl oz/acre	1	0.5	Not for Target spot. Make no more than one application before alternating with fungicides that have a different mode of action. Apply no more than 56 fl oz per crop per acre per season.
	chlorothalonil 6 F*	1.5 to 3 pt/acre	0.8 to 1.6 pt/acre	0	2	Spray at first appearance and then at 7- to 14-day intervals. Avoid late-season application after plants have reached full maturity.
	chlorothalonil + potassium phosphite (Catamaran) 5.27 SC	6 pints/acre	3.3 pints/acre	0	0.5	Apply no more than 50 pints per crop per acre per season. Do not apply to watermelon fruit when stress conditions conducive to sunburn occur.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.9 oz/acre	1	0.5	Only for *Alternaria* and Gummy stem blight. Make no more than 2 applications before alternating to a different fungicide. Maximum of 4 to 5 applications at high and low rates.
	difenoconazole + cyprodinil (Inspire Super) 2.82 SC	16 to 20 fl oz/acre	5.3 to 7.1 oz/acre	7	0.5	Not for Target spot. Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 80 fl oz per crop per acre per season.
	famoxadone + cymoxanil (Tanos) 50WP	8 oz/acre	4 oz/acre	3	0.5	Only for *Alternaria* and Anthracnose; do not make more than one application before alternating with a fungicide that has a different mode of action; must be tank-mixed with contact fungicide with a different mode of action
	fenamidone (Reason) 500 SC	5.5 fl oz/acre	0.178 lb/acre	14	0.5	Begin applications when conditions favor disease development, and continue on 5- to 10-day interval. Do not apply more than 22 fl oz per growing season. Alternate with fungicide from different resistance management group, and make no more than 4 total applications of Group 11 fungicides per season.
	fixed copper*	See label	—	0	1	Repeated use may cause leaf yellowing.

TABLE 3-12. DISEASE CONTROL FOR CUCURBITS *(FOR RELATIVE EFFICACY SEE TABLE 3-13)* (cont'd)

L. M. Quesada-Ocampo, Plant Pathologist, NCSU; S. C. Bost, Plant Pathologist, UT; A. P. Keinath, Plant Pathologist, Clemson University; D. Langston, Plant Pathologist, UGA

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Leaf spots: *Alternaria*, Anthracnose (*Colletotrichum*), *Cercospora*, Gummy stem blight (*Didymella*), Target spot (*Corynespora*) (cont'd)	mancozeb*	2 to 3 lb/acre	1.6 to 2.4 lb/acre	5	1	Labeled on all cucurbits. Apply no more than 24 lb per acre per season.
	fluopyram + tebuconazole (Luna Experience) 3.3 F	8 to 17 fl oz/acre	0.27 to 0.44 lb/acre	7	0.5	**APPLY ONLY TO WATERMELON.** Not for *Cercospora* or target spot. Make no more than 2 applications before alternating to a fungicide with different active ingredients. Do not rotate with tebuconazole.
	fluopyram + trifloxystrobin (Luna Sensation) 1.67 F	7.6 fl oz/acre	0.25 lb/acre	0	0.5	**APPLY ONLY TO WATERMELON** and only to control *Alternaria* and Anthracnose. Make no more than 2 applications before alternating to a fungicide with different active ingredients. Maximum 4 applications per season.
	potassium phosphite + tebuconazole (Viathon)	4 pints/acre	0.21 lb	7	0.5	A**PPLY ONLY TO WATERMELON.** Maximum 3 applications per crop.
	pyraclostrobin (Cabrio) 20 WG	12 to 16 oz/acre	2.4 to 3.2 oz/acre	0	0.5	Do not use for Gummy stem blight where resistance to group 11 (QoI) fungicides exists. Make no more than one application before alternating to a fungicide with a different mode of action.
	pyraclostrobin + boscalid (Pristine) 38 WG	12.5 to 18.5 oz/acre	4.8 to 7 oz/acre	0	1	Not for target spot. Do not use for gummy stem blight where resistance to group 7 and group 11 fungicides exists. Use highest rate for anthracnose. Make no more than 4 applications per season.
	thiophanate-methyl (Topsin M) 70 WP	0.5 lb/acre	0.35 lb/acre	0	0.5	Spray at first appearance and then at 7- to 10-day intervals. Resistance reported in gummy stem blight fungus.
	zoxamide + mancozeb (Gavel) 75 DF	1.5 to 2 lb	1.13 to 1.5 lb	5	2	*Cercospora* and *Alternaria* only. Begin applications when plants are in 2-leaf stage, and repeat at 7- to 10- day intervals. Now labeled on all cucurbits. Maximum 8 applications per season.
Phytophthora blight	ametoctradin + dimethomorph (Zampro) 4.38SC	14 oz/A	0.48 lb/acre	0	0.5	Make no more than 2 applications before alternating to a fungicide with different active ingredients. Do not rotate with Forum. Maximum of 3 applications per crop per season. Apply at planting as a preventive drench treatment. Addition of a spreading or penetrating adjuvant is recommended
	cyazofamid (Ranman) 400 SC	2.75 lf oz/acre	0.071 lb/acre	0	0.5	Do not apply more than 6 sprays per crop. Make no more than 3 consecutive applications followed by 3 applications of fungicides from a different resistance management group. Resistant isolates have been found.
	dimethomorph (Forum) 4.17SC	6 fl oz/acre	3.13 oz/acre	0	0.5	Must be applied as a tank mix with another fungicide with a different mode of action. Do not make more than two sequential applications.
	fluopicolide (Presidio) 4F	3 to 4 fl oz/acre	0.09 to 0.125 lb/acre	2	0.5	Tank mix with another *Phytophthora* fungicide with a different mode of action. May be applied through drip irrigation to target crown rot phase.
	mandipropamid (Revus) 2.08F	8 fl oz/acre	0.13 lb/acre	0	0.5	For disease suppression only; apply as foliar spray with copper based fungicide.
Plectosporium blight	azoxystrobin + difenoconazole (Quadris Top) 1.67 SC	12 to 14 fl oz/acre	3.6 to 4.2 fl oz/acre	1	0.5	Make no more than one application before alternating with fungicides that have a different mode of action. Apply no more than 56 fl oz per crop per acre per season.
	trifloxystrobin (Flint) 50 WDG	1.5 to 2 oz/acre	0.75 to 1 oz/acre	0	0.5	Make no more than one application before alternating with fungicides that have a different mode of action. Begin applications preventively when conditions are favorable for disease and continue as needed on a 7- to 14- day interval.
	pyraclostrobin (Cabrio) 20WG	12 to 16 oz/acre	2.4 to 3.2 oz/acre	0	0.5	Make no more than 1 application before alternating to a fungicide with a different mode of action.

TABLE 3-12. DISEASE CONTROL FOR CUCURBITS *(FOR RELATIVE EFFICACY SEE TABLE 3-13)* (cont'd)

L. M. Quesada-Ocampo, Plant Pathologist, NCSU; S. C. Bost, Plant Pathologist, UT; A. P. Keinath, Plant Pathologist, Clemson University; D. Langston, Plant Pathologist, UGA

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Powdery mildew	acibenzolar-S-methyl (Actigard) 50 WP	0.5 to 1 oz/acre	0.25 to 0.5 oz/acre	0	0.5	Apply to healthy, actively growing plants. Do not apply to stressed plants. Apply no more than 8 oz per acre per season.
	azoxystrobin + difenoconazole (Quadris Top) 1.67 SC	12 to 14 fl oz/acre	3.6 to 4.2 fl oz/acre	1	0.5	Make no more than one application before alternating with fungicides that have a different mode of action. Apply no more than 56 fl oz per crop per acre per season.
	chlorothalonil 6 F	1.5 to 3 pt/acre	1.1 to 2.25 lb/acre	0	2	Spray at first appearance and then at 7- to 14-day intervals. Avoid late-season application after plants have reached full maturity. Does not control PM on leaf undersides.
	chlorothalonil + potassium phosphite (Catamaran) 5.27 SC	6 pints/acre	3.3 pints/acre	0	0.5	Apply no more than 50 pints per crop per acre per season. Do not apply to watermelon fruit when stress conditions conducive to sunburn occur.
	difenoconazole + cyprodinil (Inspire Super) 2.82 SC	16 to 20 fl oz/acre	5.2 to 6.5 fl oz/acre	7	0.5	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 80 fl oz per crop per acre per season.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.9 oz/acre	1	0.5	Make no more than 2 applications before alternating to a different fungicide. Maximum of 4 to 5 applications at high and low rates. Not for target spot or anthracnose or cecospora.
	fixed copper*	See label	—	0	1	Repeated use may cause leaf yellowing.
	cyflufenamid (Torino) 0.85 SC	3.4 oz/acre	0.02 lb/acre	0	4 hr	Do not make more than 2 applications per crop.
	fluopyram + tebuconazole (Luna Experience) 3.3 F	8 to 17 fl oz/acre	0.27 to 0.44 lb/acre	7	0.5	**APPLY ONLY TO WATERMELON.** Make no more than 2 applications before alternating to a fungicide with different active ingredients. Do not rotate with tebuconazole.
	myclobutanil (Rally) 40 WP	2.5 to 5 oz/acre	1 to 2 oz/acre	0	1	Apply no more than 1.5 lb per acre per crop. Observe a 30-day plant-back interval.
	penthiopyrad (Fontelis) 1.67 SC	12 to 16 fl oz/acre	0.16 to 0.21 lb/acre	1	0.5	Make no more than 2 sequential applications before switching to another fungicide. Do not rotate with Pristine or Luna Experience.
	pyraclostrobin + boscalid (Pristine) 38 WG	12.5 to 18.5 oz/acre	4.8 to 7 oz/acre	0	1	Make no more than 4 applications per season.
	quinoxyfen (Quintec) 2.08 SC	4 to 6 fl oz/acre	1 to 1.3 fl oz/acre	3	0.5	Make no more than 2 applications before alternating to a different fungicide. Maximum of 24 fl oz/acre per year. **DO NOT USE ON SUMMER SQUASH or CUCUMBER**; labeled on winter squashes, pumpkins, gourds, melon and watermelon.
	sulfur*	See label	—	0	1	Do not use when temperature is over 90°F or on sulfur-sensitive varieties.
	tebuconazole (Monsoon) 3.6F	4 to 6 fl oz/acre	1.5 to 2 lb/acre	7	0.5	Apply before disease appears when conditions favor development and repeat at 10- to 14-day intervals; max 24 fl oz per season.
	triflumizole (Procure) 50 WS	4 to 8 oz/acre	2 to 4 oz/acre	0	0.5	Begin applications at vining or first sign of disease, and repeat at 7- to 10-day intervals.
Scab	acibenzolar-S-methyl (Actigard) 50 WP	0.5 to 1 oz/acre	0.25 to 0.5 oz/acre	0	0.5	Apply to healthy, actively growing plants. Do not apply to stressed plants. Apply no more than 8 oz per acre per season.
	chlorothalonil (Bravo Weather Stik, Echo, Equus) 6 F	1.5 to 3 pt/acre	0.8 to 1.6 pt/acre	0	2	Spray at first appearance and then at 7- to 14-day intervals. Avoid late-season application after plants have reached full maturity.
	chlorothalonil + potassium phosphite (Catamaran) 5.27 SC	6 pints/acre	3.3 pints/acre	0	0.5	Apply no more than 50 pints per crop per acre per season. Do not apply to watermelon fruit when stress conditions conducive to sunburn occur.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-13. RELATIVE EFFECTIVENESS OF VARIOUS CHEMICALS FOR CUCURBIT DISEASE CONTROL*

L. M. Quesada-Ocampo, Plant Pathologist, NCSU; S. C. Bost, Plant Pathologist, UT; A. P. Keinath, Plant Pathologist, Clemson University; D. Langston, Plant Pathologist, UGA

Fungicide	Fungicide Group[1]	Preharvest Interval (Days)	Relative Control Rating "—" = ineffective; "+" ..... "+++++" = very effective; "?" = lacking efficacy data														
			Alternaria Leaf Spot	Angular Leafspot	Anthracnose	Bacterial Fruit Blotch	Belly Rot	*Cercospora* Leaf Spot	Cottony Leak	Damping-off (*Pythium*)	Downy Mildew	Gummy Stem Blight	*Phytophthora* Blight (foliage and fruit)	*Phytophthora* Blight (crown and root)	*Plectosporium* Blight	Powdery Mildew	Target Spot
acibenzolar-S-methyl (Actigard)	21	0	—	?	—	++	—	—	?	?	?	—	?	?	—	?	—
ametoctradin + dimethomorph (Zampro)	45 + 40	0	?	—	—	—	—	—	?	?	+++	—	++++	++++	—	—	—
azoxystrobin[3] (Quadris)	11	1	++++	—	++++	—	+++	++++	—	—	—[R]	—[R]	—	—	++	—[R]	++++
azoxystrobin + difenoconazole (Quadris Top)	11 + 3	1	?	—	+++	—	?	?	?	?	?	++	?	?	++	++	?
chlorothalonil[6] (Bravo/Terranil/ Equus)	M	0	++++	—	++	—	—	++++	—	—	+++	+++	—	—	+++	++	++++
cyazofamid (Ranman)	21	0	—	—	—	—	—	—	?	—	++++	—	++	—	—	—	—
cyflufenamid (Torino)	U6	0	—	—	—	—	—	—	—	—	—	—	—	—	—	+++++	—
cymoxanil (Curzate)	27	3	—	—	—	—	—	—	?	?	++	—	++	—	—	—	—
cyprodinil + fludioxonil (Switch)	9 + 12	1	?	—	+++	—	?	?	—	—	—	+++	—	—	++	++	—
difenoconazole + cyprodinil (Inspire Super)	3 + 9	7	?	—	?	—	—	?	—	—	—	+++	—	—	++	++	?
dimethomorph (Forum)	40	0	—	—	—	—	—	—	—	—	+	—	+	—	—	—	—
famoxadone[3] + cymoxanil (Tanos)	11 + 27	3	?	—	?	—	—	?	—	—	++	—	?	—	—	—	—
fenamidone (Reason)	11	14	++	—	—	—	—	—	?	—	+++[R]	—	++	—	—	—	—
fixed copper[6,8]	M	1	+	+++	+	+++	—	++	—	—	+	+	?	—	+	+	+
fluopicolide (Presidio)	43	2	—	—	—	—	—	—	—	—	++[R]	—	+++	+++	—	—	—
fluopyram + tebuconazole (Luna Experience)	7 + 3	7	?	—	++	—	?	—	—	—	—	++++	—	—	—	++++	—
fluopyram + trifloxystrobin (Luna Sensation)	7 + 11	0	?	—	+++	—	—	—	—	—	—	+++	—	—	—	++	—
kresoxim-methyl (Sovran)	11	0	?	—	?	—	?	?	—	—	?	—[R]	?	—	?	—[R]	?
mancozeb (Dithane, Manzate, Penncozeb)[6]	M	5	+++	—	+++	—	—	++++	—	—	+++	+	+	—	+++	+	++++
mancozeb + fixed copper[5] (ManKocide)	M + M	5	+++	++	+++	++	—	+++	—	—	+++	+	+	—	+++	+	+++
mandipropamid (Revus)	40	0	—	—	—	—	—	—	—	—	—[R]	—	+++	+	—	—	—
mefenoxam[4] (Ridomil Gold EC, Ultra Flourish)	4	0	—	—	—	—	—	—	++	++++	—	—	+++[R]	+++[R]	—	—	—
mefenoxam[3] + chlorothalonil[6] (Ridomil Gold/Bravo, Flouronil)	4 + M	0	+++	—	+++	—	—	++	+	—	+++[R]	+++	++[R]	—	++	++	++
mefenoxam[3] + copper[6] (Ridomil Gold/Copper)	4 + M	5	+	+	—	+	—	+	+	—	++[R]	+	++[R]	—	+	—	+
mefenoxam[3] + mancozeb[6] (Ridomil Gold MZ)	4 + M	5	++	—	++	—	—	++		—	+++[R]	++	++[R]	—	++	—	++
myclobutanil[3] (Rally)	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	++	—
penthiopyrad (Fontelis)	7	1	?	—	++	—	?	?	—	—	—	—[R]	—	—	—	++	—
phosphonate[11] (Aliette, Agri-Fos, Phostrol, ProPhyte)	33	0.5	—	—	—	—	—	—	—	—	—	—	—	++	—	—	—
potassium phosphite + tebuconazole (Viathon)	33 + 3	7	?	—	++	—	?	?	?	?	+	+++	?	?	—	++	—
propamocarb (Previcur Flex)	28	2	—	—	—	—	—	—	—	?	++	—		—	—	—	—
pyraclostrobin[3] (Cabrio)	11	0	++++	—	++++	—	—	?	—	—	—[R]	—[R]	+	—	++++	—[R]	+++++
pyraclostrobin[3] + boscalid[3] (Pristine)	11 + 7	0	++++	—	++	—	?	++++	—	—	—[R]	—[R]	+	—	+++	+++	+++++
quinoxyfen (Quintec)	13	3	—	—	—	—	—	—	—	—	—	—	—	—	—	+++++	—
sulfur[P,6,10]	M	0	—	—	—	—	—	—	—	—	—	—	—	—	—	++++	—
tebuconazole (Monsoon)	3	7	?	—	?	—	—	?	—	—	—	+++	—	—	—	++	—
thiophanate-methyl[4] (Topsin M)	1	0	++	—	++	—	++	++	—	—	—	++	—	—	++	—[R]	+
trifloxystrobin[3] (Flint)	11	0	++++	—	++++	—	?	?	—	—	—[R]	—[R]	—	—	++++	—[R]	++++
triflumizole (Procure)	3	0	—	—	—	—	—	—	—	—	—	—	—	—	—	++	—
zoxamide + mancozeb (Gavel)	22 + M	5	+++	—	++	—	—	+++	—	—	+++	++	+	—	++	+	+++

Key to Fungicide Groups: 1: methyl benzimidazole carbamates; 3: demethylation inhibitors; 4: phenylamides; 7: carboxamides, 11: quinone outside inhibitors; 15: cinnamic acids; 21: quinone inside inhibitors; 22: benzamides; 27: cyanoacetamide-oximes; 28: carbamates; 33: phosphonates; M: multi-site activity. See www.frac.info

[1] To prevent resistance in pathogens, alternate fungicides within a group with fungicides in another group. Fungicides in the "M" group are generally considered "low risk" with no signs of resistance developing to the majority of fungicides.

[2] Control cucumber beetle from emergence to fruit set; bactericidal sprays alone are not effective.

[3] Curative activity; locally systemic.

[4] Systemic.

[5] When used in combination with chlorothalonil or mancozetb, gives increased control.

[6] Contact control only; no systemic control.

[8] Fixed coppers include: Basicop, Champ, Champion, Citcop, Copper-Count-N, Kocide, Nu-Cop, Super Cu, Tenn-Cop, Top Cop with Sulfur, and Tri-basic copper sulfate.

[9] Applications should begin at bloom; after symptoms are observed on watermelon fruit, it is too late to begin a copper spray program.

[10] Sulfur products include: Kumulus, Liquid Sulfur Six, Microthiol, Sulfur DF, and Thiolux.

[11] Check manufacturers label for compatibility with other products.

[R] = pathogen resistance to this fungicide (or FRAC group) has been reported, greatly reducing its efficacy. Combine with a protectant fungicide like chlorothalonil to extend the usefulness of the product.

[P] = sulfur can be phytotoxic at temperatures above 90° F; read the label carefully.

*Ratings are based on field research in the Southeastern United States. Consult product labels for manufacturer's recommendations.

TABLE 3-14. RELATIVE IMPORTANCE OF ALTERNATIVE MANAGEMENT PRACTICES FOR DISEASE CONTROL IN CUCURBITS

L. Quesada-Ocampo, Plant Pathologist, NCSU; S. Bost, Plant Pathologist, UT; A. Keinath, Plant Pathologist, Clemson University; and D. Langston, Plant Pathologist, UGA

Scale: "0" = not important/does not impact disease, "5" = very important practice to implement/impacts disease greatly; "—" = not applicable; "?" = unknown.

	Disease																	
Management Tactic	***Alternaria* leaf blight**	**Angular leaf spot**	**Anthracnose**	**Bacterial fruit blotch**	**Bacterial wilt**	**Belly rot**	***Cercospora* leaf spot**	***Choanephora* fruit rot**	**Cottony leak**	**Downy mildew**	**Gummy stem blight**	**Mosaic virus**	***Phytophthora* blight**	***Plectosporium* blight**	**Powdery mildew**	***Pythium* damping-off**	**Root knot**	**Target spot**
Avoid field operations when leaves are wet	1	2	1	2	1	0	0	1	-	1	1	-	-	?	0	-	-	
Avoid overhead irrigation	1	2	1	3	1	-	1	-	-	1	2	-	2	1	1	-	-	1
Change planting date from Fall to Spring[a]	4	1	4	1	1	3	4	2	2	4	4	3	3	3	2	4	4	4
Change planting date within a season	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	2[a]	2	-
Cover cropping with antagonist	-	-	-	-	-	0	-	-	-	-	-	-	0	-	-	0	3	-
Crop rotation with non-host (2-3 years)	2	2	2	2	-	1	2	-	0	-	3	-	1	1	-	1	3	2
Deep plowing	1	-	1	-	-	3	1	-	0	-	2	-	1	1	-	1	2	1
Destroy crop residue immediately	2	1	2	1	1	1	1	-	1	2	2	2	1	1	2	-	2	1
Encourage air movement[b]	2	1	1	1	-	0	2	3	3	2	1	-	0	1	0	-	-	2
Soil organic amendments[c]	?	-	?	-	-	1	?	0	2	-	?	-	1	?	-	2	2	?
Insecticidal/horticultural oils[d]	0	0	0	0	0	-	0	0	-	0	0	3	-	0	3	-	-	0
pH management (soil)	-	-	-	-	-	-	-	-	?	-	-	-	?	-	-	?	?	-
Plant in well-drained soil	-	-	-	-	-	2	-	1	3	-	-	-	3	-	-	3	1	-
Plant on raised beds	-	-	-	-	-	1	-	1	2	-	-	-	2	-	-	2	1	-
Plastic mulch bed covers	-	-	-	-	-	2	-	1	2	-	-	-	2	1	-	-	0	-
Postharvest temperature control (fruit)	-	-	2	2	-	2	-	3	2	-	2	-	2	2	-	-	-	-
Reflective mulch (additional effect over plastic mulch)	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Reduce mechanical injury	1	1	1	1	2	1	1	1	1	-	1	1	1	1	-	-	-	1
Rogue diseased plants/fruit (home garden)	1	1	1	1	1	-	1	1	1	1	1	2	2	-	-	1	3	1
Row covers (insect exclusion)	-	-	-	-	4	-	-	-	-	-	-	4	-	-	-	-	-	-
Soil solarization (reduce soil inoculum)	1	0	1	0	0	3	1	0	1	-	1	-	1	1	-	2	1	1
Pathogen-free planting material	1	5	2	5	-	-	-	-	-	-	3	-	-	-	-	2	-	-
Resistant cultivars	*	*	**	*	*	**	*	*	*	**	*	**	*	*	**	0	0	*
Destroy volunteer plants	2	2	2	2	2	-	2	-	-	3	2	3	2	-	3	-	1	2

[a] Early planting reduces risk.

[b] Air movement can be encouraged by increasing plant spacing, orienting beds with prevailing wind direction and increasing exposure of field to prevailing wind.

[c] Soil organic amendments = cover crops; composted organic wastes.

[d] Insecticidal/Horticultural oil = Sunspray Ultra-Fine Spray Oil (Sun Company, Inc.), JMS Stylet oil; Safe-T-Side (Brandt Consolidated, Inc.); PCC 1223 (United Ag Products).

*Cucurbits differ in susceptibility; no resistance within cucurbit types.

**Cucurbits differ in susceptibility; resistance available within cucurbit types.

TABLE 3-15. DISEASE CONTROL FOR EGGPLANT

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
D. Langston, Plant Pathologist, UGA						
Leaf blights, fruit rots	azoxystrobin (Amistar, Quadris) 2.08 F	11 to 15.4 fl oz/acre	0.18 to 0.25 lb/acre	1	4 hr	Make no more than one application before alternating with a fungicide with a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	fenamidone (Reason)	5.5 to 8.2 fl oz/acre	0.178 to 0.267 fl oz/ acre	14	12	Apply as soon as conditions are favorable for disease development and continue on a 5 – 7 day spray interval.
	fixed copper*	See label		0	2	Spray as fruit starts to form or earlier; then 10-day intervals.
	mancozeb*	2 to 3 lb/acre	1.6 to 2.4 lb/acre	5	1	Apply no more than 24 lb per acre per season.
	chlorothalonil	1.5 pt/acre	1.125 lb/acre	3	0.5	Use prior to disease onset.
	azoxystrobin + difenoconazole (Quadris Top)	12 to 14 fl oz	0.25 to 0.3 lb/acre	0	0.5	Begin applications prior to disease onset and spray on a 7-10 day interval.
	boscalid (Endura)	2.5 to 3.5 oz/acre	1.75 to 2.45 oz/acre	0	0.5	Use prior to disease onset.
	penthiopyrad (Fontelis)	10 to 24 fl oz/acre	0.13 to 0.31	0	12 hr	Use prior to disease onset.
	pyraclostrobin + fluxapyroxad (Priaxor)	4.0 to 8.0 fl oz/acre	0.13 to 0.26 lb/acre	7	12 hr	Use preventively.
Phytophthora blight	dimethomorph (Acrobat, Forum) 50 WP	6.4 oz/acre	3.2 oz/acre	4	0.5	Suppression only; must be tank-mixed with another fungicide active against *Phytophthora* blight. Do not make more than 2 sequential applications before alternating to another effective fungicide with a different mode of action. Begin applications when plants are 4 to 6 in. high. Do not make more than 5 applications per season.
	amectoctradin + dimethomorph (Zampro)	14.0 fl oz	0.27 lb/acre	4	12 hr	Use prior to disease development. Use a 5 – 7 day treatment interval depending on disease pressure.
	mefenoxam (Ridomil Gold) 4 SL (Ultra Flourish) 2 EC	 1 pt/trt acre 2 to 4 pt/trt acre	 0.5 lb/trt acre 0.5 to 1 lb/trt acre	—	0.5	Apply to 18-in. band at seeding. See label for row rates. Do not exceed 12 pt/acre. Band over roots 30 and 60 days later. Do not apply to foliage.
	metalaxyl (MetaStar) 2 E	4 to 8 pt/trt acre	0.5 to 1 lb/acre	7	2	Preplant (soil incorporated), at planting (in water or liquid fertilizer) or as a basal-directed spray after planting.
Powdery mildew	azoxystrobin (Amistar, Quadris) 2.08 F	6.2 to 15.4 fl oz/acre	0.10 to 0.25 lb/acre	0	4 hr	Do not make more than two sequential applications.
	pyraclostrobin (Cabrio) 20 WG	8 to 12 oz/acre	1.6 to 2.4 oz/acre	0	0.5	Do not make more than two applications before alternating to a fungicide with a different mode of action.
	sulfur*	See label		0	1	Spray at first appearance, 7- to 10-day intervals.
Southern blight *(Sclerotium rolfsii)*	fluoxastrobin (Evito) 480 SC	3.8 to 5.7 fl oz/ acre	0.12 to 0.18 lb/acre		4 hr	See label for details.
	pyraclostrobin + fluxapyroxad (Priaxor)	4.0 to 8.0 fl oz/acre	0.13 to 0.26 lb/acre	7	12 hr	Use preventively.
	penthiopyrad (Fontelis)	10 to 24 fl oz/acre	0.13 to 0.31	0	12 hr	Use prior to disease onset.
Pythium damping-off	mefenoxam (Ridomil Gold) 4 SL (Ultra Flourish) 2 EC	 1 to 2 pt/trt acre 2 to 4 pt/trt acre	0.5 to 1 lb/trt acre	—	2	Apply preplant and incorporate. See label for row rates.
	metalaxyl (MetaStar) 2 E	4 to 8 pt/trt acre	0.5 to 1 lb/acre	7	2	Preplant (soil incorporated), at planting (in water or liquid fertilizer).
Rhizoctonia seedling rot	azoxystrobin (Amistar, Quadris) 2.08 F	0.4 to 0.8 fl oz/1,000 row feet	0.006 to 0.013 lb/1,000 row feet	—	4 hr	Make in-furrow or banded applications shortly after plant emergence.
Verticillium wilt	chloropicrin 100%	5 to 8 gal/acre	5 to 8 gal/acre	—	—	Fumigate soil in-the-row 3 to 6 weeks before planting. Based on 42-in. rows.
	metam-sodium (Vapam; Sectagon)	32.5 to 75 gal/acre	160 to 320 lb/acre	—	2	Rate is based on soil properties and depth of soil to be treated; apply 14 to 21 days before planting.
	dichloropropene (Telone) C-17 C-35	10 gal/acre row 13 to 20.5 gal/acre	10 gal/acre row 139 to 220 lb/acre	—	5	Rate is based on soil type; see label for in-row rates.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-16. ALTERNATIVE MANAGEMENT TOOLS–EGGPLANT

D. Langston, Plant Pathologist, UGA

Disease	Resistant Varieties	Non-chemical Controls
Damping-off	No	Use raised beds to dry soil surface.
Fusarium wilt	Yes	Solarize soil before planting, use 3 year rotation, adjust pH to 6.5 and use all nitrate nitrogen.
Powdery mildew	No	Spray with sulfur at first appearance of disease.
Verticillium wilt	No	Solarize soil before planting.

TABLE 3-17. DISEASE CONTROL FOR ENDIVE

E. Sikora, Plant Pathologist, Auburn University

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Downy mildew	azoxystrobin (Quadris) 2.08 F	12.3 to 15.4 fl oz/ acre	0.2 to 0.25 fl oz/ acre	0	4 hr	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	cymoxanil/famoxadone (Tanos)	8.0 oz	0.178 to 0.267 fl oz	3	0.5	See label for directions.
	dimethomorph (Acrobat, Forum) 50 WP	6.4 oz/acre	3.2 oz/acre	0	0.5	Must be applied as a tank mix with another fungicide active against downy mildew. Do not make more than two sequential applications.
	fenamidone (Reason 500 SC)	5.5 to 8.2 fl oz	0.178 to 0.267 fl oz	2	0.5	Alternate with fungicides with a different mode of action.
	fosetyl-Al (Aliette) 80 WDG Legion 80WDG, Linebacker WDG	2 to 5 lb/acre	1.6 to 4 lb/acre	3	0.5	Do not mix with surfactants, foliar fertilizers, or products containing copper.
	fluopicolide (Presidio)	3 to 4 fl oz/acre	0.178 to 0.267 fl oz	2	0.5	Must be tank-mixed with a fungicide with a different mode of action. Do not exceed two sequential applications.
	mandipropamid (Micora)	5.5 to 8 fl oz/A	0.65 to 0.9 fl oz/A	---	4 hr	Tank mix Micora with a non-Group 40 fungicide and begin applications prior to disease development. **DO NOT** apply more than two applications per crop, or in consecutive applications.
	mandipropamid (Revus) 2.08 F	8 fl oz/acre	0.13 lb/acre	1	0.5	Apply prior to disease development and continue throughout season at 7- to 10-day intervals; maximum 32 fl oz per season.
	Pyraclostrobin (Cabrio)	12 to 16 oz/acre	0.1 to 0.20oz/acre	0	0.5	
Gray mold rot	dichloran (Botran 75-W)	2 2/3 lb/acre	1.5 to 2 lb a.i.	14	0.5	Apply 7 days following transplanting. Repeat application when plants are half mature. Do not apply to wilted plants or seedlings. Two applications may be applied per season.
	penthiopyrad (Fontelis)	14 to 24 fl oz/acre	-------	0	0.5	Begin applications before disease development. **DO NOT** make more than two sequential applications before switching to a fungicide with a different mode of action.
Leaf spots	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz	0.1 to 0.25 fl oz	0	4 hr	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	Cyprodinil/fludioxonil (Switch 62.5 WDG)	11 to 14 oz/acre	6.9 to 8.8 fl oz	0	0.5	Switch also has activity against basal rot, *Sclerotinia* and Gray mold. Alternate with a fungicide with a different mode of action after 2 applications.
	penthiopyrad (Fontelis)	14 to 24 fl oz/acre	-------	0	0.5	Begin applications before disease development. **DO NOT** make more than two sequential applications before switching to a fungicide with a different mode of action.
	Pyraclostrobin (Cabrio)	12 to 16 oz/acre	0.15 to 0.20 oz/acre	0	0.5	
Lettuce drop	penthiopyrad (Fontelis)	14 to 24 fl oz/acre	-------	0	0.5	Begin applications before disease development. **DO NOT** make more than two sequential applications before switching to a fungicide with a different mode of action.
Powdery mildew	penthiopyrad (Fontelis)	14 to 24 fl oz/acre	-------	0	0.5	Begin applications before disease development. **DO NOT** make more than two sequential applications before switching to a fungicide with a different mode of action.
	Quinoxyfen (Quintec)	6 fl oz		1	1	Alternate with fungicide with a different mode of action
	sulfur (Microthiol Disperss)	4 to 6 lb/acre	3.2 to 4.6 lb a.i.	14	0.5	Apply at early leaf stage and repeat every 10 to 14 days or as needed. Do not apply if temperatures are expected to exceed 90°F within 3 days of application due to the risk of crop injury.
	Triflumizole (Procure 480 SC)	6 to 8 fl oz/acre	3 to 6 fl oz	0	0.5	Applications should begin prior to disease development. Repeat on a 14-day schedule. Do not apply more than 18 fl oz per acre per season.
Pythium damping-off	mefenoxam (Ridomil Gold GR) (Ridomil Gold) 4 SL (Ultra Flourish) 2 EC	 20 to 40 lb/acre 1 to 2 pt/trt acre 2 to 4 pt/trt acre	 1 to 2 lb/acre 0.5 to 1 lb/trt acre 0.5 to 1 lb/trt acre	 — — —	 — 2 2	Soil-incorporate at planting. Use proportionally less for band rate. Apply preplant incorporated or surface application at planting.
	metalaxyl (MetaStar) 2 E	4 to 8 pt/trt acre	0.5 to 1 lb/trt acre	—	2	Banded over the row, preplant incorporated, or injected with liquid fertilizer.
Rust	penthiopyrad (Fontelis)	14 to 24 fl oz/acre	-------	0	0.5	Begin applications before disease development. **DO NOT** make more than two sequential applications before switching to a fungicide with a different mode of action.
	sulfur (Microthiol Disperss)	4 to 6 lb/acre	3.2 to 4.6 lb a.i.	14	1	Apply at early leaf stage and repeat every 10 to 14 days or as needed. Do not apply if temperatures are expected to exceed 90°F within 3 days of application due to the risk of crop injury.

TABLE 3-18. ALTERNATIVE MANAGEMENT TOOLS–ENDIVE

E. Sikora, Plant Pathologist, Auburn University

Disease	Resistant Varieties	Non-chemical Controls
Leaf spots, Drop (*Sclerotinia*)	No	
Powdery mildew	No	Spray with sulfur at first appearance of disease.
Rust	No	
Bottom rot (*Rhizoctonia*)	No	Use raised beds to dry soil surface.
Drop *(Sclerotinia)*	No	Use raised beds to dry soil surface.

TABLE 3-19. DISEASE CONTROL FOR GARLIC

D. Langston, Plant Pathologist, UGA

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Botrytis blight, purple blotch, downy mildew	azoxystrobin (Amistar, Quadris) 2.08 F	6.2 to 15.4 fl oz/acre	0.10 to 0.25 lb/acre	0	4 hr	Use upper rate for Downy mildew and *Botrytis*. Do not make more than two sequential applications.
	azoxystrobin + difenoconazole (Quadris Top)	14 fl oz/acre	2.38 lb/acre	7	0.5	Begin sprays prior to disease onset and spray on a 7-14 day schedule. Do not rotate with Group 11 fungicides.
	fluazinam (Omega 500)	1.0 pt/acre	0.52 lb/acre	7	2	Initiate sprays when conditions are favorable for disease or at disease onset. Spray on a 7-10 day schedule.
	boscalid (Endura) 70 WG	6.8 oz/acre	4.8 oz/acre	7	0.5	Not for Downy mildew. Do not make more than 2 sequential applications or more than 6 applications per season.
	chlorothalonil (Bravo Ultrex) 82.5 WDG	1.4 to 2.7 lb/acre	1.1 to 2.2 lb/acre	7	2	Spray at first appearance, 7- to 14-day intervals.
	difenoconazole + cyprodinil (Inspire Super)	16 to 20 fl oz/acre		14	0.5	Make no more than two applications before alternating with a fungicide with a different mode of action.
	fluopicolide (Presidio) 4F	3 to 4 fl oz/acre	0.09 to 0.125 lb/acre	2	0.5	For *Botrytis* and Downy mildew; tank mix with another fungicide with a different mode of action.
	mefenoxam + mancozeb (Ridomil Gold MZ)	2.5 lb/acre	—	7	2	
	mefenoxam + chlorothalonil (Ridomil Gold/Bravo)	2 lb/acre	—	7	2	Spray at first appearance, 7- to 14-day intervals.
	pyraclostrobin (Cabrio) 20 WG	8 to 12 oz/acre	1.6 to 2.4 oz/acre	7	0.5	Not for *Botrytis*. Use highest rate for Downy mildew. Make no more than 2 sequential applications and no more than 6 applications per season.
	pyraclostrobin + boscalid (Pristine) 38 WG	10.5 to 18.5 oz/acre	4 to 7 oz/acre	7	1	Use highest rate for suppression only on Downy mildew. Make no more than 6 applications per season.
	pyrimethanil (Scala) 5 F	9 or 18 fl oz/acre	0.35 or 0.7 lb/acre	7	0.5	Not for Downy mildew. Use lower rate in a tank mix with broad spectrum fungicide and higher rate when applied alone. Do not apply more than 54 fl oz per crop.
	tebuconazole (Folicur) 3.6F	4 to 6 fl oz/acre	1.5 to 2 lb/acre	7	0.5	Only labeled for purple blotch; apply before disease appears when conditions favor purple blotch development and repeat at 10- to 14-day intervals; maximum 32.5 fl oz per season.
Downy mildew	dimethomorph (Acrobat, Forum) 50 WP	6.4 oz/acre	3.2 oz/acre	0	0.5	Must be applied as a tank mix with another fungicide active against downy mildew. Do not make more than two sequential applications.
White rot *(Sclerotium)*	azoxystrobin (Amistar, Quadris) 2.08 F	6.2 to 12.3 fl oz/acre	0.10 to 0.20 lb/acre	0	4 hr	Do not make more that two sequential applications.
	iprodione (Rovral) 50 WP	4 lb/acre	2 lb/acre	—	1	Spray cloves as they are being covered by soil (38- to 40-in. bed spacing). One application per year.
	metam-sodium (Vapam; Sectagon)	37.5 to 75 gal/acre	160 to 320 lb/acre	—	2	Rate is based on soil properties and depth of soil to be treated.
	PCNB (Terraclor)	27.5 lb/100 gal	20.6 lb/100 gal	—	0.5	Apply as in-furrow spray at planting.
	tebuconazole (Folicur) 3.6F	20.5 fl oz/acre	8 lb/acre	7	0.5	Apply in 4 to 6 inch band over/into furrow; maybe applied in chemigation.

TABLE 3-20. ALTERNATIVE MANAGEMENT TOOLS–GARLIC

D. Langston, Plant Pathologist, UGA

Disease	Resistant Varieties	Non-chemical Controls
Purple blotch	No	Spray with sulfur, solarize soil 2 weeks prior to planting.
Downy mildew	No	Copper spray at first appearance. Remove and destroy severely infected plants, rotate and destroy residue.

Disease	Resistant Varieties	Non-chemical Controls
White rot (*Sclerotium*)		Use raised beds to dry soil surface.
Powdery mildew	No	
Garlic (bulb & stem nematode)		Use raised beds to dry soil surface.

TABLE 3-21. DISEASE CONTROL FOR GREENS, LEAFY BRASSICA

N. Dufault, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Leafy Brassica Greens **(Collard, Kale, Mustard, Rape, Turnip)**						
Alternaria leaf spot, *Various* foliar diseases (see specific labels)	boscalid (Endura) 70 WG	6 to 9 oz/acre	4.2 to 6.3 oz/acre	14	0.5	Begin applications prior to disease development, and continue on a 7- to 14-day interval. Make no more than 2 applications per season. Not labeled for turnip.
	azoxystrobin + difenoconazole (Quadris Top)	12 to 14 fl oz/acre	3.5 to 4.1 oz/acre	1	0.5	Make no more than one application before alternating to another fungicide with Group 11 mode of action (NOT Quadris or Cabrio).
	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 lb/acre	0	4 hr	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. May be applied to turnip grown for roots.
	pyraclostrobin (Cabrio) 20 WG	12 to 16 oz/acre 8 to 12 oz/acre (turnip)	2.4 to 3.2 oz/acre 1.6 to 2.4 oz/acre	3	0.5	Begin applications prior to disease development and continue on a 7-10 day interval. Make no more than 2 sequential applications before alternating to a fungicide with a different mode of action. Cabrio can only be used for turnip harvested for leaves. Cabrio cannot be used for turnip grown for roots.
	tebuconazole (Folicur) 3.6 F	3 to 4 oz/acre	1.4 to 1.8 oz/acre	7	0.5	For optimum results use as a preventative treatment. Folicur 3.6 F must have 2-4 hours of drying time on foliage for the active ingredient to move systemically into plant tissue before rain or irrigation occurs. For use on turnip where leaves only will be harvested. Not for use on turnip grown for roots.
	cyprodonil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.7 oz/acre	7	0.5	Apply when disease first appears, and continue on 7- to 10-day intervals. See label for complete list of greens.
Alternaria leaf spot, *Botrytis* gray mold, Powdery mildew, *Sclerotinia* stem rot	penthiopyrad (Fontelis)	14 to 30 fl oz/acre	2.9 to 6.2 oz/acre	0	0.5	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. May be applied to turnips grown for roots.
Alternaria leaf spot, Anthracnose, *Cercospora* leaf spot, Powdery mildew, *Botrytis* gray mold	difenoconazole + cyprodinil (Inspire Super)	16 to 20 fl oz/acre	5.2 to 6.5 oz/acre	7	0.5	Make no more than two sequential applications before alternating to a fungicide with a different mode of action.
Downy Mildew	pyraclostrobin (Cabrio) 20 WG	12 to 16 oz/acre	2.4 to 3.2 oz/acre	3	0.5	Begin applications prior to disease development and continue on a 7-10 day interval. Make no more than 2 sequential applications before alternating to a fungicide with a different mode of action.
	fluopicolide (Presidio) 4F	3 to 4 fl. oz/acre	0.09 to 0.125 lb/acre	2	0.5	Make applications on a 7-10 day schedule. Presidio must be tank mixed with another fungicide with a different mode of action. Make no more than 2 sequential applications before rotating to a fungicide with a different mode of action. Apply no more than 12 oz per acre per season.
	cyazofamid (Ranman)	2.75 fl. oz/acre	0.072 lb/acre	0	0.5	Make applications on a 7-10 day schedule. Do not apply more than 39.5 fl. oz/acre per crop growing season.
	mandipropamid (Revus) 2.08 F	8.0 fl oz/acre	0.13 lb/acre	1	0.5	Begin applications prior to disease development and continue on a 7-10 day interval. Make no more than 2 consecutive applications before switching to another effective non-group 40 fungicide. Not labeled for turnip.
	fenamidone (Reason) 500 SC	5.5 to 8.2 oz/acre	0.178 to 0.267 lb/ acre	2	0.5	Begin applications as soon as conditions become favorable for disease development. Applications should be made on a 5-10 day interval. Do not make more than one application of Reason 500 SC before alternating with a fungicide from a different resistance management group.
	amectoctradin + dimethomorph (Zampro)	14 fl oz/acre	6.6 oz/acre	0	0.5	Do not make more than two sequential applications before alternating to a fungicide with a different mode of action. Addition of an adjuvant may improve performance (see label for specifics).
	dimethomorph (Acrobat, Forum) 50 WP	6.4 oz/acre	3.2 oz/acre	0	0.5	Must be tank-mixed with another fungicide active against *Phytophthora* blight. Do not make more than 2 sequential applications before alternating to another effective fungicide with a different mode of action. Do not make more than 5 applications per season. Not labeled for turnip.
	fosetyl-Al (Aliette) 80 WDG	2 to 5 lb/acre	1.6 to 4 lb/acre	3	1	Apply when disease first appears; then repeat on 7- to 21-day intervals. Do not tank mix with copper fungicides. A maximum of seven applications can be made per season. Not labeled for turnip.

TABLE 3-21. DISEASE CONTROL FOR GREENS, LEAFY BRASSICA (cont'd)

N. Dufault, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Leafy Brassica Greens **(Collard, Kale, Mustard, Rape, Turnip)**						
Powdery mildew	boscalid (Endura) 70 WG	6 to 9 oz/acre	4.2 to 6.3 oz/acre	14	0.5	Begin applications prior to disease development, and continue on a 7- to 14-day interval. Make no more than 2 applications per season; disease suppression only. Not labeled for turnip.
	pyraclostrobin (Cabrio) 20 WG	12 to 16 oz/acre	2.4 to 3.2 oz/acre	3	0.5	Begin applications prior to disease development and continue on a 7-10 day interval. Make no more than 2 sequential applications before alternating to a fungicide with a different mode of action. Cabrio can only be used for turnip harvested for leaves. Cabrio cannot be used for turnip grown for roots.
	triflumizole (Procure) 480 SC	6 to 8 oz/acre	2.5 to 3.4 oz/acre	1	0.5	Make no more than two sequential applications before rotating with a fungicide with a different mode of action. Do not rotate with Rally or Nova.
	cyprodonil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.7 oz/acre	7	0.5	Apply when disease first appears, and continue on 7- to 10-day intervals. See label for complete list of greens. For use on turnip where leaves only will be harvested. Not for use on turnip grown for roots.
	tebuconazole (Folicur) 3.6 F	3 to 4 oz/acre	1.4 to 1.8 oz/acre	7	0.5	For optimum results use as a preventative treatment. Folicur 3.6 F must have 24 hours of drying time on foliage for the active ingredient to move systemically into plant tissue before rain or irrigation occurs. Can be applied to turnip grown for roots.
Rhizoctonia bottom rot	boscalid (Endura) 70 WG	6 to 9 oz/acre	4.2 to 6.3 oz/acre	14	0.5	Begin applications prior to disease development, and continue on a 7- to 14-day interval. Make no more than 2 applications per season; disease suppression only. Not labeled for turnip.
Sclerotinia stem rot (white mold)	boscalid (Endura) 70 WG	6 to 9 oz/acre	4.2 to 6.3 oz/acre	14	0.5	Begin applications prior to disease development, and continue on a 7- to 14-day interval. Make no more than 2 applications per season. Not labeled for turnip.
Seedling root rot, basal stem rot (*Rhizoctonia*)	azoxystrobin Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 lb/acre	0	4 hr	Make no more than two sequential applications.
White rust, *Alternaria* leaf spot, *Cercospora* leaf spot	fenamidone (Reason) 500 SC	8.2 oz/acre	0.267 lb/acre	2	0.5	Begin applications as soon as conditions become favorable for disease development. Applications should be made on a 5-10 day interval. Do not make more than one application of Reason 500 SC before alternating with a fungicide from a different resistance management group.
	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 lb/acre	0	4 hr	Make no more than two sequential applications.

TABLE 3-22. ALTERNATIVE MANAGEMENT TOOLS–GREENS (MUSTARD AND TURNIP)

N. Dufault, Plant Pathologist, UF; and S. Bost, Plant Pathologist, UT

Disease	Resistant Varieties	Non-chemical Controls
GREENS (Mustard)		
Alternaria	No	Spray with copper at first sign of disease.
Black rot	No	Spray with copper at first sign of disease.

Disease	Resistant Varieties	Non-chemical Controls
GREENS (Turnip)		
Anthracnose	No	Spray with copper at first sign of disease.

TABLE 3-23. DISEASE CONTROL FOR JERUSALEM ARTICHOKE

A. Keinath, Plant Pathologist, Clemson University

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Pythium damping-off	mefenoxam (Ridomil Gold) 4 SL	1 to 2 pt/treated acre	0.5 to 1 lb/treated acre	1	2	Soil incorporation. See label for row rates.
	fluopicolide (Presidio)	3 to 4 fl oz/acre	0.09 to 0.125 lb/acre	7	0.5	Do not use more than 2 times sequentially and not more than 4 times at the low rate or 3 times at the high rate per acre per season.
Southern blight	azoxystrobin (Quadris 2.08 F)	0.4 to 0.8 fl oz/1000 row ft	0.1 to 0.2 oz/ 1000 row ft	14	4 hr	
Rust	azoxystrobin (Quadris 2.08 F)	6.2 to 20.3 fl oz/ acre	1.6 to 4 oz/acre	14	4 hr	
Powdery mildew, *Cercospora* leaf spot	azoxystrobin (Quadris 2.08 F)	9.2 to 15.4 fl oz/ acre	2.4 to 4 oz/acre	14	4 hr	
White mold (*Sclerotinia* basal stalk rot)	Endura	10 oz/acre	7 oz/acre	30	0.5	2 applications per crop per season at 10 oz/acre

TABLE 3-24. DISEASE CONTROL FOR LETTUCE

G. Vallad, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Bottom rot (*Rhizoctonia*), drop (*Sclerotinia*)	azoxystrobin (Amistar, Quadris) 2.08 F	0.4 to 0.8 fl oz/1,000 row feet	0.006 to 0.013 lb	—	4 hr	*Rhizoctonia* only. Make in-furrow or banded applications shortly after plant emergence.
	boscalid (Endura) 70 WG	8 to 11 oz/acre	5.6 to 7.7 oz/acre	14	0.5	Suppression only on Bottom rot. Apply immediately after emergence or immediately after transplanting. Make no more than 2 applications per season.
	dicloran (Botran) 75 W	2 to 5.3 lb/acre	1.5 to 4 lb/acre	14	0.5	Rate depends on timing; 5.3 lb per crop per season maximum.
	iprodione (Rovral) 50 WP	1.5 to 2 lb/acre	0.75 to 1 lb/acre	14	1	Tank mix with another fungicide with a different mode of action.
	penthiopyrad (Fontelis)	14 to 24 fl oz/acre	0.18 to 0.31 lb/acre	0	0.5	Begin applications prior to disease development on a 7 to 14 day schedule. Do not exceed 72 fl oz of product per year. Make no more than 2 sequential applications per season before rotating to another effective product with a different mode of action.
Botrytis rot	boscalid (Endura) 70 WG	8 to 11 oz/acre	5.6 to 7.7 oz/acre	14	0.5	Make no more than 2 applications per season.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	0.43 to 0.55 lb/acre	0	0.5	Limit 56 oz per acre per year. After 2 applications, rotate to another fungicide with a different mode of action for 2 applications.
	dicloran (Botran) 75 W	1.5 to 2.6 lb/acre 1 to 2 pt/treated acre	1.1 to 2 lb/acre	14	0.5	Apply when disease is anticipated.
	fludioxonil (Cannonball) 50 WP	7 oz	3.5 oz	0	0.5	Alternate with another effective fungicide after two applications. Limit is 28 oz (0.9 lbs fludioxonil) per acre per year.
	fluopicolide (Presidio) 4F	3 to 4 fl oz/acre	0.09 to 0.125 lb/ acre	2	0.5	Tank mix with another fungicide with a different mode of action.
Damping-off (*Pythium*)	cyazofamid (Ranman)	2.75 fl oz/acre	0.071 lb/acre	0	0.5	Apply to soil as a directed post-transplant or post-planting within 24 hours of transplanting or seeding. Apply as a 4 to 6 inch band across transplants or seed line.
	mefenoxam (Ridomil Gold GR)	20 to 40 lb/acre	0.5 to 1 lb/acre	—	2	Preplant incorporated.
	(Ridomil Gold) 4 SL	1 to 2 pt/treated A	0.5 to 1 lb/acre	—	0.5	Apply preplant incorporated or surface application at planting.
	(Ultra Flourish) 2 EC	2 to 4 pt/treated A	0.5 to 1 lb/acre	—	0.5	
	metalaxyl (MetaStar) 2 E	4 to 8 pt/treated acre	0.5 to 1 lb/acre	—	2	Banded over the row, preplant incorporated, or injected with liquid fertilizer.
Downy mildew	propamocarb (Previcur Flex) 6 F	12.8 fl oz/100 gal water	0.6 lb/100 gal	2	0.5	Rates based on rock wool cube saturation in the greenhouse. See label for use in seed beds, drip system, and soil drench.

TABLE 3-24. DISEASE CONTROL FOR LETTUCE (cont'd)

G. Vallad, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Downy mildew (cont'd)	acibenzolar-S-methyl (Actigard) 50WG	0.75 to 1 oz/acre	0.375 to 0.5 oz/acre	7	0.5	Do not apply prior to thinning or within 5 days after transplanting. Apply preventatively every 7-10 days, not to exceed four applications (4 oz) per a season.
	ametoctradin + dimethomorph (Zampro)	14 fl oz/acre	0.48 lb/acre	0	0.5	Do not make more than 2 sequential applications before alternating to another effective fungicide with a different mode of action. Addition of a spreading/ penetrating adjuvant is recommended. Do not exceed 42 fl oz per acre per season.
	cyazofamid (Ranman)	2.75 fl oz/acre	0.071 lb/acre	0	0.5	Limit is 16.5 fl oz per acre per season.
	cymoxanil (Curzate) 60 DF	3.2 to 5.0 oz/acre	1.92 to 3.0 oz/acre	3	0.5	Use only in combination with a protectant fungicide. Apply on a 5 – 7 day schedule, not to exceed 30 oz/ acre per a 12 month period.
	dimethomorph (Acrobat, Forum) 50 WP	6.4 oz/acre	3.2 oz/acre	0	0.5	Must be applied as a tank mix with another fungicide active against downy mildew. Do not make more than two sequential applications.
	famoxadone + cymoxanil (Tanos) 50WP	8 oz/acre	4 oz/acre	3	0.5	Not for Gummy stem blight or leaf lettuce. Do not make more than one application before alternating with a fungicide that has a different mode of action. Must be tank-mixed with contact fungicide with a dif- ferent mode of action.
	fenamidone (Reason) 500 SC	5.5 to 8.2 fl oz/acre	0.178 to 0.267 lb/ acre	2	0.5	Begin applications when conditions favor disease development, and continue on 5- to 10-day interval. Do not apply more than 24.6 fl oz per growing sea son. Alternate with fungicide with different resistance management group.
	fluopicolide (Presidio)	3 to 4 fl oz/acre	0.09 to 0.125 lb/ acre	2	0.5	Tank mix with another downy mildew fungicide with a different mode of action.
	mandipropamid (Revus) 2.08F	8 fl oz/acre	0.13 lb/acre	1	0.5	Apply prior to disease development and continue throughout season at 7- to 10-day intervals; maximum 32 fl oz per season.
Downy mildew, leaf spots	propamocarb (Previcur Flex) 6 F	2 pt/acre	1.5 lb/acre	2	0.5	Do not apply more than 8 pt per growing season; begin applications before infection, and continue on a 7- to 10-day interval.
	azoxystrobin (Amistar, Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 fl oz/ acre	7	4 hr	Use highest rate for downy mildew. Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	fixed copper*	1.5 to 3 pt/acre	—	0	0.5	
	fosetyl-Al (Aliette) 80 WDG	2 to 5 lb/acre	1.6 to 4 lb/acre	3	1	Spray at first appearance of disease and continue on a 7- to10-day interval.
	pyraclostrobin (Cabrio)	12 to 16 oz/acre	0.15 to 0.2 lb/acre	0	0.5	Do no make more than 2 sequential applications before alternating to another effective fungicide with a different mode of action.
	mancozeb (Manzate Pro-Stick) 75 WDG	1.6 to 2.1 lb/acre	1.2 to 1.6 lb/acre	10	1	Spray at first appearance of disease and continue on a 7- to10-day interval. No more than 12.8 lbs/ acre per season.
	penthiopyrad (Fontelis)	14 to 24 fl oz/acre	0.18 to 0.31 lb/acre	0	0.5	Begin applications prior to disease development on a 7 to 14 day schedule. Do not exceed 72 fl oz of product per year. Make no more than 2 sequential applications per season before rotating to another effective product with a different mode of action.
Sclerotinia rot	fludioxonil (Cannonball) 50 WP	7 oz	3.5 oz	0	0.5	Make first application at transplanting or thinning, with a second application two weeks later if necessary. Alternate with another effective fungicide after two applications. Limit is 28 oz (0.9 lbs fludioxonil) per acre per year.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	0.43 to 0.55 lb/acre	0	0.5	Make first application after thinning and again two weeks later. Limit 56 oz per acre per year. After 2 ap- plications, rotate to another fungicide with a different mode of action for 2 applications.

TABLE 3-24. DISEASE CONTROL FOR LETTUCE (cont'd)

G. Vallad, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Powdery mildew	azoxystrobin (Amistar, Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 fl oz/ acre	7	4 hr	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	myclobutanil (Rally) 40 WSP	5 oz/acre	0.31 lb/acre	3	1	Apply when disease first appears and continue on a 14 day interval. Apply no more than 20 oz (4 applications) per season.
	penthiopyrad (Fontelis)	14 to 24 fl oz/acre	0.18 to 0.31 lb/acre	0	0.5	Begin applications prior to disease development on a 7 to 14 day schedule. Do not exceed 72 fl oz of product per year. Make no more than 2 sequential applications per season before rotating to another effective product with a different mode of action.
	quinoxyfen (Quintec)	4 to 6 fl oz/acre	1.0 to 1.6 oz/acre	1	0.5	Apply preventatively on a 10 to 14 day interval, making no more than 4 applications (24 fl oz) per a season.
	triflumizole (Procure) 480 SC	6 to 8 fl oz/acre	3 to 4 oz/acre	0	0.5	Apply when disease first appears and continue on 14 day interval. Do not exceed 18 fl oz per season.
	sulfur*	5 to 6 lb/acre	2 to 4 lb/acre	0	1	

* See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-25. ALTERNATIVE MANAGEMENT TOOLS–LETTUCE

G. Vallad, Plant Pathologist, UF

Disease	Resistant Varieties	Non-chemical Controls
LETTUCE		
Pythium damping-off	No	Use raised beds to dry soil surface.
Leaf spots, Drop (*Sclerotinia*)	No	Increase plant spacing to improve air flow and drying of soil and foliage
Bottom rot (*Rhizoctonia*)	No	

Disease	Resistant Varieties	Non-chemical Controls
LETTUCE (Head)		
Damping-off	No	Use raised beds to dry soil surface (plant bed).
Downy mildew	Yes	Copper spray at first appearance. Remove destroy severely infected plants, rotate crops and destroy residue.
Pythium damping-off	No	Use raised beds to dry soil surface.

MUSKMELON (CANTALOUPE) SEE CUBURBITS — TABLE 3-12.

TABLE 3-26. DISEASE CONTROL FOR OKRA

E. Sikora, Plant Pathologist, Auburn University

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Anthracnose, bacterial leaf spot, leaf spots, pod spots, powdery mildew	fixed copper* (various formulations)	See label	various	0	See label	
Cercospora leaf spot	chlorothalonil (Bravo Weather Stik)	1.5 pt/A	1.125 lb/A	3	0.5	Begin applications when disease is expected. Repeat every 7- to 10 days.
	tebuconazole (Orius 3.6F, Uppercut, Folicur) Toledo Tebustar 3.6 L	4 to 6 fl oz/A	1.5-2.3 oz/A	3	0.5	**DO NOT** apply more than 24 fl oz per acre per season.
Downy mildew	mandipropamid (Micora)	5.5 to 8 fl oz/A	0.65 to 0.9 fl oz/A	---	4 hr	Tank mix Micora with a non-Group 40 fungicide and begin applications prior to disease development. **DO NOT** apply more than two applications per crop, or in consecutive applications.
Powdery mildew	azoxystrobin, Quadris) 2.08 F	6.2 to 15.4 fl oz/A	0.10 to 0.25 lb/A	0	4	Do not make more than two sequential applications.
	azoxystrobin (Heritage)	3.2 to 8.0 oz/A	1.125 lb/A	0	4	Do not apply more than two sequential applications before alternating with a fungicide with a different mode of action. Do not make more than 4 applications of Heritage or other strobilurin fungicide per acre per season.
	chlorothalonil (Bravo Weather Stik)	1.5 pt/A	1.125 lb/A	3	0.5	Begin applications when disease is expected. Repeat every 7- to 10 days.
	myclobutanil (Rally 40WSP)	2.5 to 5 oz/A	0.062 to 0.125 lb/A	0	1	Do not make more than 4 applications per season. Minimum re-treatment interval: 10 to 14 days.
Rhizoctonia seedling rot	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/1,000 row feet	0.006 to 0.013 lb	—	4 hr	Make in-furrow or banded applications shortly after plant emergence.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-27. DISEASE CONTROL FOR ONION

D. Langston, Plant Pathologist, UGA

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
ONION (green)						
Damping-off (*Pythium)*	mefenoxam (Ridomil Gold) 4 SL	0.5 to 1 pt/trt acre	0.25 to 0.5 lb/trt acre	—	2	See label for low rates. Also for dry onion.
	metalaxyl (MetaStar) 2 E	2 to 4 pt/trt acre	0.25 to 0.5 pt/trt acre	—	2	Preplant incorporated or soil surface spray.
Downy mildew	azoxystrobin (Amistar, Quadris) 2.08 F	9.2 to 15.4 fl oz/ acre	0.15 to 0.25 fl oz/ acre	0	4 hr	Make no more than one application before alternating with a fungicide with a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	azoxystrobin + chlorothalonil (Quadris Opti)	2.4 to 3.7 pt/acre		14	0.5	Make no more than one application before alternating with a fungicide with a different mode of action.
	dimethomorph (Acrobat, Forum) 50 WP	6.4 oz/acre	3.2 oz/acre	0	0.5	Must be applied as a tank mix with another fungicide active against downy mildew. Do not make more than two sequential applications.
	fenamidone (Reason) 500 SC	5.5 fl oz/acre	0.178 lb/acre	7	0.5	Begin applications when conditions favor disease development, and continue on 5- to 10-day interval. Do not apply more than 22 fl oz per growing season. Alternate with fungicide from different resistance group.
	mandipropamid (Revus) 2.08F	8 fl oz/acre	0.13 lb/acre	7	0.5	Apply prior to disease development and continue throughout season at 7- to 10-day intervals; maximum 24 fl oz per season.
	amectoctradin + dimethomorph (Zampro)	14.0 fl oz/acre	0.27 lb/acre	0	12 hr	Begin applications prior to disease development and continue on a 5-7 day spray interval.
	mefenoxam + chlorothalonil (Ridomil Gold/Bravo)	2 lb/acre	—	21	2	
	pyraclostrobin (Cabrio) 20 WG	8 to 12 oz/acre	1.6 to 2.4 oz/acre	7	0.5	Make no more than 2 sequential applications and no more than 6 applications per season.
	pyraclostrobin + boscalid (Pristine) 38WG	18.5 oz/acre	4 to 7 oz/acre	7	1	For suppression only. Make a maximum of 6 applications per season.

TABLE 3-27. DISEASE CONTROL FOR ONION (cont'd)

D. Langston, Plant Pathologist, UGA

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
ONION (green) (cont'd)						
Leaf blight *(Botrytis)*	azoxystrobin (Amistar, Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 fl oz/acre	7	4 hr	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	azoxystrobin + chlorothalonil (Quadris Opti)	1.6 to 3.2 pt/acre		14	0.5	Make no more than one application before alternating with a fungicide with a different mode of action.
	boscalid (Endura) 70 WG	6.8 oz/acre	4.8 oz/acre	7	0.5	Do not make more than 2 sequential applications or more than 6 applications per season.
	penthiopyrad (Fontelis)	16 to 24 fl oz/acre	0.21 to 0.31 fl oz/ acre	3	12 hr	Begin sprays prior to disease development and continue on a 7-14 day schedule.
	chlorothalonil 7 (Bravo Weather Stik, Echo, Equus) 6 F	1 to 2 pt/acre	0.54 to 1.1 lb/acre	14	2	Spray at first appearance. Maximum of three sprays.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.8 oz/acre	7	0.5	Do not plant rotational crops other than onions or strawberries for 12 months following the last application.
	dicloran (Botran) 75 W	1.5 to 2.7 lb/acre	1.1 to 2 lb/acre	14	0.5	
	difenoconazole + cyprodinil (Inspire Super)	16 to 20 fl oz/acre		7-14	0.5	Make no more than two applications before alternating with a fungicide with a different mode of action.
	pyraclostrobin + boscalid (Pristine) 38 WG	14.5 to 18.5 oz/acre	5.5 to 7 oz/acre	7	1	Make a maximum of 6 applications per season.
	pyrimethanil (Scala) 5 F	9 or 18 fl oz/acre	0.35 or 0.7 lb/acre	7	0.5	Use lower rate in a tank mix with broad spectrum fungicide and higher rate when applied alone. Do not apply more than 54 fl oz per crop.
	azoxystrobin + chlorothalonil (Quadris Opti)	1.6 to 3.6 pts/acre	1.1 to 2.5 lb/acre	7	2	Applications should begin prior to disease onset and subsequent applications should be made on a 7-14 day interval.
Purple blotch	azoxystrobin (Amistar, Quadris) 2.08 F	6.2 to 12.3 fl oz/ acre	0.1 to 0.2 fl oz/acre	7	4 hr	Make no more than two sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	azoxystrobin + chlorothalonil (Quadris Opti)	1.6 to 3.2 pt/acre		14	0.5	Make no more than one application before alternating with a fungicide with a different mode of action.
	boscalid (Endura) 70WG	6.8 oz/acre	4.8 oz/acre	7	0.5	Do not make more than 2 sequential applications or more than 6 applications per season.
	penthiopyrad (Fontelis)	16 to 24 fl oz/acre	0.21 to 0.31 fl oz/ acre	3	12 hr	Begin sprays prior to disease development and continue on a 7-14 day schedule.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.8 oz/acre	7	0.5	Do not plant rotational crops other than onions or strawberries for 12 months following the last application.
	difenoconazole + cyprodinil (Inspire Super)	16 to 20 fl oz/acre		7-14	0.5	Make no more than two applications before alternating with a fungicide with a different mode of action.
	fenamidone (Reason) 500 SC	5.5 to 8.2 fl oz	0.178 lb/acre	7	0.5	Begin applications when conditions favor disease development, and continue on 5- to 10-day interval. Do not apply more than 22 fl oz per growing season. Alternate with fungicide from different resistance management group.
	pyraclostrobin (Cabrio) 20 WG	8 to 12 oz/acre	1.6 to 2.4 oz/acre	7	0.5	Make no more than 2 sequential applications and no more than 6 applications per season.
	pyraclostrobin + boscalid (Pristine) 38 WG	10.5 to 18.5 oz/acre	4 to 7 oz/acre	7	1	Make a maximum of 6 applications per season.
	pyrimethanil (Scala) 5 F	9 or 18 fl oz/acre	0.35 or 0.7lb/acre	7	0.5	Use lower rate in a tank mix with broad spectrum fungicide and higher rate when applied alone. Do not apply more than 54 fl oz per crop.
	tebuconazole (Folicur) 3.6F	4 to 6 fl oz/acre	1.5 to 2 lb/acre	7	0.5	Apply before disease appears when conditions favor purple blotch development and repeat at 10- to 14-day intervals; maximum 24 fl oz per season.
Stemphylium leaf blight	pyraclostrobin + boscalid (Pristine) 38 WG	10.5 to 18.5 oz/acre	4 to 7 oz/acre	7	1	Make no more than 6 applications per season.

TABLE 3-27. DISEASE CONTROL FOR ONION (cont'd)

D. Langston, Plant Pathologist, UGA

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
ONION (dry)						
Damping-off *(Pythium)*	mefenoxam (Ridomil Gold) 4 SL	0.5 to 1 pt/trt acre	0.25 to 0.5 lb/trt acre	—	2	See label for row rates. Also for green onion.
	metalaxyl (MetaStar) 2 E	2 to 4 pt/trt acre	0.25 to 0.5 pt/trt acre	—	2	Preplant incorporated or soil surface spray.
Downy mildew	azoxystrobin (Amistar, Quadris) 2.08 F	9.2 to 15.4 fl oz/ acre	0.15 to 0.25 fl oz/ acre	0	4 hr	Make no more than one application before alternating with a fungicide with a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	amectoctradin + dimethomorph (Zampro)	14.0 fl oz/acre	0.27 lb/acre	0	12 hr	Begin applications prior to disease development and continue on a 5-7 day spray interval.
	fenamidone (Reason)	5.5 fl oz/acre	0.178 lb/acre	7	12 hr	Use as soon as environmental conditions become favorable.
	azoxystrobin + chlorothalonil (Quadris Opti)	2.4 to 3.2 pt/acre		14	0.5	Make no more than one application before alternating with a fungicide with a different mode of action.
	dimethomorph (Acrobat, Forum) 50 WP	6.4 oz/acre	3.2 oz/acre	0	0.5	Must be applied as a tank mix with another fungicide active against downy mildew. Do not make more than two sequential applications.
	famoxadone + cymoxanil (Tanos)	8.0 oz/acre	0.25 lb/acre	3	0.5	Apply preventively on a 5-7 day schedule and do not rotate with group 11 fungicides.
	fluazinam (Omega 500)	1.0 pt/acre	0.52 lb/acre	7	2	Initiate sprays when conditions are favorable for disease or at disease onset. Spray on a 7-10 day schedule.
	mandipropamid (Revus) 2.08 F	8 fl oz/acre	0.13 lb/acre	1	0.5	Apply prior to disease development and continue throughout season at 7- to 10-day intervals; maxi mum 32 fl oz per season.
	mefenoxam + mancozeb (Ridomil Gold MZ)	2.5 lb/trt acre	—	7	2	
	pyraclostrobin (Cabrio) 20 WG	12 oz/acre	2.4 oz/acre	7	0.5	Make no more than 2 sequential applications and no more than 6 applications per season.
	pyraclostrobin + boscalid (Pristine) 38 WG	18.5 oz/acre	4 to 7 oz/acre	7	1	Suppression only. Make no more than 6 applications per season.
Leaf blight *(Botrytis)*	azoxystrobin (Amistar, Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 fl oz/acre	7	4 hr	Make no more than two sequential applications before alternating with fungicides with a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	azoxystrobin + chlorothalonil (Quadris Opti)	1.6 to 3.2 pt/acre		14	0.5	Make no more than one application before alternating with a fungicide with a different mode of action.
	boscalid (Endura) 70 WG	6.8 oz/acre	4.8 oz/acre	7	0.5	Do not make more than 2 sequential applications or more than 6 applications per season.
	penthiopyrad (Fontelis)	16 to 24 fl oz/acre	0.21 to 0.31 fl oz/ acre	3	12 hr	Begin sprays prior to disease development and continue on a 7-14 day schedule.
	cyprodinil + fludioxonil (Switch) 62.5WG	11 to 14 oz/acre	6.9 to 8.8 oz/acre	7	0.5	Do not plant rotational crops other than onions or strawberriesfor 12 months following the last application.
	dicloran (Botran) 75 W	1.5 to 2.7 lb/acre	1.1 to 2 lb/acre	14	0.5	Use lower rate in a tank mix with broad spectrum fungicide and higher rate when applied alone. Do not apply more than 54 fl oz per crop.
	difenoconazole + cyprodinil (Inspire Super)	16 to 20 fl oz/acre		7-14	0.5	Make no more than two applications before alternating with a fungicide with a different mode of action.
	fixed copper*	See label				Spray at first appearance, 7- to 10-day intervals. Do not apply to exposed bulbs.
	pyraclostrobin + boscalid (Pristine) 38 WG	14.5 to 18.5 oz/acre	5.5 to 7 oz/acre	7	1	Make no more than 6 applications per season.
	pyrimethanil (Scala) 5 F	9 or 18 fl oz/acre	0.35 or 0.7 lb/acre	7	0.5	Use lower rate in a tank mix with broad spectrum fungicide and higher rate when applied alone. Do not apply more than 54 fl oz per crop.
	azoxystrobin + difenoconazole (Quadris Top)	14 fl oz/acre	2.38 lb/acre	7	0.5	Begin sprays prior to disease onset and spray on a 7-14 day schedule. Do not rotate with Group 11 fungicides.
	fluazinam (Omega 500)	1.0 pt/acre	0.52 lb/acre	7	2	Initiate sprays when conditions are favorable for disease or at disease onset. Spray on a 7-10 day schedule.

TABLE 3-27. DISEASE CONTROL FOR ONION (cont'd)

D. Langston, Plant Pathologist, UGA

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
ONION (dry) (cont'd)						
Neck rot *(Botrytis),* purple blotch *(Alternaria),* downy mildew	azoxystrobin + chlorothalonil (Quadris Opti)	1.6 to 3.2 pt/acre		14	0.5	Make no more than one application before alternating with a fungicide with a different mode of action.
	penthiopyrad (Fontelis)	16 to 24 fl oz/acre	0.21 to 0.31 fl oz/ acre	3	12 hr	Begin sprays prior to disease development and continue on a 7-14 day schedule.
	chlorothalonil* (Bravo Ultrex) 82.5 WDG	0.9 to 1 lb/acre	0.75 to 1.5 lb/acre	7	2	Will only suppress neck rot and downy mildew.
	fixed copper*	See label	—	1	1	May reduce bacterial rots.
	fosetyl-Al (Aliette) 80 WDG	2 to 3 lb/acre	1.6 to 2.4 lb/acre	7	0.5	Do not mix with surfactants, foliar fertilizers, or products containing copper; will not control neck rot.
	iprodione (Rovral) 50 WP	1.5 lb/acre	0.75 lb/acre	7	0.5	Apply when conditions are favorable; 14-day intervals. Rovral is not for downy mildew.
	mancozeb 80W*	2 to 3 lb/acre	1.6 to 2.4 lb/acre	7	1	Do not exceed 30 lb per acre per crop.
	mefenoxam + chlorothalonil (Ridomil Gold/Bravo)	2 lb/acre	—	7	2	
	vinclozolin (Ronilan) 50 DF	See label	0.75 to 1 lb/acre	18	1	Three treatments minimum.
Pink rot	metam-sodium (Vapam) 42 HL	37.5 to 75 gal/trt acre	160 to 320 lb/acre	—	2	Rate is based on soil properties and depth of soil to be treated.
	dichloropropene (Telone) C-17 C-35	10.8 to 17.1 gal/ acre 13 to 20.5 gal/acre	107 to 169 lb/acre 139 to 220 lb/acre	—	5	Rate is based on soil type; see label for in-row rates.
Purple blotch, leaf blight	azoxystrobin (Amistar, Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 fl oz/acre	7	4 hr	Make no more than two sequential applications before alternating with fungicides with a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	azoxystrobin + chlorothalonil (Quadris Opti)	1.6 to 3.2 pt/acre		14	0.5	Make no more than one application before alternating with a fungicide with a different mode of action.
	famoxadone + cymoxanil (Tanos)	8.0 oz/acre	0.25 lb/acre	3	0.5	Apply preventively on a 5-7 day schedule and do not rotate with group 11 fungicides.
	boscalid (Endura) 70 WG	6.8 oz/acre	4.8 oz/acre	7	0.5	Do not make more than 2 sequential applications or more than 6 applications per season.
	penthiopyrad (Fontelis)	16 to 24 fl oz/acre	0.21 to 0.31 fl oz/ acre	3	12 hr	Begin sprays prior to disease development and continue on a 7-14 day schedule.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.8 oz/acre	7	0.5	Do not plant rotational crops other than onions or strawberries for 12 months following the last application.
	difenoconazole + cyprodinil (Inspire Super)	16 to 20 fl oz/acre		7-14	0.5	Make no more than two applications before alternating with a fungicide with a different mode of action.
	fenamidone (Reason) 500 SC	5.5 fl oz/acre	0.178 lb/acre	7	0.5	Begin applications when conditions favor disease development, and continue on 5- to 10-day inter val. Do not apply more than 22 fl oz per growing season. Alternate with fungicide from different resistance group.
	iprodione (Rovral) 50 WP	1.5 lb/acre 50 to 100 gal/acre	0.75 lb/acre 50 to 100 gal/acre	7	0	Start 7-day foliar sprays at first appearance of favorable conditions.
	pyraclostrobin (Cabrio) 20 WG	8 to 12 oz/acre	1.6 to 2.4 oz/acre	7	0.5	Make no more than 2 sequential applications and no more than 6 applications per season.
	pyraclostrobin + boscalid (Pristine) 38 WG	10.5 to 18.5 oz/acre	4 to 7 oz/acre	7	1	Make no more than 6 applications per season.
	pyrimethanil (Scala) 5 F	9 or 18 fl oz/acre	0.35 or 0.7 lb/acre	7	0.5	Use lower rate in a tank mix with broad spectrum fungicide and higher rate when applied alone. Do not apply more than 54 fl oz per crop.
	tebuconazole (Folicur) 3.6 F	4 to 6 fl oz/acre	—	7	0.5	Do not apply more than 12 fl oz per acre per season.
	vinclozolin (Ronilan) 50 DF	See label		18	1	Two treatments Minimum. Effective on purple leaf blotch when disease pressure is low.
	azoxystrobin + difenoconazole (Quadris Top)	14 fl oz/acre	2.38 lb/acre	7	0.5	Begin sprays prior to disease onset and spray on a 7-14 day schedule. Do not rotate with Group 11 fungicides.
	fluazinam (Omega 500)	1.0 pt/acre	0.52 lb/acre	7	2	Initiate sprays when conditions are favorable for disease or at disease onset. Spray on a 7-10 day schedule.
Smut	mancozeb 80W*	3 lb/29,000 ft row	3 lb/29,000 ft row	—	—	

TABLE 3-27. DISEASE CONTROL FOR ONION (cont'd)

D. Langston, Plant Pathologist, UGA

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
ONION (dry) (cont'd)						
Stemphylium leaf blight	difenoconazole + cyprodinil (Inspire Super)	16 to 20 fl oz/acre		7-14	0.5	Make no more than two applications before alternating with a fungicide with a different mode of action.
	pyraclostrobin + boscalid (Pristine) 38 WG	10.5 to 18.5 oz/acre	4 to 7 oz/acre	7	1	Make no more than 6 applications per season.
	azoxystrobin + difenoconazole (Quadris Top)	14 fl oz/acre	2.38 lb/acre	7	0.5	Begin sprays prior to disease onset and spray on a 7-14 day schedule. Do not rotate with Group 11 fungicides.
	fluazinam (Omega 500)	1.0 pt/acre	0.52 lb/acre	7	2	Initiate sprays when conditions are favorable for disease or at disease onset. Spray on a 7-10 day schedule.
	penthiopyrad (Fontelis)	16 to 24 fl oz/acre	0.21 to 0.31 fl oz/acre	3	12 hr	Begin sprays prior to disease development and continue on a 7-14 day schedule.
White rot *(Sclerotium)*	azoxystrobin + chlorothalonil (Quadris Opti)	1.6 to 3.2 pt/acre		14	0.5	Make no more than one application before alternating with a fungicide with a different mode of action.
	penthiopyrad (Fontelis)	16 to 24 fl oz/acre	0.21 to 0.31 fl oz/acre	3	12 hr	Begin sprays prior to disease development and continue on a 7-14 day schedule.
	dicloran (Botran) 75 W	5.3 lb/acre	4 lb/acre	14	0.5	Apply 5-in. band over seed row and incorporate in top 1.5 to 3 in. of soil, 1 to 2 weeks before seeding.
	dichloropropene (Telone) C-17 C-35	10.8 to 17.1 gal/acre 13 to 20.5 gal/acre	107 to 169 lb/acre 139 to 220 lb/acre	—	5	Rate is based on soil type; see label for in-row rates.
	thiophanate-methyl (Topsin M) 70 WP	See label		—	—	Spray into open furrow at time of seeding or planting in row.
	vinclozolin (Ronilan) 50 DF	See label		18	0.5	Three treatments minimum.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-28. ALTERNATIVE MANAGEMENT TOOLS–ONION

D. Langston, Plant Pathologist, UGA

Disease	Resistant Varieties	Non-chemical Controls
ONION (green)		
Leaf blast *(Botrytis)*	No	Remove infected leaves and encourage air movement.
Purple blotch	No	
Downy mildew	Yes	Copper spray at first appearance. Remove and destroy severely infected plants, rotate and destroy residue.
ONION (dry)		
Fusarium basal rot	No	Solarize soil two weeks prior to planting.
Leaf blast *(Botrytis)*	No	Remove infected leaves and encourage ventilation.
Neck rot	No	Sulfur
Purple blotch *(Alternaria)*	No	Good curing practices. Spray with sulfur, solarize soil two weeks prior to planting and long rotations.

Disease	Resistant Varieties	Non-chemical Controls
ONION (dry) (cont'd)		
Downy mildew	Yes	Copper spray at first appearance. Remove and destroy severely infected plants, rotate and destroy residue.
Pythium damping-off	No	Use raised beds to dry soil surface.
Powdery mildew	Yes	Spray with sulfur at first appearance of disease.
Pink root	Yes	Drench roots with fish emulsion to supply nitrogen.
White rot (*Sclerotium)*	No	Solarization
Smut		Solarize soil two weeks prior to planting.

TABLE 3-29. RELATIVE EFFECTIVENESS OF VARIOUS CHEMICALS FOR ONION DISEASE CONTROL

D. Langston, Plant Pathologist, UGA

Information in this table was derived from ratings given at the IR-4 Bulb Vegetable Crop Workshop held during the 1999 American Phytopathological Society annual meeting in Montreal, Canada. Ratings for products do not necessarily indicate a labeled use. Always follow all directions on the pesticide label.

Fungicide or Fumigant	Fungicide Group[1]	Preharvest Interval	Disease Scale: "-" = ineffective; "+"…….. "++++" = very effective; "?" = unknown efficacy.												
			Bacterial Streak (*Pseudomones viridiflava*)	Black Mold (*Aspergillus niger*)	*Botrytis* Leaf Blight (*B. squamosa*)	*Botrytis* Neck Rot (*B. allii*)	Damping-Off (*Pythium* spp.)	Downy Mildew (*P. destructor*)	*Fusarium* Basal Rot (*F. oxysporum*)	Onion Smut (*Urocystis colchici*)	Center Rot (*Pantoea ananatis*)	Pink Root (*Phoma terrestris*)	Purple Blotch (*Alternaria porri*)	*Stemphylium* Leaf Blight and Stalk Rot	White Rot (*Sclerotium cepivorum*)
azoxystrobin (Quadris)	11	7	—	?	+++	—	—	+++++	—	?	—	—	++++	++++	?
azoxystobin + difenoconazole (Quadris Top)	11+ 3	1	—	—	+++	—	—	+++++	—	—	—	—	++++	++++	—
chlorothalonil (Bravo, Echo, Equus)	M	14	—	—	+++	—	—	++	—	—	—	—	+++	++	—
cyprodinil + fludioxonil (Switch)	9 + 12	7	—	—	++++	?	—	—	—	—	—	—	+++	+++	—
dichloropropene + chloropicrin, fumigant (Telone C-17)	—	—	—	—	—	—	+	—	++	—	—	++	—	—	++
dimethomorph (Forum)	40	0	—	—	—	—	—	++	—	—	—	—	—	—	—
famoxadone/cymoxanil (Tanos)	11 + 27	3	—	—	++	—	—	+++++	—	—	—	—	++	++	—
fixed copper[2]	M	1	++	—	++	—	—	++	—	—	++	—	++	—	—
fluazinam (Omega 500)	29	2	—	—	++++	—	—	++++	—	—	—	—	+++++	+++++	—
fluopicolide (Presidio)	43	2	—	—	—	—	?	+++	—	—	—	—	—	—	—
fosetyl-Al (Aliette)	33	7	—	—	—	—	—	—	+++	—	—	—	—	—	—
iprodione (Rovral)	2	7	—	—	+++++	+	—	—	—	—	—	—	+++++	+++	+++
mancozeb (Dithane, Manzate, Manex, Penncozeb)	M	7	—	—	++	—	—	+++	—	+++++	—	—	+++	++	—
mancozeb + copper (ManKocide)	M + M	7	++	—	++	—	—	+++	—	+++	++	—	+++	++	—
mandipropamid (Revus)	40	7	—	—	—	?	+++	—	—	—	—	—	—	—	—
mefenoxam (Ridomil Gold EC)	4	7	—	—	—	—	+++	+++	—	—	—	—	—	—	—
mefenoxam + chlorothalonil (Ridomil Gold Bravo)	4 + M	14	—	—	+++	—	+	+++	—	—	—	—	+++	++	—
mefenoxam + copper (Ridomil Gold/Copper)	4 + M	7	++	—	—	—	+	+++	—	—	++	—	—	—	—
mefenoxam + mancozeb (Ridomil Gold MZ)	4 + M	7	—	—	++	—	+	+++	—	+++	—	—	+++	++	—
metam sodium, fumigant (Vapam)	—	—	—	—	—	—	+++	—	++	—	—	+++++	—	—	++
pyraclostrobin (Cabrio)	11	7	—	?	+++	—	—	+++++	—	?	—	—	++++	++++	?
pyraclostrobin + boscalid (Pristine)	11 + 7	7	—	?	++++	++	—	++++	—	?	—	—	+++++	+++++	?
pyrimethanil (Scala)	9	7	—	?	+++	—	—	—	—	?	—	—	+++	+++	—
tebuconazole (Folicur)	3	7	—	?	—	—	—	—	?	?	—	?	++	++	++

[1] **Key to Fungicide Groups:** 1: methyl benzimidazole carbamates; 2: dicarboxamides; 3: demethylation inhibitors; 4: phenylamides; 7: carboxamides, 9: anilonopyrimidines; 11: quinone outside inhibitors; 12: phenylpyrroles; 15: cinnamic acids; 22: benzamides; 33: phosphonates; M: multi-site activity

[2] Fixed coppers include: Basicop, Champ, Champion, Citcop, Copper-Count-N, Kocide, Nu-Cop, Super Cu, Tenn-Cop, Top Cop with Sulfur, and Tri-basic copper sulfate.

TABLE 3-30. DISEASE CONTROL FOR PARSLEY

A. Keinath, Plant Pathologist, Clemson University

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Cercospora leaf spot (Early blight)	azoxystrobin (Quadris) 2.08 F	2 to 5 oz/acre	0.1 to 0.25 fl oz/acre	0	4 hr	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 1.88 lb per crop per acre per season.
	penthiopyrad (Fontelis) 1.67 F	14 to 24 fl oz	0.18 to 0.31 lb/acre	3	0.5	Do not make more than two sequential applications. Maximum of 72 fl oz/acre per year.
	pyraclostrobin (Cabrio) EG	12 to 16 oz/acre	2.4 to 3.2 oz/acre	0	0.5	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 64 oz per crop per acre per season.
Damping-off and root rot (*Pythium*, *Phytophthora*)	mefenoxam (Ridomil Gold) 4 SL (UltraFlourish) 2 EC	1 to 2 pt/treated acre 2 to 4 pt/treated acre	0.5 to 1 lb/treated acre	0	0.5	Apply preplant incorporated or surface application at planting.
	metalaxyl (MetaStar) 2 E	2 to 8 pt/treated acre	0.5 to 1 lb/treated acre	0	2	Banded over the row, preplant incorporated, or injected with liquid fertilizer.
Powdery mildew, *Septoria* leaf spot (late blight)	azoxystrobin (Quadris) 2.08 F	2 to 5 oz/acre	0.1 to 0.25 fl oz/acre	0	4 hr	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 1.88 lb per crop per acre per season.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.8 oz/acre	0	0.5	Make no more than two sequential applications before alternating with fungicides that have a different mode of action for two applications. Apply no more than 56 oz per crop per acre per season.
	fixed copper*	See label	See label	0	0	Spray at first disease appearance, 7- to 10-day intervals.
	penthiopyrad (Fontelis) 1.67 F	14 to 24 fl oz	0.18 to 0.31 lb/acre	3	0.5	Do not make more than two sequential applications. Maximum of 72 fl oz/acre per year.
	pyraclostrobin (Cabrio) EG	12 to 16 oz/acre	2.4 to 3.2 oz/acre	0	0.5	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 64 oz per crop per acre per season.
Web blight and root rot (*Rhizoctonia*)	azoxystrobin (Quadris) 2.08 F	0.125 to 0.25 oz/ 1000 row ft	0.10 to 0.20 oz/1000 row ft	0	4 hr	Apply as banded spray to the lower stems and soil surface. Make no more than two sequential applications. Apply no more than 1.88 lb per crop per acre per season. Soil applications are included in this maximum.
White mold	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.8 oz/acre	0	0.5	Make no more than two sequential applications before alternating with fungicides that have a different mode of action for two applications. Apply no more than 56 oz per crop per acre per season. First application at thinning and second application 2 weeks later.
	penthiopyrad (Fontelis) 1.67 F	16 to 30 fl oz	0.21 to 0.39 lb/acre	3	0.5	Do not make more than two sequential applications. Maximum of 72 fl oz/acre per year.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-31. RELATIVE IMPORTANCE OF ALTERNATIVE MANAGEMENT PRACTICES FOR DISEASE CONTROL IN PARSLEY

A. Keinath, Plant Pathologist, Clemson University

Scale: "0" = not important/does not impact disease, "5" = very important practice to implement/impacts disease greatly.
For planting date: "E" = early planting date has less disease; "L" = late planting date has less disease.

Management tactic	Disease					
	Powdery mildew	*Pythium* damping-off and root rot	*Rhizoctonia* damping-off and root rot	Root knot (nematode)	*Sclerotinia* white mold	*Septoria* blight
Avoid field operations when leaves are wet	0	0	0	0	0	4
Avoid overhead irrigation	0	0	0	0	5	5
Biofungicide	3	0	0	0	3	0
Change planting date	0	0	E	E	L	0
Suppressive cover crops	0	0	0	2	0	0
Crop rotation with non-host	0	2	1	1	2	5
Deep plowing	1	0	2	1	3	4
Destroy crop residue	1	0	1	1	3	4
Encourage air movement	0	1	0	0	5	4
Flooding (where feasible)	0	0	2	4	4	0
Increase soil organic matter	2	1	1	2	0	1

Management tactic	Disease					
	Powdery mildew	*Pythium* damping-off and root rot	*Rhizoctonia* damping-off and root rot	Root knot (nematode)	*Sclerotinia* white mold	*Septoria* blight
Hot water seed treatment	0	0	0	0	0	5
Plant in well-drained soil	0	5	4	0	3	1
Plant on raised beds	0	5	4	0	3	0
Plastic mulch bed covers	2	0	0	1	0	0
Postharvest temperature control	0	0	0	0	5	0
Reduce mechanical injury	0	0	1	0	4	0
Soil solarization	0	1	3	2	1	2
Pathogen-free planting material	1	0	0	0	1	5
Resistant/tolerant cultivars	0	0	1	0	0	2
Weed control	3	0	0	2	2	0

TABLE 3-32. DISEASE CONTROL FOR PEA

A. Keinath, Plant Pathologist, Clemson University

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
PEA (English)						
Anthracnose	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.10 to 0.25 lb/acre	0	4 hr	Do not make more than two sequential applications.
	penthiopyrad (Fontelis) 1.67 F	14 to 30 fl oz	0.18 to 0.39 lb/acre	0	0.5	Do not make more than two sequential applications. Maximum of 72 fl oz/acre per crop.
	pyraclostrobin + fluxapyroxad (Priaxor)	4.0 to 8.0 fl oz/acre	0.13 to 0.26 lb/acre	7	12 hr	Do not make more than two sequential applications. Maximum of 16 fl oz/acre per crop.
Ascochyta leaf spot and blight	Azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.10 to 0.25 lb/acre	0	4 hr	Do not make more than two sequential applications.
	boscalid (Endura) 70 WG	8 to 11 oz/ acre	5.6 to 7.7 oz/acre	7	0.5	Maximum of 2 applications per crop.
	penthiopyrad (Fontelis) 1.67 F	14 to 30 fl oz	0.18 to 0.39 lb/acre	0	0.5	Do not make more than two sequential applications. Maximum of 72 fl oz/acre per crop.
	pyraclostrobin + fluxapyroxad (Priaxor)	4.0 to 8.0 fl oz/acre	0.13 to 0.26 lb/acre	7	12 hr	Do not make more than two sequential applications. Maximum of 16 fl oz/acre per crop.
Gray mold (*Botrytis*), White mold (*Sclerotinia*)	boscalid (Endura) 70 WG	8 to 11 oz/ acre	5.6 to 7.7 oz/acre	7	0.5	Maximum of 2 applications per crop.
	penthiopyrad (Fontelis) 1.67 F	14 to 30 fl oz	0.18 to 0.39 lb/acre	0	0.5	Do not make more than two sequential applications. Maximum of 72 fl oz/acre per year.
	pyraclostrobin + fluxapyroxad (Priaxor)	4.0 to 8.0 fl oz/acre	0.13 to 0.26 lb/acre	7	12 hr	Do not make more than two sequential applications. Maximum of 16 fl oz/acre per crop.
Powdery mildew	boscalid (Endura) 70 WG	8 to 11 oz/ acre	5.6 to 7.7 oz/acre	7	0.5	Maximum of 2 applications per crop.
	fixed copper*	See label	See label	0	1-2	
	penthiopyrad (Fontelis) 1.67 F	14 to 30 fl oz	0.18 to 0.39 lb/acre	0	0.5	Do not make more than two sequential applications. Maximum of 72 fl oz/acre per year.
	pyraclostrobin + fluxapyroxad (Priaxor)	4.0 to 8.0 fl oz/acre	0.13 to 0.26 lb/acre	7	12 hr	Do not make more than two sequential applications. Maximum of 16 fl oz/acre per crop.
	sulfur*	See label	2 to 4 lb/100 gal	0	1	Spray at first appearance, 10- to 14-day intervals. Do not use sulfur on wet plants or on hot days (in excess of 90°F).
Pythium damping-off	mefenoxam (Ridomil Gold) 4 EC	0.5 to 1 pt/trt acre	0.25 to 0.5 lb/trt acre	—	2	Incorporate in soil. See label for row rates.
Rhizoctonia root rot	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/ 1,000 sq ft	0.0006 to 0.13 lb/ 1,000 sq ft	—	4 hr	Make in-furrow or banded applications shortly after plant emergence.
Rust *(Uromyces)*	azoxystrobin (Quadris) 2.08 F	6.2 fl oz/acre	0.10 lb/acre	0	4 hr	Do not make more than two sequential applications.
	penthiopyrad (Fontelis) 1.67 F	14 to 30 fl oz	0.18 to 0.39 lb/acre	0	0.5	Do not make more than two sequential applications. Maximum of 72 fl oz/acre per year.
	pyraclostrobin + fluxapyroxad (Priaxor)	4.0 to 8.0 fl oz/acre	0.13 to 0.26 lb/acre	7	12 hr	Do not make more than two sequential applications. Maximum of 16 fl oz/acre per crop.
PEA (Southern)						
Anthracnose	thiophanate-methyl (Topsin M) 70 WP	1 to 1.5 lb/acre	0.7 to 1.1 lb/acre	28	0.5	Use no more than 4 lb (2.8 lb a.i.) per acre per year.
Anthracnose, Rust	azoxystrobin (Quadris) 2.08 F	2 to 5 oz/acre	0.1 to 0.25 lb/acre	14 (dry) 0 (succulent)	4 hr	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Use no more than 1.5 lb a.i. per acre per season.
Ascochyta blight, Gray mold, White mold	boscalid (Endura) 70 WG	8 to 11 oz/acre	5.6 to 7.7 oz/acre	21 (dried) or 7 (succulent)	0.5	Maximum of 2 applications per season.
Ascochyta blight, Rust, white mold	prothioconazole (Proline) 480 SC	5.7 fl oz /acre	2.85 oz /acre	7	0.5	Maximum of 3 applications per year. Use no more than 17.1 fl oz per acre per year.
Downy mildew, Bacterial blights	fixed copper*	See label				
Downy mildew, *Cercospora*, Anthracnose, Rust	chlorothalonil (Bravo Ultrex) 82.5 WDG	1.4 to 2 pt/acre	1.1 to 1.5 lb/acre	14	2	Spray early bloom; repeat at 7- to 10-day intervals; for dry beans only.
Downy mildew, *Cercospora*, Anthracnose, Rust, Powdery mildew	pyraclostrobin (Headline) 2.09 EC	6 to 9 fl oz/acre	0.1 to 0.15 lb/acre	21	0.5	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Use no more than 18 fl oz per acre per season.
	sulfur*	See label	2 to 4 lb/100 gal	0	1	Spray at first appearance; 7- to 10-day interval.

TABLE 3-32. DISEASE CONTROL FOR PEA (cont'd)

A. Keinath, Plant Pathologist, Clemson University

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
PEA (Southern) (cont'd)						
Pythium damping-off	mefenoxam (Ridomil Gold) 4 SL	0.5 to 1 pt/ treated acre	0.25 to 0.5 lb/ treated acre	-	0.5	Broadcast or banded over the row as a soil spray at planting or preplant incorporation into the top 2 inches of soil.
	metalaxyl (MetaStar) 2 E	2 to 4 pt/treated acre	0.5 to 1 lb/treated acre	-	2	Broadcast or banded over the row as a soil spray at planting or preplant incorporation into the top 2 inches of soil.
Rhizoctonia root rot	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/1,000 row feet	0.006 to 0.013 lb/1,000 row feet	-	4 hr	Make in-furrow or banded application shortly after plant emergence.
White mold (*Sclerotinia*)	fludioxonil (Cannonball) 50 WP	7 oz/acre	3.5 oz/acre	7	0.5	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action for 2 applications. Use no more than 28 oz/ acre per year.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-33. ALTERNATIVE MANAGEMENT TOOLS – PEA (ENGLISH)

A. Keinath, Plant Pathologist, Clemson University

Disease	Resistant Varieties	Non-chemical Controls
Pythium Damping-off		Use raised beds to dry soil surface.
Powdery mildew	No	Spray with sulfur at first appearance of disease.

TABLE 3-34. ALTERNATIVE MANAGEMENT TOOLS – PEA (SOUTHERN)

E. Sikora, Plant Pathologist, Auburn University

Disease	Resistant Varieties	Non-chemical Controls
Pythium Damping-off	No	Use raised beds to dry soil surface.
Downy mildew	Yes	Copper spray at first appearance. Remove and destroy severely infected plants, rotate and destroy residue.
Cercospora	No	
Anthracnose	No	Spray with copper or bordeaux mix. Do not handle when leaves are wet.
Powdery mildew		Spray with sulfur at first appearance of disease.

TABLE 3-35. DISEASE CONTROL FOR PEPPER

K. Ivors, Plant Pathologist, NCSU; D. Langston, Plant Pathologist, UGA; and G. Vallad, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Aphid-transmitted viruses: PVY, TEV, WMV, CMV	JMS Stylet-Oil	3 qt/100 gal water Use in 50 to 200 gal per acre depending on plant size		0	Dry	Spray weekly when winged aphids first appear.
Anthracnose fruit rot	azoxystrobin (Quadris) flowable 2.08F	2 to 5 oz/acre 6.2 oz/acre	0.1 to 0.25 lb/acre	0	4 hr	A new disease complex, Anthracnose green fruit rot, may require initiation of applications at fruit set. Make no more than two sequential applications and no more than four applications per crop year. Consider Quadris, and Cabrio as the same chemistry for resistance management.
	fenamidone (Reason)	5.5 to 8.2 fl oz/acre	0.178 to 0.267 fl oz/ acre	14	12 hr	Apply as soon as conditions are favorable for disease development and continue on a 5 – 7 day spray interval.
	pyraclostrobin (Cabrio) EG 20%	8 to 12 oz/acre	1.6 to 2.4 oz/acre	0	4 hr	
	chlorothalonil (Bravo, Echo)	1.5 pt/acre	—	3	1	
	azoxystrobin + difenoconazole (Quadris Top) 29.6 SC	8 fl oz/acre	0.17 lb/acre	0	0.5	Begin applications prior to disease development, and continue on a 7 – 10 day interval. Make no more than 2 sequential applications before rotating to another effective fungicide with a different mode of action.
	pyraclostrobin + fluxapyroxad (Priaxor)	4.0 to 8.0 fl oz/acre	0.13 to 0.26 lb/acre	7	12 hr	Use preventively.
	penthiopyrad (Fontelis)	10 to 24 fl oz/acre	0.13 to 0.31 fl oz/acre	0	12 hr	Use prior to disease onset.
Bacterial and other post-harvest rots	sodium hypochlorite (Clorox 5.25%)	1 gal/1,000 gal (53 ppm Sodium hypochlorite)		—	—	Use in dump-tank water or as a spray. Monitor chlorine concentration and dump-tank water pH. There may be specific regulations as to disposal of used dump-tank water. Foliar applications of a copper fungicide 1 to 3 days before harvest and immediately after first harvest may reduce Bacterial soft rot.
Bacterial spot (field)	copper (Champ, Champion, Cuprofix Ultra, Kocide 3000, MasterCop, Nordox, Nu-Cop, etc.)	Check label; varies between products		Check label; varies between products	2	Make first application 7 to 10 days after transplanting. Carefully examine field for disease to determine need for additional applications. If disease is present, make additional applications at 5- today intervals. Applying mancozeb with copper significantly enhances Bacterial spot control.
	Actigard 50 WG	0.33 oz to 0.75 oz/ acre		14	0.5	**FOR CHILI PEPPERS ONLY.** Begin applications within one week of transplanting or emergence. Make up to 6 weekly, sequential applications
	quinoxyfen (Quintec)	6.0 oz/acre		3	0.5	Use 6 oz of product per acre in no less than 30 gallons of water per acre.
Bacterial spot (transplants)	streptomycin sulfate (Agri-Mycin 17, Firewall, Streptrol)	1 lb/100 gal		**NOT FOR FIELD USE**	1	Spray at first disease appearance and continue at 5-day intervals until trans planting into field. **NOTE: Some pathogen strains are resistant to streptomycin sulfate and tolerant of copper.**
	copper (Kocide 3000, MasterCop, etc.)	Kocide 3000: 0.5 to 1.5 TBSP per 1000 sq ft in GH or shadehouses; check label for others		—	1 to 2 days depending on product	Begin applications when conditions first favor disease development and repeat at 3 to 10 day intervals if needed depending on disease severity. Use the higher rates when conditions favor disease
Bacterial spot (seed)	sodium hypochlorite (Clorox 5.25%)	1 pt + 4 pt water		—	—	See table for Sanitizing Greenhouses and Plant Beds.
Cercospora leaf spot	azoxystrobin + difenoconazole (Quadris Top) 29.6 SC	8 fl oz/acre	0.17 lb/acre	0	0.5	Begin applications prior to disease development, and continue on a 7 – 10 day interval. Make no more than 2 sequential applications before rotating to another effective fungicide with a different mode of action.
Pythium (damping-off)	Propamocarb hydrochloride (Previcur Flex)	1.2 pt/acre	—	5	0.5	Begin applications when conditions favor disease, before infection.
Pythium damping-off (plant bed)	soil treatment before seeding	—	—	—	—	

TABLE 3-35. DISEASE CONTROL FOR PEPPER (cont'd)

K. Ivors, Plant Pathologist, NCSU; D. Langston, Plant Pathologist, UGA; and G. Vallad, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Phytophthora foliar blight	cyazofamid (Ranman)	2.75 fl oz/acre		0	0.5	For *Phytophthora* blight control apply to the base of the plants at time of transplanting or include in transplant water.
	mefenoxam + copper hydroxide (Ridomil Gold/ Copper)	2.5 lb/acre		7	2	If this spray is used, start in place of the second supplemental soil application.
	famoxadone + cymoxanil (Tanos) 50% DF	8 to 10 oz/acre	4 to 5 oz/acre	3	4 hr	Make no more than 1 application before alternating with a fungicide with a different mode of action, such as maneb or copper.
	fluopicolide (Presidio)	3 to 4 fl oz/acre	0.09 to 0.125 lb./acre	2	0.5	Do not use more than 2 times sequentially and not more than 4 times per acre per season. Must be tank-mixed with another mode of action product.
	mandipropamid (Revus)	8 fl oz/acre	0.13 lb/acre	1	12 hr	Should always be tank mixed with protectant to provide adequate control.
	amectoctradin + dimethomorph (Zampro)	14.0 fl oz/acre	0.27 lb/acre	4	12 hr	Apply prior to disease onset and continue on a 5 – 7 day spray interval.
Phytophthora, Pythium damping-off (field)	mefenoxam (Ridomil Gold) SL (Ultra Flourish) 2 EC	1 pt/treated acre 1 qt/treated acre		**CAN ONLY BE APPLIED AT PLANTING**	2	Must be applied to soil before plants are infected. Can be applied at planting time in 20 to 50 gal water per acre. Apply in a 12 to 16 in. band. Mechanical incorporation or 0.5 to 1 in. irrigation water is needed for movement into root zone if rain is not expected. After initial application, two supplemental applications (1 pt per treated acre) can be applied. **NOTE: Strains of *Phytophthora capsici* insensitive to Ridomil Gold have been detected in some North Carolina pepper fields.**
	metalaxyl (MetaStar) 2 E	4 to 8 pt/treated acre	0.5 to 1 lb/acre	7	2	Preplant (soil incorporated), at planting (in water or liquid fertilizer), or as a basil-directed spray after planting.
Powdery mildew	azoxystrobin (Quadris) flowable 2.08F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 lb/acre	0	4 hr	Do not apply more than 2 sequential applications and no more than 4 per crop year.
	azoxystrobin + difenoconazole (Quadris Top) 29.6 SC	8 fl oz/acre	0.17 lb/acre	0	0.5	Begin applications prior to disease development, and continue on a 7 – 10 day interval. Make no more than 2 sequential applications before rotating to another effective fungicide with a different mode of action.
	quinoxyfen (Quintec)	4.0 to 6.0 fl oz/acre		3	0.5	Avoid consecutive use of quinoxyfen or other Group 13 fungicides.
	sulfur*	See label		0	1	Apply at first appearance and repeat at 14-day intervals as needed.
Southern blight *(Sclerotium rolfsii)*	fluoxastrobin (Evito) 480 SC	2.0 to 5.7 fl oz/ acre	0.06 to 0.18 lb/acre	7	4 hr	See label for details.
	pyraclostrobin + fluxapyroxad (Priaxor)	4.0 to 8.0 fl oz/acre	0.13 to 0.26 lb/acre	0	12 hr	Use preventively.
	penthiopyrad (Fontelis)	10 to 24 fl oz/acre	0.13 to 0.31	0	12 hr	Use prior to disease onset.
	PCNB (Terrachlor) 75 WP 4 F	3 lb/100 gal 4.5 pt/100 gal		**CAN ONLY BE APPLIED AT PLANTING**		Apply only at planting time. Use 1/2 pt per plant, or if applied as in-furrow spray to open "V" trench see label for specific rates and instructions. This material is a protective fungicide and must be placed into the soil.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-36. RELATIVE EFFECTIVENESS OF VARIOUS CHEMICALS FOR PEPPER DISEASE CONTROL

K. Ivors, Plant Pathologist, NCSU; D. Langston, Plant Pathologist, UGA; and G. Vallad, Plant Pathologist, UF

Scale: "—" = ineffective; "+"…….. "++++" = very effective; "?" = activity unknown; "NA" = not applicable.

Pesticide	Fungicide Group[1]	Preharvest Interval (Days)	Relative Control Rating					
			Anthracnose (immature fruit rot)	Bacterial Spot	*Phytophthora* Blight (root and crown)	*Phytophthora* Blight (fruit and foliage)	*Pythium* Damping off	Southern Blight
azoxystrobin (Quadris)	11	0	+++	—	—	—	—	?
famoxadone + cymoxanil (Tanos)	11 + 27	3	+	—	—	+	—	?
fluoxastrobin (Evito)	11	3	+++	—	—	—	—	?
pyraclostrobin (Cabrio)	11	0	++++	—	—	—	—	?
fluxapyroxad + pyraclostrobin (Priaxor)	11 + 7	7	+++	—	—	—	—	?**
chlorothalonil (Bravo, Echo)	M	3	+	—	—	+	—	—
cyazofamid (Ranman)	21	0	—	—	+++	++++	—	—
dimethomorph (Acrobat, Forum)	40	4	—	—	—	+	—	—
dimethomorph + amectoctradin (Zampro)	40 + 45	4	—	—	+++	++++	?	—
fixed copper[2]	M	Check label	+	+++	—	++	—	—
fluopicolide (Presidio)	43	2	—	—	+++	++++	—	—
mancozeb[3] (Manzate, Dithane)	M	5	++	+	+	+	—	—
mandipropamid (Revus)	40	1	—	—	+++	++++	—	—
mefenoxam[R] (Ridomil Gold SL, Ultra Flourish)	4	0	—	—	+++++	NA	++++	—
mefenoxam + copper (Ridomil Gold/Copper)	4 + M	14	+	++	NA	++++	—	—
PCNB (Terraclor)	14	Only at planting	—	—	—	—	—	+++
penthiopyrad (Fontelis)	7	0	?	—	—	—	—	?
propamocarb (Previcur Flex)	28	5	—	—	—	—	+++	—
quinoxyfen (Quintec)	13	3	—	+	—	—	—	—
streptomycin sulfate[4] (Agri-mycin, Streptrol, Firewall)	25	Not for field use	—	+++	—	—	—	—
sulfur	M	0	—	—	—	—	—	—

[1] **Key to Fungicide Groups**: 3: demethylation inhibitors; 4: phenylamides; 7: carboxamides, 9: anilonopyrimidines; 11: quinone outside inhibitors; 14: aromatic hydrocarbons; 15: cinnamic acids; 25: glucopyranosyl antibiotic; 27: cyano-acetamide-oximes; 28: carbamates; 40: carboxylic acid amine; 43: acylpicolides; 45: complex III, cytochrome bc1 (ubiquinone reductase); M: multi-site activity; NA: not applicable.

[2] Fixed coppers include: Basicop, Champ, Champion, Citcop, Copper-Count-N, Kocide, Nu-Cop, Super Cu, Tenn-Cop, Top Cop with Sulfur, and Tri-basic copper sulfate.

[3] Copper tank-mixed with mancozeb enhances the efficacy against bacterial spot.

[4] Streptomycin may only be used on transplants; not registered for field use.

[R] Resistance to this pesticide has been detected in the pathogen population. In the case of mefenoxam, *Phytophthora* (late blight) resistant strains predominate.

TABLE 3-37. RELATIVE EFFECTIVENESS OF ALTERNATIVE MANAGEMENT PRACTICES FOR DISEASE CONTROL ON PEPPER

K. Seebold, Plant Pathologist, University of Kentucky; K. Ivors, Plant Pathologist, NCSU; and D. Langston, Plant Pathologist, UGA

Key to Efficacy Ratings: "++++" = Excellent; "+++" = Good; "++" = Fair; "+" = Poor; "—" = Not effective
"V" = efficacy variable by region; "L" = late planting date is most effective; "E" = early planting date is most effective

	RELATIVE CONTROL RATING										
Practice	**Anthracnose (immature fruit)**	**Bacterial soft rot of fruit**	**Bacterial spot**	**Blossom-end rot**	***Phytophthora* blight (fruit and foliage)**	***Phytophthora* blight (root and crown)**	***Pythium* damping-off**	**Root-knot nematode**	**Southern blight**	**Aphid-transmitted viruses (PVX, CMV, TEV, AMV, PVY)**	**Tomato Spotted Wilt Virus**
Avoid field operations when foliage is wet	+++	-	++++	-	++	+	-	-	-	-	-
Avoid overhead irrigation	++++	++	++++	-	++++	++++	+	-	-	-	-
Change planting date within a season	-	-	++E	-	-	-	+L	++E	+E	++E	V
Cover cropping with antagonist	-	-	-	-	-	-	-	+++	-	-	-
Rotation with non-host (2-3 years)	++++	-	-	-	+	+	-	+++	+	-	-
Deep plowing	++	-	-	-	-	-	-	+	+++	-	-
Prompt destruction of crop residue	++	-	+	-	+	+	-	++	+	++	-
Promote air movement	+	-	++	-	+	+	-	-	-	-	-
Use of soil organic amendments	-	-	-	-	+V	+V	+V	++	+V	-	-
Application of insecticidal/horticultural oils	-	-	-	-	-	-	-	-	-	++	-
pH management (soil)	-	-	-	+++	-	-	-	++	-	-	-
Plant in well-drained soil / raised beds	-	-	-	-	-	++++	++++	-	-	-	-
Eliminate standing water / saturated areas	-	-	-	-	-	++++	++++	-	-	-	-
Postharvest temp control (fruit)	-	++++	-	-	-	-	-	-	-	-	-
Use of reflective mulch	-	-	-	-	-	-	-	-	-	+++	++++
Reduce mechanical injury	-	-	-	-	-	-	-	-	-	-	-
Rogue diseased plants / fruit	-	-	-	-	++	++	-	-	-	-	-
Soil solarization	-	-	-	-	-	+	-	++	-	-	-
Use of pathogen-free planting stock	+++	-	++++	-	-	-	-	-	-	-	-
Use of resistant cultivars	-	-	++++	+++	+++	+++	-	++++	-	-	++++
Weed management	+	-		-	+	+	-	++	-	++	+

TABLE 3-38. DISEASE CONTROL FOR POTATO, IRISH

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Black and silver scurf	azoxystrobin (Amistar, Amistar) 0.8 F	0.125 to 0.25 oz/1,000 sq ft	0.006 to 0.012 lb/1,000 sq ft	0.16	4 hr	Apply in furrow at planting according to label directions.
Fusarium seedpiece decay, *Rhizoctonia* stem canker, *Streptomyces* common scab	azoxystrobin + mefenoxam 2.08 F + 4 F	0.82 fl oz/1,000 ft of row	0.01 lb/1,000 ft of row	—	0	Apply as an in-furrow spray in 3 to 5 gal of water per acre at planting. Not for *Fusarium* or Scab.
	fludioxonil (Maxim) (Maxim) 4FS (Maxim) MZ	0.5 lb/100 lb seed 0.08 to 0.16 oz/100 lb seed 0.5 lb/100 lb seed	—	—	— 0.5 1	If possible, cut seed pieces, wound-heal for 2 to 3 days at 55° to 65° F at high relative humidity, then treat (dust or dip) with fungicide prior to planting. If cut seedpieces are not wound-healed, dust or dip with fungicides and allow to dry in a cool place before planting. Do not use treated seedpieces for feed or food.
	mancozeb (Dithane Rainshield NT) DF (Dithane F-45 Rainshield) 4F (Dithane M-45) 80 WP (Manex II) 4F (Manzate) 75 DF or 80 WP (Penncozeb) 75 DF or 80 WP	 1.25 lb/50 gal water 1 qt/50 gal water 1.25 lb/50 gal water 1 qt/50 gal water 1.25 lb/50 gal water 1.25 lb/50 gal water	0.02 lb/gal water	—	—	
	maneb (Manex) 4F	0.8 qt/10 gal water	0.02 lb/gal water	—	—	
	thiophanate-methyl + mancozeb (Tops MZ)	0.75 lb/100 lb seed	—	—	—	
	thiophanate-methyl + mancozeb + cymoxanil (Evolve)	0.75 lb/100 lb seed	—	—	—	
Early blight, white mold	iprodione (Rovral) 50 WP 4 F	1 to 2 lb/acre 1 to 2 pt/acre	0.5 to 1 lb/acre	14	1	For White mold control, apply at first sign of disease or immediately before row closure. If conditions favor disease development, apply again 14 to 28 days later. For early blight, make a maximum of 4 applications, beginning when disease first appears and then on 10- to 14-day intervals or as required.
	boscalid (Endura)	2.5 to 10 oz/acre	0.11 to 0.44 lb/acre	30	0.5	For control of *Sclerotinia* White mold, use 5.5 to 10 oz rate and begin applications prior to row closure or at the onset of disease. Make a second application 14 days later if conditions continue to favor disease development. For Early blight control, use 2.5 to 4.5 oz rate. **DO NOT** apply more than 20.5 oz of product per acre per season.
Late blight, white mold	fluazinam (Omega) 500 F	5.5 to 8 oz/acre	0.16 to 0.26 oz/acre	14	1	Begin applications when plants are 6 to 8 in. tall or when conditions favor disease development. Repeat applications at 7- to 10-day intervals. When white mold pressure is low to moderate, use 5.5 fl oz. When conditions favor moderate to high white mold pressure, increase the rate to 8 fl oz. **DO NOT** apply more than 3.5 pt per acre during each growing season.
Early blight, late blight	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 oz/acre	0.1 to 0.25 lb/acre	14	4 hr	Alternate with protectant fungicide (chlorothalonil or mancozeb). **DO NOT** apply more than 1.88 lb per acre per season.
	(Amistar) 0.8 F	2 to 5 oz/acre	0.1 to 0.25 lb/acre	0.16	4 hr	Check label for rates and application schedules. Also manages Black dot and Powdery mildew. **DO NOT** apply more than 1.88 lb per acre per season.

TABLE 3-38. DISEASE CONTROL FOR POTATO, IRISH (cont'd)

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Early blight, late blight (cont'd)	chlorothalonil			7		*Bravo S is not labeled for control of *Botrytis* vine rot.
	(Bravo Ultrex) 82.5 WDG	0.7 to 1.4 lb/acre	0.6 to 1.2 lb/acre		2	
	(Bravo Weather Stik) 6F	0.75 to 1.5 pt/acre	0.6 to 1.2 lb/acre		2	
	(Bravo Weather Stik Zn)	0.75 to 1.5 pt/acre	0.5 to 1.1 lb/acre		2	
	(Bravo 500)	1.2 to 2.4 pt/acre	0.6 to 1.2 lb/acre		2	
	(Bravo S)	2.5 to 4.25 pt/acre	—		2	
	(Bravo Zn)	1.25 to 2.25pt/acre	0.6 to 1.125 lb/acre		2	
	(Equus) 720	0.75 to 1.5 pt/acre	0.6 to 1.1 lb/acre		0.5	
	(Equus) DF	0.7 to 1.36 lb/acre	0.6 to 1.1 lb/acre		0.5	
	copper hydroxide (Champ 2)	0.6 to 2.6 pt/acre	—	0	1	Apply at 7- to 10-day intervals. Use higher rates when disease pressure is high.
	copper hydroxide (Kocide)			—	1	
	DF	1 to 4 lb/acre	0.6 to 2.5 lb/acre			
	4.5 LF	0.6 to 2.6 pt/acre	0.3 to 1 lb/acre			
	101	1 to 4 lb/acre	0.8 to 3 lb/acre			
	2000	0.75 to 3 lb/acre	0.4 to 1.6 lb/acre			
	copper hydroxide + manzate (ManKocide)	1.5 to 5 lb/acre	—	14	1	
	copper salts of fatty and rosin acids (Tenn-Cop) 5E	3 pt/acre	—	0	0.5	
	copper sulfate (Basicop)	3 to 6 lb/acre	1.6 to 3.2 lb/acre	—	1	
	cyazofamid (Ranman) 400 SC	1.4 to 2.75 fl oz/acre	0.036 to 0.071 lb/acre	7	0.5	Late blight only. Do not apply more than 10 sprays per crop. Make no more than 3 consecutive applications followed by 3 applications from a different resistance management group.
	cymoxanil (Curzate) 60 DF	3.2 oz/acre	0.1 lb/acre	14	1	Use Curzate or Acrobat in combination with a protectant fungicide (chlorothalonil, mancozeb, metiram, or triphenyltin hydroxide). **DO NOT** exceed more than 32 oz per acre per season.
	dimethomorph (Acrobat, Forum) 50 WP	4 to 6.4 oz/acre	2 to 3.2 oz/acre	4	0.5	Apply on a 5- to 10-day schedule depending on disease pressure. Check label for rotational crop guidelines. Use in combination with a protectant fungicide. **DO NOT** tank mix with metalaxyl or mefenoxam.
	dimethomorph (9%) + mancozeb (60%) (Acrobat 50 MZ)	2.25 lb/acre	—	14	1	Apply on a 5- to 10-day schedule depending on disease pressure. **DO NOT** make more than five applications per season.
	famoxadone + cymoxanil (Tanos)	6 to 8 oz/acre	3 to 4 oz/acre	14	1	Begin applications when conditions favor disease development or when disease is present in area. Should be tank mixed with a protectant fungicide (chlorothalonil or mancozeb). **DO NOT** apply more than 48 oz per acre per season.
	fenamidone (Reason) 500 SC	5.5 to 8.2 fl oz/acre	0.178 to 0.267 lb/acre	14	0.5	Begin applications when conditions favor disease development, and continue on 5- to 10-day interval. Do not apply more than 24.6 fl oz per growing season. Alternate with fungicide from different resistance management group.
	fluoxastrobin (Evito) 480 SC	3.8 fl oz/acre	0.12 lb/acre	7	0.5	Begin applications when conditions favor disease development, on 7- to 10-day intervals. Do not apply more than once before alternating with fungicides that have a different mode of action. Do not apply more than 22.8 fl oz per acre per season.

TABLE 3-38. DISEASE CONTROL FOR POTATO, IRISH (cont'd)

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Early blight, late blight (cont'd)	mancozeb			14	1	Apply when conditions favor disease but before symptoms appear. Continue applications on a 5- to 10-day schedule depending on disease pressure. Under high disease pressure, shorten spray interval and use maximum rate. Fungicides should be used as part of an integrated pest management program.
	(Dithane DF Rainshield NT)	0.5 to 2 lb/acre	0.4 to 1.5 lb/acre			
	(Dithane F-45 Rainshield 4F)	0.4 to 1.6 qt/acre	0.4 to 1.6 lb/acre			
	(Dithane M-45) 80 WP	0.5 to 2 lb/acre	0.4 to 1.6 lb/acre			
	(Manex II 4F)	0.8 to 1.6 qt/acre	0.8 to 1.6 lb/acre			
	(Manzate) 75 DF	1 to 2 lb/acre	0.7 to 1.5 lb/acre			
	(Manzate) 80 WP	1 to 2 lb/acre	0.8 to 1.6 lb/acre			
	(Penncozeb) 75WP	0.5 to 2 lb/acre	0.375 to 1.5 lb/acre			
	(Penncozeb) 80DF	0.5 to 2 lb/acre	0.4 to 1.6 lb/acre			
	mandipropamid + difenoconazole (Revus Top)	5.5 to 7 oz/acre		1	0.5	Begin applications when conditions favor disease development, on 7- to 10-day intervals. Do not apply more than twice before alternating with fungicides that have a different mode of action. Do not apply more than 28 fl oz per acre per season.
	maneb (Manex) 4F	0.8 to 1.6 qt/acre	0.8 to 1.6 lb/acre	14	1	
	mefenoxam+ chlorothalonil (Ridomil Gold/Bravo, Flouronil) 76.5 WP	2 lb/acre	—	14	2	Do not exceed more than three to four foliar applications. See label for more details.
	mefenoxam+ copper hydroxide (Ridomil Gold/ Copper)	2 lb/acre	—	14	2	
	mefenoxam+ mancozeb (Ridomil Gold MZ)	2.5 lb/acre	—	14	2	
	metiram (Polyram) 80 DF	1.5 to 2 lb/acre	1.2 to 1.6 lb/acre	14	1	
	propamocarb (Previcur Flex) 6 F	0.7 to 1.2 pt/acre	0.5 to 0.9 lb/acre	14	0.5	Do not apply more than 6 pt per growing season. Use lower rates when conditions favor disease but disease is not present. Increase rate as risk of disease development increases.
	pyraclostrobin (Headline) 2.08 F	6 to 12 oz/acre	1.4 to 2.8 oz/acre	3	1	**DO NOT** exceed more than six foliar applications or 72 total oz of product per acre per season. For early blight, use 6- to 9-oz rate; for late blight, use 6- to 12-oz rate, depending on weather conditions and disease pressure.
	pyraclostrobin + fluxapyroxad (Priaxor)	4.0 to 8.0 fl oz/acre	0.13 to 0.26 lb/acre	7	12 hr	Use preventively. Offers some suppression of late blight.
	pyrimethanil (Scala) 5 F	7 fl oz/acre	0.27 lb/acre	7	0.5	Early blight only. Use only in a tank mix with another Early blight fungicide. Do not apply more than 35 fl oz per crop.
	trifloxystrobin (Gem)	6 to 8 oz/acre	1.5 to 2 oz/acre	7	0.5	Begin applications preventively and continue as needed on a 7- to 10-day schedule. Alternate every other application with a protectant fungicide. **DO NOT** apply more than 48 oz per acre per season.
	triphenyltin hydroxide (Super Tin) 80 WP	2.5 to 3.75 oz/acre	0.2 to 0.3 lb/acre	21	1	Add to 3 to 15 gal of water depending on method of application. Do not exceed more than 15 oz of product per acre per season.
	zoxamide + mancozeb (Gavel) 75DF	1.5 to 2 lb/acre	1.13 to 1.5 lb/acre	14	2	
Fusarium tuber rot	thiabendazole (Mertect 340F)	0.2 oz/100 lb seed	—	—	—	Mist whole, unwashed tubers with fungicide solution to ensure proper coverage. Tubers may be treated again after storage and before shipping if needed. Do not apply to cut seed-pieces. Some isolates of *Fusarium* are resistant to Mertect.
Late blight	cyazofamid (Ranman) 400 SC	1.4 to 2.75 fl oz/acre	0.036 to 0.071 lb/acre	7	0.5	**Late blight only.** Do not apply more than 10 sprays per crop. Make no more than 3 consecutive applications followed by 3 applications of fungicides from a different resistance management group.

TABLE 3-38. DISEASE CONTROL FOR POTATO, IRISH (cont'd)

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Pink rot, *Pythium* leak, tuber rot	azoxystrobin + mefenoxam (Quadris Ridomil Gold) 2.08 F + 4 F	0.82 fl oz/1,000 fl of row	0.01 lb/1,000 ft of row	—	0	Apply as an in-furrow spray in 3 to 15 gal of water per acre at planting.
	mefenoxam + chlorothalonil (Ridomil Gold/Bravo, Flouronil) 76.5 WP	2 lb/acre	—	14	2	Apply at flowering and then continue on a 14-day interval. Do not exceed more than four applications per crop.
	mefenoxam + copper hydroxide (Ridomil Gold/ Copper)	2 lb/acre	—	14	2	
	mefenoxam + mancozeb (Ridomil Gold MZ)	2.5 lb/acre	—	14	2	
	metalaxyl (MetaStar) 2 E	4 to 8 pt/trt acre	0.5 to 1 lb/acre	7	2	Preplant incorporated or soil surface spray
Powdery mildew	chlorothalonil + sulfur (Bravo S)	4.3 pt/acre	—	7	2	Apply when disease first appears; then repeat as needed. Check label for application intervals. Avoid applying sulfur on days over 90°F.
	sulfur (Microthiol Disperss) 80 MWS	5 lb/acre	4 lb/acre	0	2	

TABLE 3-39. ALTERNATIVE MANAGEMENT TOOLS–POTATO, IRISH

Disease	Resistant Varieties	Non-chemical Controls
Seed piece decay	No	Use fir bark to keep cut surface dry.
Early blight	Yes	Spray with copper or Bordeaux mix and keep plants actively growing. There are a few resistant cultivars.
Late blight	Tolerant varieties	Spray with copper or Bordeaux mix and keep plants actively growing. There are a few tolerant cultivars.
Verticillium wilt	Tolerant varieties	Use tolerant cultivars and solarize soil with clear plastic before planting, use 3 year rotation.

PUMPKIN, WINTER SQUASH, SUMMER SQUASH SEE CUCURITS

RADISH SEE ROOT VEGETABLES

SCALLION SEE ONION, GREEN

SHALLOT SEE ONION, DRY

TABLE 3-40. DISEASE CONTROL FOR ROOT VEGETABLES (EXCEPT SUGAR BEET)

S. Bost, Plant Pathologist, UT

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Beet (red, garden or table), Carrot, Parsnip, Radish, Turnip – Harvested for roots only						
Downy mildew	fixed copper*	See label	-	1	1-2	Spray or dust at first appearance, 7- to 10-day intervals.
	Actigard 50WG	0.5 to 1 oz/acre	0.25 to 0.5 oz/acre	7	0.5	**FOR RADISH, RUTABAGA, AND TURNIP ONLY.** Make up to 4 applications at 7-day intervals.
Leaf spots	fixed copper*	See label	-	1	1-2	Spray or dust at first appearance, 7- to 10-day intervals.
Pythium root rot	mefenoxam (Ridomil Gold) 4 SL (Ultra Flourish) 2 EC	1 to 2 pt/trt acre 2 to 4 pt/trt acre	0.5 to 1 lb/trt acre	-	2	Apply preplant incorporated into top 2 inches, as a soil spray at planting, or in drip irrigation at planting.
	metalaxyl (MetaStar) 2 E	4 to 8 pt/ trt acre	0.9 to 1.8 pt/trt acre	-	2	Apply preplant incorporated into top 2 inches of soil or as a post-plant soil spray at planting followed by 0.5 to 1 inches of water.
Rust	penthiopyrad (Fontelis) 1.67 SC	16 to 30 fl oz/acre	3.26 to 6.78 fl oz/ acre	0	0.5	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 61 fl oz/acre per year.
	sulfur*	See label	2 to 4 lb/100 gal	0	1	
Alternaria blight, black crown rot	iprodione (Rovral) 4 F	1 to 2 pt/acre	0.5 to 1 lb/acre	0	1	**FOR USE ON CARROTS ONLY!** Make no more than 4 applications per season.
Alternaria leaf blight, *Cercospora* leaf spot	azoxystrobin (Quadris) 2.08 F	9.0 to 15.5 fl oz/ acre	0.15 to 0.25 lb/acre	0	4 hr	No more than 1 application before alternating with a fungicide with a different mode of action. Make no more than 123 fl oz per acre per year.
	boscalid (Endura) 70WG	4.5 oz/acre	0.2 lb/acre	0	0.5	**FOR USE ON CARROTS ONLY!** Not for *Cercospora*. Do not make more than 2 sequential applications or more than 5 applications per season.
	chlorothalonil (Bravo Ultrex) 82.5 WDG	1.4 to 1.8 lb/acre	1.1 to 1.5 lb/acre	-	0.5	**FOR USE ON CARROTS ONLY!** Spray at first appearance, 7- to 10-day intervals.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	6.9 to 8.7 oz/acre	7	0.5	Not for *Cercospora*. Apply when disease first appears, and continue on 7- to 10-day intervals if conditions remain favorable for disease development. Do not exceed 56 oz of product per acre per year.
	fixed copper*	3 to 4.5 pt/acre	-	1	1-2	
	penthiopyrad (Fontelis) 1.67 SC	16 to 30 fl oz/acre	3.26 to 6.78 fl oz/ acre	0	0.5	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 61 fl oz/acre per year.
	pyraclostrobin (Cabrio) 20 WG	8 to 12 oz/acre	1.6 to 2.4 oz/acre	0	0.5	Alternate with a fungicide with a different mode of action.
	pyraclostrobin + boscalid (Pristine) 38 WG	8 to 10.5 oz/acre	3 to 4 oz/acre	0	0.5	**FOR USE ON CARROTS ONLY!** Make no more than 2 sequential applications before alternating with a different mode of action. Use no more than 63 oz or make no more than 6 applications per season.
	trifloxystrobin (Flint) 50 WDG	2 to 3 oz/acre *For radish:* 2 to 4 oz/acre	1 to 1.5 oz/acre *For radish:* 1 to 2 oz/acre	7	0.5	Make no more than 1 application before alternating with a fungicide with another mode of action.
	trifloxystrobin (Gem) 500 SC	1.9 to 2.9 fl oz/acre	0.81 to 1.24 fl oz/ acre			Make no more than 4 applications per season.
Cercospora leaf spot or blight, powdery mildew	propiconazole (Tilt) 3.6 F	3 to 4 fl oz/acre	0.084 to 0.112 lb/ acre	14	0.5	**FOR USE ON GARDEN BEETS AND CARROTS ONLY!** Use higher rate for carrots. Make no more than 2 consecutive applications before alternating with a fungicide with a different mode of action. Apply no more than 16 fl oz/acre/season.
	tebuconazole (Folicur) 3.6EC	4 to 7.2 fl oz/acre	0.113 to 0.203 lb/ acre	7	0.5	**FOR USE ON TURNIP ONLY**. Repeat applications at 12- to 14-day intervals. Apply no more than 28 fl oz / acre/ season.
Pythium cavity spot	fenamidone (Reason) 500 SC	8.2 fl oz/acre	0.27 lb/acre	14	0.5	**FOR USE ON CARROTS ONLY!** Make no more than 1 application before alternating with a mefenoxam-containing fungicide. Apply no more than 24.6 fl oz per growing season.
Pythium cavity spot, root dieback, root forking	cyazofamid (Ranman) 400 SC	6 fl oz/acre	0.156 lb/acre	14	0.5	**FOR USE ON CARROTS ONLY!** Maximum of 5 applications per crop. Alternate with a fungicide with a different mode of action. Maximum of 30 fl oz/acre per growing season.
	fluopicolide (Presidio) 4 F	3 to 4 fl oz/acre	0.09 to 0.125 lb/acre	7	0.5	***NOT* FOR USE ON CARROTS!** Must be tank-mixed with a fungicide with a different mode of action on the target pathogen. Make no more than 4 applications per year with no more than 2 sequential applications before alternating with another fungicide. Maximum of 12 fl oz/acre/year.

TABLE 3-40. DISEASE CONTROL FOR ROOT VEGETABLES (EXCEPT SUGAR BEET) (cont'd)

S. Bost, Plant Pathologist, UT

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Beet (red, garden or table), Carrot, Parsnip, Radish, Turnip – Harvested for roots only (cont'd)						
Powdery mildew	azoxystrobin (Quadris) 2.08 F	9.0 to 15.5 fl oz/ acre	0.15 to 0.25 lb/acre	0	4 hr	No more than 1 application before alternating with a fungicide with a different mode of action. Apply no more than 123 fl oz per acre per season.
	boscalid (Endura) 70 WG	See label	0.2 lb/acre	0	0.5	**FOR USE ON CARROTS ONLY!** Make more than 2 sequential applications before alternating with a fungicide with a different mode of action. Make no more than 5 applications per season.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	0.430 to 0.547 lb/ acre	7	0.5	Make no more than 2 applications per crop. For radish, apply no more than 28 oz per crop or 56 oz per plot of land per year.
	pyraclostrobin (Cabrio) 20 EG	8 to 12 oz/acre	1.6 to 2.4 oz/acre	0	0.5	Alternate with a fungicide with a different mode of action.
	pyraclostrobin + boscalid (Pristine) 38 WG	8 to 10.5 oz/acre	3 to 4 oz/acre	0	0.5	**FOR USE ON CARROTS ONLY!** Make no more than 2 sequential applications before alternating with a different mode of action. Use no more than 63 oz or make no more than 6 applications per season.
	penthiopyrad (Fontelis) 1.67 SC	16 to 30 fl oz/acre	3.26 to 6.78 fl oz/ acre	0	0.5	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 61 fl oz/acre per year.
	sulfur*	3 to 10 lb/acre	-		1	Spray at first appearance. Avoid applying on days over 90°F.
Sclerotinia, *Botrytis*	boscalid (Endura) 70 WG	7.8 oz	0.34 lb/acre	0	0.5	**FOR USE ON CARROTS ONLY!** No more than 2 applications before alternating with a fungicide with a different mode of action. Limit of 3 applications per season.
	penthiopyrad (Fontelis) 1.67 SC	16 to 30 fl oz/acre	3.26 to 6.78 fl oz/ acre	0	0.5	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 61 fl oz/acre per year.
Sclerotinia, *Botrytis* (postharvest)	thiabendazole (Mertect 340-F) 4.1 F	41 fl oz/100 gal	1.31 lb/100 gal	-	0.5	Dip harvested roots 5 to 10 seconds. Do not rinse.
Southern blight	dichloropropene (Telone) C-17 C-35	 10.8 to 17.1 gal/A 13 to 20.5 gal/A	 107 to 169 lb/acre 139 to 220 lb/acre	-	5	Fumigate soil in-the-row 3 to 6 weeks before seeding. Rate is based on soil type; see label for in-row rates.
	pyraclostrobin + boscalid (Pristine) 38 WG	8 to 10.5 oz/acre	3 to 4 oz/acre	0	0.5	**FOR USE ON CARROTS ONLY!** Suppression only. Make no more than 6 applications per season.
	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/1000 row ft	0.0065 to 0.013 lb/1000 row ft	0	4 hr	Make one application, applied either in-furrow at planting, in a 7-inch band over the row prior to or shortly after planting, or in drip irrigation.
	penthiopyrad (Fontelis) 1.67 SC	16 to 30 fl oz/acre	3.26 to 6.78 fl oz/ acre	0	0.5	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 61 fl oz/acre per year.
Rhizoctonia root canker	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/1000 row ft	0.0065 to 0.013 lb/1000 row ft	0	4 hr	Make one application, applied either in-furrow at planting, in a 7-inch band over the row prior to or shortly after planting, or in drip irrigation.
White rust	azoxystrobin (Quadris) 2.08 F	6.0 to 15.5 fl oz/ acre	0.1 to 0.25 lb/acre	0	4 hr	No more than 1 application before alternating with a fungicide with a different mode of action. Apply no more than 123 fl oz per acre per season.
	pyraclostrobin (Cabrio) 20 EG	8 to 16 oz/acre	1.6 to 3.2 oz/acre	0	0.5	Alternate with a fungicide with a different mode of action. Apply no more than 48 oz/acre/season.
	mefenoxam + copper hydroxide (Ridomil Gold/ Copper)	2 lb/acre	-	7	1	Spray leaves. Use with preplant Ridomil 2E soil applications. Make 2 to 4 applications if needed on 14-day intervals.
Rhizoctonia root canker	azoxystrobin (Quadris) 2.08 F	9.2 to 15.4 fl oz/ acre	0.15 to 0.25 lb/acre	0	4 hr	No more than 1 application before alternating with a fungicide with a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	chlorothalonil (Bravo Ultrex) 82.5 WDG	1.4 to 1.8 lb/acre	1.1 to 1.5 lb/acre	10	2	
Phytophthora basal stem rot	mefenoxam (Ridomil Gold) 4 SL	1 to 2 pt/acre	0.5 to 1 lb/acre	-	2	Apply as a broadcast, preplant application to soil and incorporate into top 2 inches of soil.
	metalaxyl (MetaStar) 2 E	See label.				
White rust	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 lb/acre	7	4 hr	No more than 2 sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	mefenoxam + copper hydroxide (Ridomil Gold/ Copper)	2 lb/acre	-	7	1	Spray leaves. Use with preplant Ridomil 2E soil applications. Make 2 to 4 applications if needed on 14-day intervals.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-41. ALTERNATIVE MANAGEMENT TOOLS – BEET

S. Bost, Plant Pathologist, UT; and E. Sikora, Plant Pathologist, Auburn University

Disease	Resistant Varieties	Non-chemical Controls
Pythium damping-off	No	Use raised beds to dry soil surface.
Downy mildew	No	Copper spray at first appearance; Remove and destroy severely infected plants, rotate, destroy residue.
Leaf spots	Tolerant varieties	Destroy crop residue and rotate location.

TABLE 3-42. RELATIVE IMPORTANCE OF ALTERNATIVE MANAGEMENT PRACTICES FOR CARROT DISEASE CONTROL

S. Bost, Plant Pathologist, UT; and E. Sikora, Plant Pathologist, Auburn University

Scale: "0" = not important/does not impact disease; "5" = very important practice to implement/impacts disease greatly.

Management tactic	*Alternaria* blight	*Cercospora* blight	Powdery mildew	*Pythium* cavity spot	*Pythium* damping off	Southern blight	*Rhizoctonia* cavity spot	*Sclerotinia* postharvest	*Botrytis* postharvest	Bacterial leaf blight	Root-knot nematode
Avoid field operations when leaves are wet	1	1	0	0	0	0	0	0	0	3	0
Avoid overhead irrigation	3	3	0	0	0	0	0	2	0	3	0
Change planting date	1	1	0	2	2	3	0	0	0	0	2
Cover cropping with antagonist	0	0	0	0	0	0	0	0	0	0	2
Crop rotation	2	2	0	1	1	1	1	1	0	2	1
Deep plowing	4	4	1	0	0	3	2	2	1	4	0
Destroy crop residue	5	5	1	0	0	0	1	0	1	5	1
Encourage air movement	2	2	0	0	0	0	0	2	0	0	0
Plant in well-drained soil	0	0	0	4	4	1	2	2	0	0	0
Plant on raised beds	0	0	0	3	3	0	2	1	0	0	0
Postharvest temperature control	0	0	0	0	0	0	0	5	5	0	0
Reduce mechanical injury	0	0	0	0	0	0	0	2	4	0	0
Destroy volunteer carrots	2	2	1	0	0	0	0	0	0	0	0
Pathogen-free planting material	5	5	0	0	0	0	0	0	0	5	0
Resistant cultivars	4*	4*	3	0	0	0	0	0	0	0	0

* Tolerance/resistance.

TABLE 3-43. ALTERNATIVE MANAGEMENT TOOLS – PARSNIP

S. Bost, Plant Pathologist, UT; and E. Sikora, Plant Pathologist, Auburn University

Disease	Resistant Varieties	Non-chemical Controls
Leaf spot	No	Copper spray at first appearance.
Root canker	No	Rotate crop land.
Sclerotinia	No	Rotate crop land.
Botrytis neck rot	No	Increase aeration.
Alternaria	No	Increase aeration.

TABLE 3-44. DISEASE CONTROL FOR SPINACH

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Damping-off (*Pythium*)	mefenoxam (Ridomil Gold) 4 SL (Ultra Flourish) 2 EC	 1 to 2 pt/trt acre 2 to 4 pt/trt acre	0.5 to 1 lb/trt acre	21	2	Broadcast or banded over the row as a soil spray or preplant incorporation into the top two inches of soil.
	metalaxyl (MetaStar) 2 E	4 to 8 pt/trt acre	1 to 2 lb/trt acre	21	2	Broadcast or banded over the row as a soil spray or preplant incorporation into the top two inches of soil.
Seedling blight (*Rhizoctonia*), damping-off (*Pythium*)	azoxystrobin + mefenoxam (Uniform)	0.34 fl oz/ 1000 ft of row	0.13 fl oz/ 1000 ft of row	-	0	Apply as an in furrow spray in 5 gal of water per acre prior to covering seed. Make only 1 application per season.
Downy mildew	cymoxanil (Curzate) 60DF	5 oz /acre	0.1875 lb/acre	1	0.5	Apply with a protectant fungicide. Apply no more than 30 oz per acre in a 12-month period.
	mandipropamid (Revus) 2.08 F	8 fl oz/acre	0.13 lb/acre	1	4 hr	Make no more than 2 consecutive applications before alternating with a fungicide with a different mode of action. Apply no more than 32 fl oz/acre/season.
Downy mildew, white rust	acibenzolar-*S*-methyl (Actigard) 50 WG	0.5 to 0.75 oz/acre	0.25 to 0.37 oz/acre	7	0.5	Do not apply to young seedlings or plants stressed due to drought, excessive moisture, cold weather, or herbicide injury.
	famoxadone + cymoxanil (Tanos) DF	8 to 10 oz/acre	-	1	0.5	Must be tank-mixed with a contact downy mildew fungicide with a different mode of action. Make no more than 1 application before alternating with a fungicide with a different mode of action. Apply no more than 84 oz/acre per cropping season.
	fluopicolide (Presidio) 4F	3 to 4 fl oz/acre	0.09 to 0.125 lb/acre	2	0.5	Tank mix with another downy mildew fungicide with a different mode of action.
	fosetyl-Al (Aliette) 80 WDG	2 to 5 lb/acre	1.4 to 4 lb/acre	3	0.5	Do not mix with surfactants, foliar fertilizers, or products containing copper.
	mefenoxam (Ridomil) 4 SL	0.25 pt/acre	0.125 lb/acre	21	2	Apply preplant as above for damping-off. Shank in 21 days after planting or after first cutting. Another application may be shanked in after the next cutting. A total of 2 shank applications may be made on a 21-day interval. Do not use post-emergence if a preplant application was not made.
	mefenoxam + copper hydroxide (Ridomil Gold/Copper)	2.5 lb/acre	-	21	2	Spray to foliage. Use with preplant Ridomil Gold soil application.
	metalaxyl (MetaStar) 2 E	1 pt/trt acre	0.125 lb/acre	21	2	Shank in 21 days after planting. Apply no more than 2 shanked applications on 21-day intervals.
White rust	cyazofamid (Ranman) 400 SC	2.1 to 2.75 fl oz/ acre	0.054 to 0.071 lb/ acre	0	0.5	No more than 5 applications per crop. No more than 3 consecutive applications followed by at least three applications of a fungicide with a different mode of action. Do not apply more than 13.75 fl oz per acre per crop per growing season
	fenamidone (Reason) 500 SC	5.5 to 8.2 fl oz/acre	0.18 to 0.27 lb/acre	2	0.5	Make no more than 1 application before alternating with a fungicide with a different mode of action. Apply no more than 24.6 fl oz/acre per growing season.
	pyraclostrobin (Cabrio) 20 EG	8 to 12 oz/acre	0.1 to 0.15 lb/acre	0	0.5	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 64 oz per acre per growing season.
Downy mildew, leaf spot	pyraclostrobin (Cabrio) 20 EG	12 to 16 oz/acre	0.15 to 0.2 lb/acre	0	0.5	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 64 oz per acre per growing season.
Downy mildew, leaf spot, white rust	fixed copper*	See label.		0	2	Some formulations of copper may cause flecking on the leaves.
Leaf spot, white rust	azoxystrobin (Quadris) 2.08 F	6 to 15.5 fl oz/acre	0.10 to 0.25 lb/acre	0	4 hr	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 92.3 fl oz/acre/season.
Leaf spots	penthiopyrad (Fontelis) SC	14 to 24 fl oz/acre	2.86 to 4.90 fl oz/ acre	3	0.5	Make no more than 2 sequential applications before alternating with a fungicide with a different mode of action. Apply no more than 72 fl oz/acre/year.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-45. ALTERNATIVE MANAGEMENT TOOLS–SPINACH

Disease	Resistant Varieties	Non-chemical Controls
Pythium damping-off	No	Use raised beds to dry soil surface.
White rust	Yes	
Downy mildew	No	Copper spray at first appearance. Remove and destroy severely infected plants, rotate and destroy residue.
Powdery mildew	No	Spray with sulfur at first appearance of disease.
Leaf spots	No	Copper spray at first appearance.

TABLE 3-46. DISEASE CONTROL FOR SWEETPOTATO

L. Quesada-Ocampo, Plant Pathologist, NCSU; and R. French-Monar, Plant Pathologist, TAMU

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Bedding root decay: scurf, Black rot, Foot rot, *Sclerotial* blight	thiabendazole (Mertect) 340 F	107 oz/100 gal	4 lb/100 gal	—	—	Dip seed roots 1 to 2 minutes and plant immediately; not for *Sclerotial* blight.
	dicloran (Botran) 75 W	13.3 lb/100 gal	10 lb/100 gal	—	—	Can be used as a seed root dip or as a plantbed spray.
Circular spot, Southern blight, *Rhizoctonia* stem canker, *Pythium* root rot	azoxystrobin (Quadris) 2.08 F	0.4 to 0.8 fl oz/1,000 row feet	0.006 to 0.013 lb	—	4 hr	Make in-furrow or banded applications shortly after transplanting.
Seed-borne and soil-borne fungi that cause decay, damping-off or seedling blight	azoxystrobin (Dynasty) 0.83 F	0.19 to 0.38 fl oz per 100 lb of propagating roots	0.009 to 0.036 fl oz per 100 lb of propagating roots	—	4 hr	Apply uniformly to seed roots as a water-based slurry.
	fludioxonil (Maxim) 4 FS	0.08 to 0.16 fl oz per 100 lb of propagating roots	0.032 to 0.064 fl oz per 100 lb of propagating roots	—	0.5	Apply uniformly to seed roots as a water-based slurry.
Damping-off *(Pythium)*	mefenoxam (Ridomil Gold) 4 SL	1 to 2 pt/treated acre	0.5 to 1 lb/treated acre	—	2	Incorporate in soil. See label for row rate.
	metalaxyl (MetaStar) 2 E	4 to 8 pt/treated acre	0.5 to 1 lb/acre	7	2	Preplant incorporated or soil surface spray.
Postharvest sanitation	calcium hypochlorite 65%	3 to 10 oz/100 gal	150 to 500 ppm	—	—	Dip or spray 2 to 5 minutes. Monitor chlorine concentration and add chlorine or change solution as needed.
Postharvest *Rhizopus* soft rot	dicloran (Botran) 75 W	1 lb/100 gal	0.75 lb/100 gal	—	—	Spray or dip. Dip for 5 to 10 seconds in well-agitated suspension. Add 1/2 lb Botran to 100 gal of treating suspension after 500 bu treated. Do not rinse.
	fludioxonil (Scholar) 1.9 SC	16 to 32 fl oz/100 gal	3.3 to 6.5 fl oz/100 gal	—	—	Dip for approximately 30 seconds and allow sweetpotatoes to drain. Add 8 fl oz to 100 gals after 500 bushels are treated. OR mix 16 fl oz in 7 to 25 gal of water, wax/emulsion, or aqueous dilution of wax/ oil emulsion.
	Pseudomonas syringae (Bio-Save) 11 LP	250 g/40 gal	74.5 g/40 gal	—	—	**OMRI listed.** Apply to freshly cleaned roots, recycled suspensions need to be recharged, and ensure adequate coverage. Can be applied as conventional drip or drench and through an overhead application system.
	hydrogen peroxide (SaniDate 5.0)	59.1 to 209.5 fl oz per 1000 gal	13.5 to 48.1 fl oz per 1000 gal	—	—	**OMRI listed.** Apply to freshly cleaned roots, recycled suspensions need to be recharged, and ensure adequate coverage. Roots can be sprayed or submerged I solution for a minimum contact time of 45 seconds.
Root rot *(Fusarium, Phytophthora, Pythium, Rhizoctonia, Verticillium)*	hydrogen dioxide + peroxyacetic acid (Oxidate 2.0)	32 fl oz/ 100 gal; apply 30-100 gal per treated acre	7.3 fl oz /acre (hydrogen dioxide); 0.6 fl oz/acre (Peroxyacetic acid)	0	Until spray has dried	**OMRI listed.** Begin application before disease appears. Maintain 5-day interval spray cycle. First three treatments can be done at 128 fl oz per 100 gallons; apply 30-100 gal per treated acre.
Root rot (Fusarium, Phytophthora, Pythium, Rhizoctonia)	*Reynoutria sachalinensis* (Regalia)	1 to 4 quarts per acre	0.05 to 0.2 quarts/ acre	0	4 hr	**OMRI listed.** Can be applied as soil drench (1-3 quarts per 100 gallons of water, 10-14 day interval), in-furrow (1-4 quarts per acre, check soil treatment directions on label) or chemigation (1-4 quarts per acre, 14 day intervals).
Root rot and Damping off fungi *(Fusarium, Phytophthora, Pythium, Rhizoctonia*, others)	*Streptomyces lydicus* WYEC 108 (Actinovate AG)	3-12 oz of Actinovate AG per acre (soil drench or foliar) Applied in furrow, over treated seed pieces, or as a side dressing	0.001 to 0.004 oz/ acre	0	1 hr or until spray has dried	**OMRI listed.** Reapply every 7-14 days. For best results, use with a spreader-sticker.
Streptomyces soil rot (pox)	dichloropropene (Telone) C-17 C-35	10.8 to 17.1 gal/A 13 to 20.5 gal/acre	107 to 169 lb/acre 139 to 220 lb/acre	—	5	Rate is based on soil type; see label for in-row rates.
	chloropicrin	1.8 gal/acre	—	—	—	
White rust	azoxystrobin (Quadris) 2.08 F	6.2 to 15.4 fl oz/ acre	0.1 to 0.25 fl oz/acre	7	4 hr	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	fenamidone (Reason) 500 SC	5.5 to 8.2 fl oz/acre	0.178 to 0.267 lb/ acre	14	0.5	Begin applications when conditions favor disease development, and continue on 5- to 10-day interval. Do not apply more than 16.4 fl oz per growing season. Alternate with a fungicide from different resistance management group.
	pyraclostrobin (Cabrio) 20 WG	8 to 16 oz/acre	1.6 to 3.2 oz/acre	0	0.5	Do not apply more than 48 oz per acre per season. Alternate with a fungicide with a different mode of action after each use.

TABLE 3-47. SWEETPOTATO STORAGE HOUSE SANITATION

L. Quesada-Ocampo, Plant Pathologist, NCSU; and R. French-Monar, Plant Pathologist, TAMU

Material	Rate per 1,000 Cubic Feet of Space	Methods and Remarks
Heat	140°F 4 to 8 hr/day for 7 days or 180°F for 30 min	See remarks under sanitizing greenhouses. The storage house, ventilation system, and equipment must be very clean and moist during the procedure. *Caution:* rot-causing organisms inside a drain will probably not be exposed to lethal temperature.

SWEETPOTATO STORAGE HOUSE SANITATION

Plant Pathology

Follow manufacturers label in all cases. Scurf and rot-producing organisms may survive over the summer on crates and on the walls and floors of the storage house, and then infect the new crop. Usually, cleaning the house and surroundings thoroughly by sweeping and rinsing with water to remove all rotted sweetpotatoes, dirt, and other trash is adequate to avoid contamination from carry-over sources. Most rot problems in storage are caused by storing sweetpotatoes injured in the field or in harvesting, or by improper ventilation and temperature control. The treated room must be airtight and moistened thoroughly with water one or two days in advance of treatment. Fumigation should never be done by one person. Great care should be taken to ensure that nobody is in the room during treatment. Start treating in rear and move toward the exit. After treatment, ventilate the area thoroughly for at least one day or until all traces of the fumigant are gone. Do not fumigate facilities that are near inhabited areas. Check local regulations. Read label carefully.

TABLE 3-48. RELATIVE IMPORTANCE OF PRODUCTS FOR SWEETPOTATO DISEASE CONTROL

L. Quesada-Ocampo, Plant Pathologist, NCSU; and R. French-Monar, Plant Pathologist, TAMU

Key to Efficacy Ratings: "++++" Excellent; "+++" Good; "++" Fair; "+" Poor; "—" Not effective; "?" Unknown; "NA" Not applicable

Product	Nematicide (N) or Fungicide (F)	Bacterial stem and root rot (*E. chrysanthemi*)	Black rot (*C. fimbriata*)	Foot rot (*P. destruens*)	*Fusarium* root rot and stem canker (*F. solani*)	*Fusarium* surface rot (*F. oxysporum*)	*Fusarium* wilt (*F. oxysporum* f. sp. *batatas*)	Java black rot (*D. gossypina*)	Root-knot and Reniform nematodes (*Meloidogyne* & *Rotylenchus* spp.)	*Rhizopus* soft rot (*R. stolonifer*)	*Sclerotial* blight/Circular spot (*S. rolfsii*)	Scurf (*M. infuscans*)	Soil rot/Pox (*S. ipomoea*)	Sweetpotato feathery mottle virus
aldicarb (Temik)	N	NA	NA	NA	NA	NA	NA	NA	++++	NA	NA	NA	NA	NA
Pseudomonas syringae (Bio-Save)	F	NA	NA	NA	NA	NA	NA	NA	NA	+	NA	NA	NA	NA
chlorine	F	+++	+++	+	NA	NA	NA	+	NA	NA	NA	+	+	NA
chloropicrin	N, F	NA	+	+	++	+	++	++	++	NA	++	NA	+++	NA
dicloran (Botran 75W)	F	—	?	NA	NA	++	NA	+	NA	+++	+	++	—	NA
ethoprop (Mocap)	N	NA	NA	-	NA	NA	NA	NA	+	NA	NA	NA	NA	NA
fludioxonil (Scholar)	F	—	?	?	?	?	?	?	—	+++	—	?	—	NA
metam sodium (Vapam)	N	NA	+	+	++	+	++	NA	+++	NA	NA	NA	NA	NA
oxamyl (Vydate)	F	NA	NA	—	NA	NA	NA	NA	++	NA	NA	NA	NA	NA
dichloropropene (Telone II)	N	NA	NA	—	+	+	+	NA	++++	NA	NA	NA	NA	NA
thiabendazole (Mertect 340-F)	F	—	++	+++	+	+	NA	++	NA	—	++	+	—	NA

TABLE 3-49. RELATIVE IMPORTANCE OF ALTERNATIVE MANAGEMENT PRACTICES FOR SWEETPOTATO DISEASE CONTROL

L. Quesada-Ocampo, Plant Pathologist, NCSU; and R. French-Monar, Plant Pathologist, TAMU

Key to Efficacy Ratings: "++++" Excellent; "+++" Good; "++" Fair; "+" Poor; "—" Not effective; "?" Unknown; "NA" Not applicable

	Bacterial stem & root rot (*E. chrysanthemi*)	Black rot (*C. fimbriata*)	Foot rot (*P. destruens*)	*Fusarium* root rot & stem canker (*F. solani*)	*Fusarium* surface rot** (*F. oxysporum*)	*Fusarium* wilt (*F. oxysporum* f. sp. *batatas*)	Java black rot (*D. gossypina*)	Root-knot & Reniform nematodes (*Meloidogyne & Rotylenchus*)	*Rhizopus* soft rot (*R. stolonifer*)	Sclerotial blight/Circular spot (*S. rolfsii*)	Scurf (*M. infuscans*)	Soil rot/Pox (*S. ipomoea*)	Sweepotato Feathery Mottle Virus
Crop rotation (3-4 years)	+	++	+	++	+	+++	++	+++	—	++	+	+++	+
Disease-free planting stock	++++	++++	++++	++++	+	++++	++++	++	—	+	++++	++++	++++
Resistant cultivars	+++	+	+	+	+	++++	++	++	+++	+	+	++++	+++
Careful handling to reduce mechanical injury	+	+++	-	++	++++	-	++	—	+++	—	—	—	—
Cutting plants (in beds) above soil line	?	++++	++++	+++	—	+++	+++	—	—	—	++++	+++	—
Soil sample for nematode analysis	—	—	—	—	—	—	—	++++	—	—	—	—	—
Sanitation (equipment, fields, storage houses)	+++	+++	++	+	+++	—	+++	—	+++	—	+	+++	—
Manage insects that transmit pathogens	—	—	—	—	—	—	—	—	—	—	—	—	—
Sulfur added to soil to reduce pH	—	—	—	—	—	—	—	—	—	—	—	+++	—
Prompt curing and proper storage conditions	+++	+++	—	++	++++	—	+++	—	+++	—	—	—	—
Site selection (drainage)	+	—	—	++	++	++	?	—	++	—	—	—	—
Manage insects that cause feeding injuries to roots	+	—	—	—	—	—	+	—	+	—	—	—	—

**Avoid harvesting when soils are wet.

TABLE 3-50. DISEASE CONTROL FOR TOMATILLO

G. Vallad, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
Powdery mildew	azoxystrobin (Quadris) 2.08 F	6 to 15.5 fl oz/acre	0.1 to 0.25 fl oz/acre	0	4 hr	Make no more than two sequential applications before alternating with fungicides that have a different mode of action. Apply no more than 2.88 qt per crop per acre per season.
	chlorothalonil (Bravo Weatherstick)	1.5 pts/acre	1.125 lb/acre	3	0.5	Limit of 12 pints per acre per season.
	cyprodinil + difenoconazole (Inspire Super)	16 to 20 fl oz/acre	0.60 to 0.75 lb/acre	0	0.5	Limit of 47 fl oz per acre per season.
	cyprodinil + fludioxonil (Switch) 62.5 WG	11 to 14 oz/acre	0.43 to 0.55 lb/acre	0	0.5	Limit 56 oz per acre per year. After 2 applications, rotate to another fungicide with a different mode of action for 2 applications.
	penthiopyrad (Fontelis)	10 to 24 fl oz/acre	0.13 to 0.31 lb/acre	0	0.5	Do not exceed 72 fl oz of product per year. Make no more than 2 sequential applications per season before rotating to another effective product with a different mode of action.
	polyoxin D (Ph-D)	6.2 oz/acre	0.7 oz/acre	0	4 hr	Limit 5 applications per season. Must alternate with another fungicide with a different mode of action.
	pyraclostrobin (Cabrio) 20% EG	8 to 16 oz/acre	1.6 to 3.2 oz/acre	0	4 hr	
	mandipropamid + difenoconazole (Revus Top)	5.5 to 7 oz/acre		1	0.5	

TABLE 3-51. DISEASE CONTROL FOR TOMATO

K. Ivors, Plant Pathologist, NCSU; G. Vallad, Plant Pathologist, UF; F. Louws, Plant Pathologist, NCSU; M. Paret, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
TOMATO (grown for transplant and retail sale to consumers)						
Late blight	mandipropamid (Micora)	5.5 to 8.0 fl oz/acre	0.65 to 0.9 fl oz/acre	NA	4 hr	Apply no more than two applications containing Micora per crop
TOMATO (transplants)						
Bacterial canker, Bacterial spot, Bacterial speck	sodium hypochlorite (Clorox 5.25%)	1 qt + 4 qt water	same	NA	0	Wash seed for 40 min in solution with continuous agitation; air dry promptly. Use 1 gal of solution per 1 lb seed.
	streptomycin sulfate (Agri-Mycin) 17 WP (Streptrol) 21.3%	1 lb/100 gal		NA	0	Begin application at first true leaf stage, repeat weekly until transplanting. For plant bed use only.
Bacterial spot, Bacterial speck	bacteriophage (AgriPhage)	3 to 8 oz/9,600 sq ft		NA	0	Works best if applied during or after last watering of the day.
	mancozeb (Protect) DF	0.75 to 3.0 lb./acre		NA	1	Begin applications when seedlings emerge or transplants are set. Repeat applications of 0.6 – 1.2 lbs. active ingredient per acre (0.75 – 1.5 lbs. product) at 3- to 7-day intervals, or 1.2 - 2.4 lbs. active ingredient per acre (1.5 - 3.0 lbs. product) at 7- to 10-day intervals throughout the season.
Botrytis (gray mold) and Early blight	polyoxin D (Affirm) WDG	6.2 oz/acre	0.7 oz/acre	NA	4 hr	For seedlings or transplants in a greenhouse, lath or shade house
Early blight, Late blight	chlorothalonil			NA		Apply in sufficient water to obtain good coverage. Begin spray when seedlings emerge. Repeat every 5 to 7 days. Use chlorothalonil for plant beds only; do not use in the greenhouse.
	(Bravo Ultrex) 82.5 WDG	1.3 to 1.8 lb/acre	1.1 to 1.5 lb/acre	NA	0.5	
	(Bravo Weather Stik) 6F	1.375 to 2 pt/acre	1 to 1.5 lb/acre	NA	0.5	
	(Echo 702) 54%	1.375 to 2 pt/acre	0.75 to 1.1 lb/acre		0.5	
	(Equus 720) 54%	1.35 to 2 pt/acre	0.75 to 1.1 lb/acre	NA	0.5	
	mancozeb (Dithane DF, Manzate) 75 W	1.35 to 3 lb/acre	1.1 to 2.4 lb/acre	NA	1	
	mancozeb (Protect) DF	0.75 to 3.0 lb./acre		NA	1	Begin applications when seedlings emerge or transplants are set. Repeat applications of 0.6 – 1.2 lbs. active ingredient per acre (0.75 – 1.5 lbs. product) at 3- to 7-day intervals, or 1.2 - 2.4 lbs. active ingredient per acre (1.5 - 3.0 lbs. product) at 7- to 10-day intervals throughout the season.
Late blight	chlorothalonil + potassium phosphite (Catamaran)	5.0 to 7.0 pints/acre		NA	0.5	Be careful of phytotoxicity in the greenhouse
Pythium damping off	cyazofamid (Ranman)	3.0 fl oz/100 gallons water		NA	0.5	Make a single **DRENCH** application to seedling tray at the time of planting or at any time thereafter up until one week before transplanting.
TOMATO (field)						
Anthracnose	azoxystrobin (Quadris) 2.08 F	5 to 8.2 fl oz/acre	0.08 to 0.1 lb/acre	0	4 hr	Quadris, Tanos, and Cabrio are strobilurin fungicides. Integrate them in a rotation fungicide program. Make no more than 5 applications of strobilurin fungicide per crop year. Resistance reported.
	famoxadone + cymoxanil (Tanos)	6 to 8 oz/acre	3 to 4 oz/acre	0	4 hr	
	pyraclostrobin (Cabrio) 20% EG	8 to 12 oz/acre	1.6 to 3.2 oz/acre	3	4 hr	
	mandipropamid + difenoconazole (Revus Top)	5.5 to 7 oz/acre		1	0.5	Begin Revus Top applications when conditions favor disease development, on 7- to 10-day intervals. Do not apply more than twice before alternating with fungicides that have a different mode of action. Do not apply more than 28 fl oz per acre per season.
	zinc dimethyldithiocarbamate (Ziram) 76 DF	3 to 4 lb/acre	2.3 to 3 lb/acre	7	2	**DO NOT** use on cherry tomatoes. Begin applications at first sign of infection and continue at 7- to 14-day intervals. **DO NOT** apply more than 24 lb per acre per season. Ziram can be mixed with copper to enhance bacterial disease control.
Botrytis (gray mold)	boscalid (Endura) 70%	9 to 12.5 oz/acre	6.3 to 8.75 oz/acre	0	0.5	Make no more than 2 sequential applications and no more than 2 per crop year.
	pyrimethanil (Scala) SC	7 fl oz/acre	0.27 lb/acre	1	0.5	Use only in a tank mix with another fungicide recommended for gray mold. Applications should be made on 7- to 14-day intervals. Do not apply more than 35 fl oz per acre per season.

TABLE 3-51. DISEASE CONTROL FOR TOMATO (cont'd)

K. Ivors, Plant Pathologist, NCSU; G. Vallad, Plant Pathologist, UF; F. Louws, Plant Pathologist, NCSU; M. Paret, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
TOMATO (field) (cont'd)						
Bacterial speck, Bacterial spot	acibenzolar-*S*-methyl (Actigard) 50 WG	0.33 to 0.75 oz/acre	0.165 to 0.375 oz/ acre	14	0	Begin within one week of transplanting, spray at 7- to 10- day intervals for up to six applications. High rates may cause plant stunting.
Bacterial speck, Bacterial spot, Bacterial canker	fixed copper* products (various formulations)	See label	various	0	1-2	A fixed copper spray can suppress spot and canker. Most strains of speck are copper resistant. Spot control benefits with tank mixes of mancozeb + fixed copper, see above. REI varies with copper formulation, check label.
Buckeye rot	mefenoxam + copper hydroxide (Ridomil Gold/ Copper)	2 lb/acre	1.3 lb/acre	14	2	Tank mix with 0.8 lb a.i. of either maneb or mancozeb.
Cristulariella leaf spot, Powdery mildew	myclobutanil (Rally) 40 WSP	2.5 to 4 oz/acre	1 to 1.6 oz/acre	1	1	Spray weekly beginning at first sign of disease. Do not apply more than 1.25 lb/acre.
Damping-off *(Pythium)*, Root and fruit rots *(Phytophthora)*	fosetyl-Al (Aliette) 80 WDG	2.5 to 5 lb/acre	2 to 4 lb/acre	14	0.5	Start sprays at 2- to 4-leaf stage or at transplanting on a 7- to 14-day schedule. Not for *Phytophthora* fruit rot. Check label for specific counties in each state where use is prohibited.
	mefenoxam (Ridomil Gold GR) (Ridomil Gold) 4 SL (Ultra Flourish) 2 EC	 20 lb/treated acre 1 to 2 pt/treated A 1 to 2 qt/treated A	 0.5 lb/treated acre 0.5 to 1 lb/treated A 0.5 to 1 lb/treated A	 7 28 28	2	Apply uniformly to soil at time of planting. Incorporate mechanically if rainfall is not expected before seeds germinate. A second application may be made up to 4 weeks before harvest. Do not exceed 3 pt of Ridomil Gold EC or 40 lb of Ridomil Gold GR per acre.
Early blight, *Septoria* leaf spot and Target spot	boscalid (Endura) 70%	2.5 to 3.5 oz/acre	1.75 to 2.45 oz/acre	0	0.5	Make no more than 2 sequential applications and no more than 6 per crop year.
	fluoxastrobin (Aftershock, Evito) 480 SC	2.0 to 5.7 fl oz/acre	0.063 to 0.18 lb/acre	3	0.5	Begin applications when conditions favor disease development, on 7- to 10-day intervals. Do not apply more than once before alternating with fungicides that have a different mode of action. Do not apply more than 22.8 fl oz per acre per season.
	pyrimethanil (Scala) SC	7 fl oz/acre	0.27 lb/acre	1	0.5	Use only in a tank mix with another fungicide recommended for target spot or early blight. Applications should be made on 7- to 14-day intervals. Do not apply more than 35 fl oz per acre per season. **Only labeled for Target Spot in Florida.**
	azoxystrobin (Quadris)	8.2 fl oz/acre	0.1 lb/acre	1	4 hr	**SOME POPULATIONS OF EARLY BLIGHT ARE NOW RESISTANT TO THIS CHEMISTRY.** Begin applications when conditions favor disease development. Do not apply more than once before alternating with fungicides that have a different mode of action.
	azoxystrobin + difenoconzole (Quadris Top) 29.6 SC	8 fl oz/acre	0.17 lb/acre	0	0.5	Begin applications prior to disease development, and continue on a 7 to 10 day interval. Make no more than 2 sequential applications before rotating to another effective fungicide with a different mode of action. Do not exceed 47 fl oz per season. Do not use on tomato varieties that bear mature fruit less than 2 inches in diameter. Do not apply until 21 days after transplanting or 35 days after seeding.
	cyprodinil + difenoconazole (Inspire Super) 32.5 SC	16 to 20 fl oz/acre	5.6 to 7.1 oz/acre	0	0.5	Begin applications prior to disease development, and continue on a 7 to 10 day interval. Make no more than 2 sequential applications before rotating to another effective fungicide with a different mode of action. Do not exceed 47 fl oz per season. Do not use on tomato varieties that bear mature fruit less than 2 inches in diameter.
	fenamidone (Reason) 500 SC	5.5 to 8.2 fl oz/acre	0.178 to 0.267 fl oz/ acre	14	4 hr	Begin applications when conditions favor disease development, on 5 to 10 day intervals. Do not apply more than once before alternating with fungicides that have a different mode of action. Do not apply more than 24.6 fl oz per acre per season.
	mandipropamid + difenoconazole (Revus Top)	5.5 to 7 oz/acre	0.09 + 0.09 to 0.12 + 0.12 lb/acre	1	0.5	Begin applications when conditions favor disease development, on 7 to 10-day intervals. **THIS PRODUCT IS A PREMIX AND PROVIDES GOOD EFFICACY AGAINST LATE BLIGHT AS WELL.** Do not apply more than twice before alternating with fungicides that have a different mode of action. Do not apply more than 28 fl oz per acre per season.

TABLE 3-51. DISEASE CONTROL FOR TOMATO (cont'd)

K. Ivors, Plant Pathologist, NCSU; G. Vallad, Plant Pathologist, UF; F. Louws, Plant Pathologist, NCSU; M. Paret, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
TOMATO (field) (cont'd)						
Early blight, *Septoria* leaf spot and Target spot (cont'd)	pyraclostrobin (Cabrio) 20% EG	8 to 12 oz/acre	1.6 to 3.2 oz/acre	0	4 hr	**SOME POPULATIONS OF EARLY BLIGHT ARE NOW RESISTANT TO THIS CHEMISTRY.** Begin applications when conditions favor disease development. Do not apply more than once before alternating with fungicides that have a different mode of action.
	zinc dimethyldithiocarbamate (Ziram) 76 DF	3 to 4 lb/acre	2.3 to 3 lb/acre	7	2	**DO NOT** use on cherry tomatoes. Begin applications at first sign of infection and continue at 7- to 14-day intervals. **DO NOT** apply more than 24 lb per acre per season. Ziram can be mixed with copper to enhance bacterial disease control.
	mancozeb* (Dithane DF, Manzate) 75 W, 80 W	1.5 to 3 lb/acre	1.1 to 2.4 lb/acre	5	1	
	mancozeb + zoximide (Gavel) 75 DF	1.5 to 2 lb/acre	1.13 to 1.5 lb/acre	3	2	See Gavel label for use restrictions and use of surfactant to improve performance.
	famoxadone + cymoxanil (Tanos)	6 to 8 oz/acre	3 to 4 oz/acre	3	4 hr	Begin applications when conditions favor disease development or when disease is present in area. Must be tank mixed with a protectant fungicide (chlorothalonil or mancozeb) appropriate for targeted disease(s). **DO NOT apply more than 72 oz per acre per season.** Tanos does not list *Botrytis* Gray mold or Bacterial canker on label.
	penthiopyrad (Fontelis)	10 to 24 fl oz/acre	0.13 to 0.31 lb/acre	0	0.5	Begin applications prior to disease development on a 7 to 14 day interval. No more than 2 sequential applications before switching to another fungicide with a different mode of action. Limited to 72 fl oz/acre per season.
	fluxapyroxad + pyraclostrobin (Priaxor)	4 to 8 fl oz/acre	0.13 to 0.26 lbs/acre	7	0.7	Begin applications prior to disease development on a 7 to 14 day interval. No more than 2 sequential applications before switching to another fungicide with a different mode of action. Limited to 3 applications or 24 fl oz/acre per season. Can be mixed with a nonionic surfactant at up to 0.125%. Check label for incompatibility with other surfactants and oils.
Powdery mildew	cyprodinil + fludioxonil (Switch 62.5 WG)	11 to 14 oz/acre	6.88 to 8.75 oz/acre	0	0.5	Begin applications prior to disease development on a 7 to 10 day interval. No more than 2 sequential applications before switching to another fungicide with a different mode of action for 2 applications. Limited to 56 oz/acre per year.
Late blight	chlorothalonil (Bravo Weather Stik) 6 F (Bravo Ultrex) 82.5 WDG (Echo 720) 54% (Equus 720) 54%	 1.375 to 2.75 pt/A 1.3 to 2.6 lb/acre 1.375 to 3 pt/acre 1.35 to 2.88 pt/acre	 1 to 2.1 lb/acre 1.1 to 2.2 lb/acre 0.75 to 1.6 lb/acre 0.75 to 1.6 lb/acre	 0 0 0 0	 0.5 0.5 0.5 0.5	Apply in sufficient water to obtain adequate coverage. Apply every 5 to 7 days. Use higher rates following fruit set.
	mancozeb + copper hydroxide (ManKocide) 61 DF	2.5 to 5 lb/acre	1.5 to 3 lb/acre	5 0	1 1	Apply at 7- to 10-day intervals. Do not mix with other fungicide products.
	mancozeb (Dithane DF, Manzate) 75 W 80 W + fixed copper	1.5 to 3 lb/acre + See label	1.1 to 2.4 lb/acre	5	1	Apply in 100 to 150 gal water per acre.
	mefenoxam + chlorothalonil (Ridomil Gold Bravo)	2.5 to 3 lb/acre	1.5 to 2.2 lb/acre	14	2	Do not make more than 3 applications of Ridomil Gold/Bravo or Ridomil Gold MZ per crop. Tank mix Bravo MZ58 with 0.45 lb mancozeb 80W.
	mefenoxam + mancozeb (Ridomil Gold MZ)	2.5 lb/acre	1.7 lb/acre	5	2	Do not make more than 3 applications of Ridomil Gold/Bravo or Ridomil Gold MZ per crop. Tank mix Bravo MZ58 with 0.45 lb mancozeb 80W.
	cyazofamid (Ranman) 400 SC	2.1 to 2.75 fl oz/ acre	0.05 to 0.0710 lb/ acre	0	0.5	Alternate sprays with a fungicide with a different mode of action. **DO NOT apply more than 6 sprays of Ranman 400 SC per crop.** Must be tank mixed with an organosilicate surfactant.
	cymoxanil (Curzate 60 DF)	3.2 to 5 oz/acre	1.9 to 3.0 oz	3	0.5	Use only in combination with a labeled rate of a protectant fungicide.
	dimethomorph (Acrobat) 50 WP (Forum) 4.18 F	 6.4 oz/acre 6 oz/acre	 3.2 oz/acre 2.6 oz/acre	4	0.5	Must be applied as a tank mix with another fungicide with a different mode of action. Follow label restrictions carefully.

TABLE 3-51. DISEASE CONTROL FOR TOMATO (cont'd)

K. Ivors, Plant Pathologist, NCSU; G. Vallad, Plant Pathologist, UF; F. Louws, Plant Pathologist, NCSU; M. Paret, Plant Pathologist, UF

Disease	Material	Rate of Material to Use		Minimum Days		Method, Schedule, and Remarks
		Formulation	Active Ingredient	Harv.	Reentry	
TOMATO (field) (cont'd)						
Late blight (cont'd)	dimethomorph + ametoctradin (Zampro)	14 fl oz/acre		4	0.5	Begin applications prior to disease development and continue on a 5-day to 7-day interval. Use the shorter interval when disease pressure is high. The addition of a spreading or penetrating adjuvant is recommended to improve disease control performance.
	fluopicolide (Presidio) 4F	3 to 4 fl oz/acre	0.09 to 0.125 lb/acre	2	0.5	Use only in combination with a labeled rate of another fungicide product with a different mode of action.
	mandipropamid + difenoconazole (Revus Top)	5.5 to 8.0 fl oz/acre	0.09 + 0.09 to 0.12 + 0.12 lb/acre	1	4 hr	Begin applications prior to disease development, continuing on a 7 to 10 day interval. Do not apply more than 2 consecutive applications before alternating to a fungicide with a different mode of action. Do not apply more than 32 fl oz/acre/season.
	propamocarb (Previcur Flex) 6.0	0.7 to 1.5 pt/acre	0.5 to 1.0 pt/acre	5	0.5	Use only in combination with a labeled rate of a protectant fungicide.
Southern blight	fluoxastrobin (Aftershock, Evito) 480 SC	2.0 to 5.7 fl oz/acre	0.063 to 0.18 lb/acre	3	0.5	Begin applications when conditions favor disease development, on 7- to 10-day intervals. Do not apply more than once before alternating with fungicides that have a different mode of action. Do not apply more than 22.8 fl oz per acre per season.
	pyraclostrobin (Cabrio) 20% EG	8 to 16 oz/acre	1.6 to 3.2 oz/acre	0	4 hr	Do not apply more than 96 oz per acre per season.

*See **TABLE 3-61** for a listing of available products for generic fungicides.

TABLE 3-52. RELATIVE EFFECTIVENESS OF ALTERNATIVE MANAGEMENT PRACTICES FOR FOLIAR DISEASE CONTROL ON TOMATO

K. Ivors, Plant Pathologist, NCSU; G. Vallad, Plant Pathologist, UF; F. Louws, Plant Pathologist, NCSU; M. Paret, Plant Pathologist, UF

Key to Efficacy Ratings: "++++" Excellent; "+++" Good; "++" Fair; "+" Poor; "—" Not effective; "?" Unknown; "NA" Not applicable

Practice	RELATIVE CONTROL RATING							
	Bacterial canker	Bacterial speck	Bacterial spot	*Botrytis*	Buckeye rot	Early blight	Late blight	*Septoria*
Use of resistant cultivars	—	+	+	—	—	+++	+++	—
Crop rotation (3-4 years)	++	+	+	—	++	++	—	++
Fertility	—	—	—	+++	—	++	—	—
Use of cover crops	—	—	—	—	++	+	—	—
Destroy crop residue	—	—	—	—	—	+	—	—
Rogue plants	+	—	—	—	—	—	—	—
Promote air movement	++	++	++	+++	+	+	++	++
Use of disease free seed/ seed treatment	++++	++++	++++	—	—	—	—	—

Practice	RELATIVE CONTROL RATING							
	Bacterial canker	Bacterial speck	Bacterial spot	*Botrytis*	Buckeye rot	Early blight	Late blight	*Septoria*
Use of plastic mulches	—	—	—	—	+++	—	—	—
Do not handle plants when wet	++++	+++	+++	—	—	+	+	+
Use of drip irrigation	+++	+++	+++	++	+	++	++	++
Biological control	+	+	++	+	—	+	+	—
Application of fungicides	++	+	+	+++	+++	++++	++++	++++
Fumigation	—	—	—	—	+++	—	—	—

TABLE 3-53. RELATIVE EFFECTIVENESS OF VARIOUS CHEMICALS FOR TOMATO FOLIAR DISEASE CONTROL

K. L. Ivors, Plant Pathologist, NCSU; G. Vallad, Plant Pathologist, UF; F. J. Louws, Plant Pathologist, NCSU; and M.Paret, Plant Pathologist, UF

Pesticide	Fungicide Group[1]	Preharvest Interval (Days)	Relative Control Rating: "—" = ineffective or not labeled; "+++++" = very effective; "?" = activity unknown										
			Bacterial Canker	Bacterial Speck	Bacterial Spot	Botrytis Graymold	Buckeye Rot	Early Blight	Late Blight	Leaf mold (Fulvia fulva)	Powdery Mildew	Septoria Leaf Spot	Target Spot
azoxystrobin[2] (Quadris)	11	1	—	—	—	—	?	+++++[R]	++	++++	+++++	++++	++[R]
famoxadone/cymoxanil (Tanos)	11 + 27	3	—	—	—	—	+	+++	+++	+++	?	+++	+++[R]
pyraclostrobin (Cabrio)	11	0	—	—	—	—	?	+++++[R]	++	++++	+++++	++++	++[R]
bacteriophage[3] (AgriPhage)	NA	0	—	+	+	—	—	—	—	—	—	—	-
acibenzolar-S-methyl9 (Actigard)	21	14	?	+++	+++	—	—	—	—	—	—	—	++
boscalid (Endura)	7	0	—	—	—	+++	—	++++	—	?	?	?	+++
chlorothalonil (Bravo, Equus, Echo)	M	0	—	—	—	++	+	++	++++	++++	+	++++	++
chlorothalonil + ProPhyt[2] (Catamaran)	M + 33	1	—	—	—	++	+	++	++++	++++	+	++++	++
cyazofamid (Ranman)	21	0	—	—	—	—	—	++	+++	—	—	—	-
cymoxanil (Curzate)	27	3	—	—	—	—	+?	—	+++	?	—	?	-
cymoxanil + famoxadone (see *Tanos* above)	27 + 11	3	—	—	—	—	+	+++	+++	+++	?	+++	+++[R]
dimethomorph (Acrobat, Forum)	40	4	—	—	—	—	+++	—	+++	—	—	—	-
difenoconazole + cyprodinil (Inspire Super)	3 + 9	0	—	—	—	—	—	+++	—	+++	++++	+++	+++
dimethomorph + ametoctradin (Zampro)	40 + 45	4	—	—	—	—	—	—	++++	—	—	—	—
fenamidone (Reason)	11	14	—	—	—	—	++	+++	+++	+	?	+	+++[R]
fixed copper[4]	M	0	+++	+++	+++	—	+	++	++	++	+	++	—
fluopicolide (Presidio)	43	2	—	—	—	—	+	—	++++	—	—	—	—
fluxapyroxad + pyraclostrobin (Priaxor)	11 + 7	0	—	—	—	+++	—	++++	—	?	?	?	+++
mancozeb (Dithane, Manzate, Penncozeb)	M	5	—	—	—	—	+	+++	++	+++	—	+++	++
mancozeb + fixed copper (ManKocide)	M + M	5	+++	+++	++	—	+	+++	+++	+++	+	+++	+
mancozeb + zoxamide (Gavel)	M + 22	3	—	—	—	—	+	+++	++	++	—	++	-
mandipropamid + difenoconazole (Revus Top)	40 + 3	1	—	—	—	—	+	+++	++++	?	—	?	++++
mefenoxam[8] + chlorothalonil (Ridomil Gold Bravo, Flouronil)	4 + M	14	—	—	—	+	+++++	+	+++++	++	—	++	++
mefenoxam + copper (Ridomil Gold/Copper)	4 + M	14	++	++	++	—	+++++	++	+++++[R]	++	+	++	—
mefenoxam + mancozeb (Ridomil Gold MZ)	4 + M	5	—		—	—	+++++	+++	++++[R]	++	—	++	+
myclobutanil (Rally)	3	1	—	—	—	—	—	—	—	—	++++	—	?
penthiopyrad (Fontelis)	7	0	—	—	—	+++	—	++++	—	?	?	?	+++
propamocarb (Previcur Flex)	28	5	—	—	—	—	+	—	+++	—	—	—	—
pyrimethanil (Scala)	9	1	—	—	—	++	—	++	—	?	?	?	+++
streptomycin[5] (Agri-Mycin, Streptrol)	25	0	+++	+++	+++	—	—	—	—	—	—	—	-
sulfur[6]	M	0	—	—	—	—	—	—	—	—	+++	—	-
zinc dimethyldithiocarbamate[10] (Ziram)	M	7	—	—	—	—	—	++	?	++	?	++	?

[1]**Key to Fungicide Groups:** 1: methyl benzimidazole carbamates; 2: dicarboxamides; 3: demethylation inhibitors; 4: phenylamides; 7: carboxamides, 9: anilonopyrimidines; 11: quinone outside inhibitors; 12: phenylpyrroles; 15: cinnamic acids; 21: quinone inside inhibitors; 22: benzamides; 25: glucopyranosyl antibiotic; 27: cyanoacetamide- oximes; 28: carbamates; 33: phosphonates; 40: carboxylic acid amines; 43: acylpicolides; M: multi-site activity; NA: not applicable.

[2]Contact control only; not systemic.

[3]Biological control product consisting of a virus that attacks pathogenic bacteria.

[4]Fixed coppers include: Basicop, Champ, Champion, Citcop, Copper-Count-N, Kocide, Nu-Cop, Super Cu, Tenn-Cop, Top Cop with Sulfur, and Tri-basic copper sulfate.

[5]Streptomycin may only be used on transplants; not registered for field use.

[6]Sulfur may be phytotoxic; follow label carefully.

[7]Curative activity; not systemic.

[8]Curative activity; systemic.

[9]Systemic activated resistance.

[10]Do not use on cherry tomatoes.

[R]Resistance to this pesticide has been detected in the pathogen population. In the case of mefenoxam, Phytophthora (late blight) resistant strains predominate.

SPRAY SCHEDULE FOR FOLIAR DISEASE CONTROL IN FRESH-MARKET TOMATO PRODUCTION

The following schedule is based on research conducted at the Mountain Horticulture Research Station, Fletcher, N.C. Products and schedules may be different for other regions of North Carolina depending upon the disease involved and the amount of disease pressure.

TABLE 3-54. SUGGESTED WEEKLY SPRAY SCHEDULE FOR FOLIAR DISEASE CONTROL IN FRESH-MARKET TOMATO PRODUCTION

K. L. Ivors, Plant Pathologist, NCSU

Week	Chemical	Number of Applications of Chemical Per Season
BEFORE HARVEST		
1	mancozeb* + copper + Actigard*	mancozeb, 1; Actigard, 1
2	mancozeb* + copper	mancozeb, 2
3	mancozeb* + strobilurin* + Actigard	mancozeb, 3; strobilurin, 1; Actigard, 2
4	mancozeb* + copper	mancozeb, 4
5	Endura low rate** + Actigard	Endura 1; Actigard, 3
6	mancozeb* + copper	mancozeb, 5
7	mancozeb* + strobilurin* + Actigard	mancozeb, 6; strobilurin, 2; Actigard, 4
8	mancozeb* + copper	mancozeb, 7
DURING HARVEST (Note: For fields in the Coastal Plain or other SE regions with low or no danger of Late Blight, Revus Top, Ranman and Presidio may not be essential tools; the protectant, chlorothalonil may suffice. Contact your local Extension office to learn if Late Blight is present in your region).		
9	Endura low or high rate + chlorothalonil	chlorothalonil, 1; Endura, 2
10	Revus Top* OR Presidio OR Ranman	Revus Top, 1; Presidio, 1; Ranman, 1
11	chlorothalonil + strobilurin*	chlorothalonil, 2; strobilurin, 3;
12	Revus Top* OR Presidio OR Ranman	Revus Top, 2; Presidio, 2; Ranman, 2
13	Endura low or high rate + chlorothalonil	chlorothalonil, 3; Endura, 3
14	Revus Top* OR Presidio OR Ranman	Revus Top, 3; Presidio, 3; Ranman, 3
15	chlorothalonil + strobilurin*	chlorothalonil, 4; strobilurin, 4
	Finish season with chlorothalonil	

Mancozeb, copper, chlorothalonil and strobilurins are common names for products sold under various trade names. Actigard, Endura, Ranman, Revus, Top and Presidion are trade names of products from Syngenta, BASF, FMC, Syngenta and Valent, respectively. Refer to the Label and complementary tables above and below for rates to use in volume-based spraying.

* Total number of applications per season restricted by the label.

For an electronic version of this spray guide, visit http://www.ces.ncsu.edu/fletcher/programs/plantpath/

TABLE 3-55. SUGGESTED WEEKLY SPRAY SCHEDULE AND PRODUCTSX FOR FOLIAR TOMATO DISEASE CONTROL IN FIELDS WHERE THE QOI FUNGICIDES HAVE FAILED TO PROVIDE ADEQUATE EARLY BLIGHT CONTROL

K. L. Ivors, Plant Pathologist, NCSU; D. Langston, Plant Pathologist, UGA; and F. J. Louws, Plant Pathologist, NCSU

(where early blight has developed resistance to the products Cabrio or Quadris)

Before Harvest (Weeks 1-8): Mancozeb, Fontelis, and the low rate of Endura are recommended to control early blight and other foliar leaf spots like *Septoria*. Copper plus mancozeb, and Actigard target the bacterial leaf spots.	Week 1 - mancozeb (1)[Y] + copper + Actigard (1)[Y]
	Week 2 - mancozeb (2) + copper
	Week 3 - mancozeb (3) + Fontelis (1)[Y] + Actigard (2)
	Week 4 - mancozeb (4) + copper
	Week 5 - Endura LOW rate[Z] (1) + Actigard (3)
	Week 6 - mancozeb (6) + copper
	Week 7 - mancozeb (7) + Fontelis (2) + Actigard (4)
	Week 8 - mancozeb (8) + copper
During Harvest (Weeks 9-15+): Fontelis, Revus Top and the low rate of Endura are recommended to control early blight and other foliar leaf spots like *Septoria*. Chlorothalonil and Revus Top are recommended to control late blight. The HIGH rate of Endura is recommended for gray mold if conditions are favorable.	Week 9 - Endura LOW rate + chlorothalonil (1)
	Week 10 - Revus Top (1)[Y]
	Week 11 - chlorothalonil (2) + Fontelis (3)
	Week 12 - Revus Top (2)
	Week 13 - Endura LOW rate + chlorothalonil (3)
	Week 14 - Revus Top (3)
	Week 15 - chlorothalonil (4) Finish season with chlorothalonil

[x] Mancozeb, copper, chlorothalonil, and strobilurin are common names for products sold under various trade names. Actigard, Endura, Fontelis, and Revus Top are trade names of products from Syngenta, BASF, DuPont, and Syngenta respectively. Refer to labels, table below and the text above for rates to use in volume-based spraying.

[Y] Total number of applications per season is restricted by the label.

[Z] Low rate of Endura controls early blight; high rate controls early blight & Botrytis gray mold. High rate is only necessary if conditions are conducive for gray mold (cool/wet right before & during harvest). Total max rate allowed per season is 25 oz.

TURNIP ROOTS – SEE GREENS AND LEAFY BRASSICAS

TURNIP ROOTS – SEE ROOT VEGETABLES

WATERMELONS – SEE CUCURBITS

NEMATODE CONTROL IN VEGETABLE CROPS

Crop losses due to nematodes can be avoided or reduced by using the following management tactics.

1. Practice crop rotation.
2. Plow out and expose roots immediately after the last harvest.
3. Plow or disk the field two to four times before planting.
4. Use nematode-free planting material.
5. Sample soil and have it assayed for nematodes, preferably in the fall. There is a fee for each sample. Ship sample via DHL, FedEx, or UPS to: State Agency.
6. Where warranted, fumigate or use other nematicides according to guidelines listed on the label. (Soil should be warm, well worked, and free from undecomposed plant debris and have adequate moisture for seed germination.)
7. For in-row application, insert chisel 6 to 8 inches deep and throw a high, wide bed up over it; do not rework rows after fumigating.
8. For broadcast treatments, insert chisels 6 to 8 inches deep, and space chisels 12 inches apart for most fumigants; use 5-inch spacing for Vapam.
9. Row rates in this section are stated for rows on 40-inch spacing. For other row spacings, multiply the stated acre rate by the appropriate conversion factor to determine the amount of material applied per acre (Do not alter stated amount per 100-foot row). This will be a guide to the amount of material to purchase for the acreage you want to treat.

Your Row Spacing (inches)	Conversion Factor
24	1.67
26	1.54
28	1.43
30	1.33
32	1.25
34	1.18
36	1.11
38	1.05
40	1.00
42	0.952
44	0.909
46	0.870
48	0.833
5 ft	0.667
6 ft	0.556
7 ft	0.476
8 ft	0.417

For example, if 10 gallons per acre are used on 40-inch rows, for 36-inch rows, it will take 11.1 gallons to treat an acre.

CAUTION: Read labels carefully. Some products have restrictive crop rotations.

CAUTION: At the time this table was prepared, the entries were believed to be useful and accurate. However, labels change rapidly and errors are possible, so the user must follow all directions on the container of the pesticide. *Follow manufacturers label in all cases.*

TABLE 3-56. NEMATODE CONTROL IN VEGETABLE CROPS

Commodity	Material	Application Method for Given Soils	Formulated Rate per Acre	Formulated Rate Per 100 Sq Ft Or 100 Ft Row	Schedule and Remarks
FUMIGANTS					
MOST VEGETABLES	dichloropropene (Telone II)	Broadcast, mineral soil	9 to 12 gal	2.6 to 3.5 fl oz	Fall application usually preferred to spring application. Wait 3 weeks before planting, longer if soil is cold or very wet.
		Broadcast, peat, or muck soil	25 gal	7.4 fl oz	
MOST VEGETABLES (MULTI-PURPOSE FUMIGANTS)	Vapam HL, Sectagon 42, Metam CLR	Broadcast, mineral soil	37.5 to 75 gal	11 to 22 fl oz	Fall application is often preferred to spring application. Wait 3 weeks before planting or longer in cold, wet soil, or if odor persists. Read label for row application use in organic soils, chisel depth and spacing, exact rates, and special uses. Metam sodium can also be used with overhead and drip irrigation. When used with plastic covers, all products are more effective, and lower rates can be used. Use products with 15% or more chloropicrin (Telone C-17, Telone C-35, and Terr-O-Gas) for soilborne bacterial diseases. Methyl bromide may have use restrictions associated with Critical Use Exemptions. Use VIF plastic to reduce rates.
	Pic-chlor 60	Broadcast, mineral	19.5 to 31.5 gal	5.7 to 9.0	
		Muck or peat	50.5 to 55.0	14.5 to 15.9	
	Telone C-17	Broadcast, mineral soil	10.8 to 17.1 gal	3.2 to 5.0 fl oz	
		Broadcast, muck or peat soil	27.4 to 30.0 gal	8.1 to 8.8 fl oz	
	Telone C-35 or Inline (drip application only)	Broadcast, mineral soil	13 to 20.5 gal	3.8 to 6 fl oz	
		Broadcast, muck or peat soil	33 to 36 gal	9.6 to 10.6 fl oz	
Crops with Critical Use Nominations	methyl bromide + chloropicrin	Broadcast, mineral soil	270 to 360 lb	0.6 to 0.8 fl oz	
	various formulations		215 to 430 lb	0.5 to 1.0 lb	
BEAN (snap and lima)	ethoprop (Mocap) various formulations	Broadcast or banded	See label	See label	Incorporate 2 to 4 in. deep. See label.
CABBAGE (transplants Florida only)	fenamiphos (Nemacur) 15G	Banded	5.0 fl oz/ 1000 ft		Restricted use pesticide
CABBAGE	ethoprop (Mocap) various formulations	Broadcast or banded	See label	See label	Restricted use pesticide. Incorporate 3 in. deep.
CARROT	oxamyl (Vydate) 2L	Preplant broadcast	2 to 4 gal in 20 gal water	1 to 2 gal in 20 gal water	Apply (in furrow) within 1 wk of planting, and thoroughly incorporate into soil 4- to 6-in. deep.
		At planting seed furrow	1 to 2 gal in 20 gal water	0.3 to 0.6 fl oz in 5.9 fl oz water	
CUCUMBER	ethoprop (Mocap G) various formulations	Banded only	See label	See label	Incorporate 2 to 4 in. deep. See label.

TABLE 3-56. NEMATODE CONTROL IN VEGETABLE CROPS (cont'd)

Commodity	Material	Application Method for Given Soils	Formulated Rate per Acre	Formulated Rate Per 100 Sq Ft Or 100 Ft Row	Schedule and Remarks
CUCURBITS (cucumber, squash, cantaloupe, watermelon, honeydew, pumpkin)	oxamyl (Vydate) 2L	Preplant broadcast	1 to 2 gal	—	Incorporate 2 to 4 in. into soil.
		Foliar spray	2 to 4 pt Use enough water for uniform coverage of foliage	0.07 to 0.15 fl oz	First application 2 to 4 weeks after planting; repeat 14 to 21 days later. Do not treat within 1 day of harvest.
EGGPLANT	fenamiphos (Nemacur) 15G	Banded	5.9 fl oz/ 1000 ft		On narrow rows do not let bands overlap. See label.
	oxamyl (Vydate) 2L	Banded on soil	—	1 gal	See label.
		Foliar	4 pt	—	Apply twice by ground equipment at 1- to 2 week intervals 2 to 4 weeks after the second soil treatments.
PEPPER (bell)	oxamyl (Vydate) 2L	Transplant water	2 pt in 200 gal water	—	Do not treat within 7 days of harvest.
		Drip irrigation	2 to 4 pt in 40 to 200 gal water	—	Use as a supplement to transplant treatment 14 days after transplanting; repeat at 1- to 2-week intervals.
POTATO	ethoprop (Mocap) various formulations	Broadcast or banded	See label	See label	Incorporate 2 to 4 in. deep. See label.
	oxamyl (Vydate) 2L	Furrow	1 to 2 gal in 20 gal water	—	Apply to seed furrow at planting; begin foliar sprays when early season control has diminished.
		Foliar	2 to 4 pt		
SWEETPOTATO	aldicarb (Temik) 15 G **For use ONLY in LA or MS.**	40-in. rows	10 to 20 lb	0.4 to 0.7 oz	Apply in a 12- to 15-in. band and incorporate 4 to 8 in. deep, plant. Do not harvest within 120 days of treatment. Do not use vines.
	ethoprop (Mocap) various formulations	Broadcast or banded	See label	See label	Incorporate 2 to 4 in. deep. See label.
	oxamyl (Vydate) 2L	Preplant broadcast	2 to 3 gal in 20 gal water	—	Thoroughly incorporate into soil 4 to 6 in. deep and plant.
		Transplant water	1 to 2 gal in 200 gal water		
SWEET CORN	ethoprop (Mocap) various formulations	Banded only	See label	See label	Incorporate 2 to 4 in. deep. See label.
SWEET CORN, POPCORN	terbufos (Counter) 15G	Row, 30-in. min.	8 oz/1,000-ft row	0.8 oz	Place granules directly in the seed furrow behind planter shoe. Maximum 8.7 lb/acre.
TOMATO	oxamyl (Vydate) 2L	Foliar	2 to 4 pt	—	Spray when plants are established. Repeat 1- to 2-week intervals.
		Drip irrigation	2 to 8 pt	—	Apply at first irrigation to field. Repeat every 1 to 2 weeks while plants are small. As plants enlarge, increase dosage progressively to 8 pt.

GREENHOUSE VEGETABLE CROP DISEASE CONTROL SCHEDULE

Note: Follow manufacturer's directions on label in all cases.

Caution: At the time this table was prepared, the entries were believed to be useful and accurate. However, labels change rapidly and errors are possible, so the user must follow all directions on the pesticide container.

Information in the following table must be used in the context of a total disease control program. For example, many diseases are controlled by the use of resistant varieties, crop rotation, sanitation, seed treatment, and cultural practices. Always use top-quality seed or plants obtained from reliable sources. Seeds are ordinarily treated by the seed producer for the control of seed decay and damping-off.

Most foliar diseases can be reduced or controlled by maintaining relative humidity under 90 percent, by keeping the air circulating in the house with a large overhead polytube, and by avoiding water on the leaves.

Caution: The risk of pesticide exposure in the greenhouse is high. Use protective clothing laundered daily or after each exposure. Ventilate during application and use appropriate respirator.

TABLE 3-57. GREENHOUSE DISEASE CONTROL FOR TOMATO AND OTHER VEGETABLE CROPS[1]

Commodity	Disease	Material[4]	Rate of Formulation	Rate of Active Ingredient	Minimum Days		Schedule, and Remarks
					Harv.	Reentry	
GREENHOUSE	Sanitation	Solarization	140°F, 4 to 8 hr for 7 days	—	—	—	Close up greenhouse during hottest and sunniest part of summer for at least 1 week. Greenhouse must reach at least 140°F each day. Remove debris and heat sensitive materials and keep greenhouse and contents moist; will not control pests 0.5 in. or deeper in soil; not effective against TMV.
		Added heat	180°F for 30 min	—	—	—	Remove all debris and heat-sensitive materials. Keep house and contents warm.
		methyl bromide 98%	3 lb/1,000 cu ft		—	—	Clean out greenhouse, moisten interior, close tightly, treat for 24 hr at 65°F or higher, and ventilate.
SOIL	Soilbore diseases	Steam, metamsodium, or chloropicrin	—		—	7 to 21	Preplant soil treatment. See table on sanitizing greenhouses and plant beds.
VEGETABLE BEDDING PLANTS (in beds or container grown): BEANS (excluding cowpeas), BROCCOLI, BRUSSEL SPROUTS, CABBAGE, CAULIFLOWER, PEPPERS, TOMATOES	Root and stem rot, damping off *(Rhizoctonia solani)*	PCNB (Terraclor) 75 WP	4 to 8 oz/100 gal		—	0.5	See label for guidelines to achieve penetration to different depths.
BEAN (dry)	Leaf spots	mancozeb 80 W	1.5 to 2 lb/ 43,560 sq ft		30	1	Spray at first appearance of leaf spot or downy mildew. Not effective against powdery mildew. Approximate equivalencies: 1.5 lb/acre = 6.8 grams/gal; 1.5 lb/acre = 2.5 tsp/gal.
BROCCOLI, BRUSSELS SPROUT, CAULIFLOWER					7	1	
CABBAGE, KOHLRABI					7	1	
CUCURBITS					5	1	
EGGPLANT					5	1	
KALE					10	1	
LETTUCE, ENDIVE					10	1	
MELON					5	1	
ONION			2 to 3 lb/ 43,560 sq ft		7	1	
CUCUMBER	*Sclerotium*, Southern stem blight, *Sclerotinia*, white mold	Botran 75W	1.3 lb/43,560 sq ft		14	1	Apply when disease first appears to diseased areas of plants.
LETTUCE (leaf)	*Botrytis*	Botran 75W	2.6 lb/43,560 sq ft		14	1	Spray 7 days after transplanting and when half mature.
RHUBARB	*Botrytis*	Botran 75W	1.3 lb/43,560 sq ft		3	1	Start weekly sprays at bud emergence.
TOMATO, LEAF LETTUCE, CUCURBIT, PEPPERS	*Pythium*, *Phytophthora*	propamocarb (Previcur Flex)	1:1,000		2	0.5	See label instructions for use before and after transplanting.
TOMATO[1] *Seedling and Pretransplant*	Bacterial spot, speck, and canker	Streptomycin sulfate (Agri-mycin) 17 WP	16 oz/100 gal	2.7 oz/ 100 gal	0	0.5	For transplant production only. Begin applications at the first true leaf stage. Repeat weekly until transplanting.
	Pythium, *Phytophthora* root rot	propamocarb hydrochloride (Previcur Flex)	12.8 fl oz/ 100 gal water		5	0.5	Prepare stock solution and apply 3.4 to 6.8 fl oz per cube as a drench to pre-wet cubes. 100 gal will treat 3,800 plants and 1,900 plants respectively.

[1] Products registered for field use may be used on the greenhouse crop (but not transplants) unless excluded on the label.

[2] Resistance available.

[3] Use sanitation, seed treatment.

[4] Other formulations may be available.

TABLE 3-57. GREENHOUSE DISEASE CONTROL FOR TOMATO AND OTHER VEGETABLE CROPS[1] (cont'd)

Commodity	Disease	Material[4]	Rate of Formulation	Rate of Active Ingredient	Minimum Days		Schedule, and Remarks
					Harv.	Reentry	
TOMATO *Transplant soil drench*	*Pythium*	cyazofamid (Ranman)	3 fl. oz/100 gal water	0.078 lb/100 gal water	0	0.5	Make a single application to the seeding tray one week before transplanting. Apply as a drench to thoroughly wet the growing medium. Do not use any surfactant with this drench application.
TOMATO *After transplanting in greenhouse*	Anthracnose, Early blight, Powdery mildew, Target spot, Suppression of Bacterial spot and speck	famoxadone + cymoxanil (Tanos)	6 to 8 oz/acre	3 to 3 oz/ acre	3	4 h	Tank mixing Tanos with a contact fungicide appropriate for the targeted disease is required. Do not apply more than 72 oz per crop cycle.
	Late Blight	propamocarb hydrochloride (Previcur Flex)	0.7 to 1.5 pt/acre	0.47 to 1.0 pt/ acre	5	0.5	Must tank mix Previcur Flex with mancozeb for best control. Apply on a 7-10 day interval.
	Anthracnose, Leaf mold, Early blight, Late blight, *Septoria* leaf spot, Gray leaf spot	maneb (Maneb) 75 DF (Maneb) 80 (Manex) 4 F Mancozeb (Dithane M45)	 1.5 to 3 lb/acre 1.5 to 3 lb/acre 1.2 to 2.4 qt/acre 1.5 to 3.0 lb/acre	 1.1 to 2.25 lb/A 1.2 to 2.4 lb/A 0.4 to 0.9 qt/A 1.2 to 2.4 lb/A	5	1	Do not apply more than 21 lb Maneb per acre per crop cycle. Do not apply more than 16.8 qt Manex per acre per crop cycle. Repeat applications at 7-10 d intervals. Do not apply more than 8 lb product per acre per crop
	Early blight, Late blight, *Botrytis* gray mold, Target spot	potassium phosphite + chlorothalonil (Catamaran)	5 to 7 pt/acre	2.8 to 3.9 pt/ acre	0	0.5	Phytotoxicity potential- do not combine Catamaran with other pesticides, surfactants, or fertilizers. Apply on a 7-10 day interval. Use the higher rate for fruit rot diseases.
	Bacterial soft rot, speck, and spot	fixed copper products (various formulations)	See label	various	0	1	**Some products are OMRI-approved.** See product label for complete application instructions
	Bacterial spot and speck Suppression of bacterial canker[3]	bacteriophage (AgriPhage)	1 to 2 pt/acre	naturally occurring bacteriophage	0	0.5	Apply preventively 2 to 3 times per week. Can be used as a drench in the irrigation water or as a foliar spray. Do not mix AgriPhage with copper-based fungicides. The pH of water should be above 5.
	Botrytis (gray mold)	fenhexamide (Decree 50 WG)	½ lb/acre	0.6 lb/acre	1	0.5	Can be applied up to 1 day before harvest.
	Botrytis (gray mold), Early blight	pyrimethanil (Scala) SC	7 fl oz/acre	3.8 fl oz/acre	1	0.5	Use only in a tank mix with suitable fungicide labeled for these diseases. Ventilate greenhouse for 2 hours after application as vapors may injure crop. Do not apply more than 35 fl oz per crop cycle.
	Botrytis (gray mold), *Sclerotinia* stem rot	dicloram (Botran) 75W or 75 WSB	1 lb/acre	0.75 lb/acre	10	0.5	Spray stems of plants from the ground to a height of 18 to 24 in. Do not treat seedlings or new transplants, as injury may occur. Make no more than 4 applications per crop cycle.
	Powdery mildew[2]	sulfur (Microthiol Disperss)	5 to 10 lb/acre	0	1		Do not apply if temperatures will exceed 90 F for 2 days following application or plant injury may occur. **OMRI-approved.**
	Pythium and *Phytophthora* root rot	propamocarb hydrochloride (Previcur Flex)	12.8 fl oz/100 gal water	8.5 oz/100 gal water	5	0.5	Prepare stock solution, and apply 3.4 fl oz per cube through drop irrigation for first 2 weeks. After first 2 weeks, apply 3.4 to 6.8 fl oz stock solution per cube through drip irrigation. 100 gal will treat 3,800 plants in the first 2 weeks and 1,900 plants after the first 2 weeks. Do not make more than 4 applications per crop cycle.
		etridiazole (Terramaster)	6 to 7 oz/acre	2.7 to 3.1 fl oz/acre	3	0	Mix a 0.01% solution (6.5 oz/500 gal water), and apply through drip irrigation no sooner than 3 weeks after transplanting. Do not apply more than 27.4 oz per acre per cropping season. Potential phytotoxicity if not mixed and applied properly. **Terramaster is not labeled for this use in North Carolina.**

[1] Products registered for field use may be used on the greenhouse crop (but not transplants) unless excluded on the label.

[2] Resistance available.

[3] Use sanitation, seed treatment.

[4] Other formulations may be available.

TABLE 3-57. GREENHOUSE DISEASE CONTROL FOR TOMATO AND OTHER VEGETABLE CROPS[1] (cont'd)

Commodity	Disease	Material[4]	Rate of Formulation	Rate of Active Ingredient	Minimum Days		Schedule, and Remarks
					Harv.	Reentry	
BIORATIONALS AND BIOLOGICALS	Leaf mold, Powdery mildew, *Botrytis* (gray mold)	Neem oil	1:200 up to 1:100 solution		0	Until spray dries	Apply to just before runoff. **OMRI-approved.** Toxic to Honey bees.
BIORATIONALS AND BIOLOGICALS	*Botrytis* (gray mold) Suppression of bacterial canker	Extract of *Reynoutria sachalinensis* (Regalia)	0.5-1.0% v/v solution	-	0	4 hr	
BIORATIONALS AND BIOLOGICALS	Powdery mildew	sulfur (Microthiol Disperss)	5 to 10 lb/acre	4 to 8 lb/acre	0	1	Do not apply if temperatures will exceed 90°F for 3 days following application as plant injury may occur. **ORMI-approved.**
	Pythium, *Rhizoctonia*, *Phytophthora* suppression	*Streptomyces griseoviridis* (Mycostop)	1 to 2 g/100 sq ft of area enough to water to cover root zone	0.04 to 0.08 oz/1,000 sq ft	0	4 hr	**OMRI-approved.**
	Pythium root rot, *Botrytis* (gray mold)	*Trichoderma harzianum* (Plant Shield)	See Remarks	See Remarks	0	0	Suspend in 100 gal water. Apply 50 to 100 gal per 800 square-foot area as a drench for *Pythium*. Use 0.5 to 1 oz per gal water for *Botrytis* as a foliar spray.
	Target spot, Early blight, Bacterial spot and speck, Powdery mildew, *Botrytis* (gray mold)	*Bacillus subtilis* (Serenade)	2 to 6 qt/acre	0.3 to 0.8 qt/ acre	0	4 hr	Begin applications prior to disease development, and repeat at 5- to 10-day intervals as needed.
	Timber rot or White mold (*Sclerotinia*)	*Coniothyrium minitans* (Contans WG)	0.75 to 1.5 oz/1,000 sq ft applied to growing medium	0.04 to 0.08 oz/1,000 sq ft	0	4 hr	**OMRI-approved.**
	Viruses[3] (e.g., ToMV, TMV	Milk (skim)					Dip hands before handling plants.

[1] Products registered for field use may be used on the greenhouse crop (but not transplants) unless excluded on the label.

[2] Resistance available.

[3] Use sanitation, seed treatment.

[4] Other formulations may be available.

TABLE 3-58. RELATIVE EFFECTIVENESS OF VARIOUS PRODUCTS FOR GREENHOUSE TOMATO DISEASE CONTROL

Fungicide	Fungicide Group [1]	Preharvest Interval (days)	KEY: "—" = ineffective; "+"....."++++" = very effective; "?" = unknown efficacy.												
			Anthracnose (*Colletotrichum coccodes*)	Bacterial Soft Rot (*Erwinia carotovora*)	Bacterial Canker (*Clavibacter michiganense*)	*Botrytis* Gray Mold (*Botrytis cinerea*)	Early Blight (*Alternaria solani*)	Leaf Mold (*Fulvia fulva*)	Powdery Mildew (*Leveillula taurica*)	*Phytophthora* Root Rot (*Phytophthora* sp.)	*Pythium* Root Rot (*Pythium myriotylum*)	*Rhizoctonia* Root Rot (*Rhizoctonia solani*)	*Septoria* Leaf Spot (*Septoria lycopersici*)	Target Spot (*Corynespora cassicola*)	Timber Rot (White Mold) (*Sclerotinia sclerotiorum*)
acibenzolar-*S*-methyl (Actigard)	P	14	—	++	++	—	—	—	—	—	—	—	—	—	—
bacteriophage (AgriPhage)	NC	0	—	+	++	—	—	—	—	—	—	—	—	—	—
Bacillus subtilis (Rhapsody)	NC	0	?	?	—	+	+	?	+	—	—	—	?	+	?
boscalid (Endura)	7	0	?	—	—	+++	+++	?	—	—	—	—	?	++++	+++
Coniothyrium minitans (Contans WG)	NC	0	—	—	—	—	—	—	—	—	—	—	—	—	+
dicloran (Botran 75 WP)	14	10	—	—	—	++++	—	—	—	—	—	—	—	—	++
etridiazole (Terramaster)[2]	14	3	—	—	—	—	—	—	—	+++	+++	?	—	—	—
famoxadone + cymoxanil (Tanos)	11 + 27	3	+++	?	+	?	+++	++	+	—	—	—	++	++	?
fenhexamide (Decree 50 WDG)	17	1	—	—	—	—	—	—	+++	—	—	—	—	—	—
fixed copper[2]	M	0	+	+++	++	+	++	+	+	—	—	—	+	+	—
mancozeb (Dithane 75 DF)	M	5	++++	—	—	++	++++	+++	?	—	—	—	+++	+++	?
neem oil (Trilogy, Triact 70)	NC	0	?	?	?	?	?	?	?	?	?	?	?	?	?
penthiopyrad (Fontelis)	7	0	+	-	-	++	+++	++	+	-	-	-	++	+++	?
propamocarb hydrochloride (Previcur Flex)	28	5	—	—	—	—	—	—	—	+++	+++	—	—	—	—
pyrimethanil (Scala)	9	1	—	—	—	+++[R]	—	—	—	—	—	—	—	—	—
Streptomyces griseoviridis (Mycostop)	NC	0	—	—	—	—	—	—	—	—	++	++	—	—	—
streptomycin sulfate (Agri-Mycin 17)[3]	18	0	—	+++	++	—	—	—	—	—	—	—	—	—	—
sulfur[4] (Microthiol Disperss)	M	0	+	—	—	—	—	—	+++	—	—	—	—	—	—
Trichoderma harzianum (Plant Shield)	NC	0	—	—	—	—	—	—	—	—	+	++	—	—	—
hydrogen dioxide (Oxidate)	NC	0	?	?	?	?	?	?	+	+	+	?	?	?	?

[1] **Key to fungicide groups:** 7: carboxamides; 9: anilonopyrimidines; 11: quinine outside inhibitors; 14: aromatic hydrocarbons; 17: hydroxyanalides; 25: glucopyranosil antibiotic; 27: cyanoacetamide-oximes; 28: carbamates; M: multi-site; NC: not classified and P: host plant defense induction

[2] Fixed coppers include: Basicop, Champ; Champion, Cit-Cop, Copper-Count-N, Kocide, Nu-Cop, Super Cu, Tenn-Cop, Top-Cop with Sulfur, Tri-basic copper sulfate.

[3] For use on transplants only.

[4] Sulfur may be phytotoxic; follow label carefully.

[R] Resistance to this pesticide has been detected in the pathogen population.

SANITIZING GREENHOUSES AND PLANT BEDS

Follow manufacturers label in all cases. The objective of treating soil in greenhouses and plant beds is to reduce to acceptable levels weeds, nematodes, insects, fungi, and bacteria in the soil that cause damage and disease in plants. This is critical for the successful production of greenhouse crops and healthy plants for field use.

Follow general procedures for successful soil fumigation as outlined in commercial literature. Do not overtreat soil. Treated soils might develop nutrient imbalance and be especially susceptible to secondary infestation of disease-causing agents. Always follow directions on the label on the pesticide containers.

CAUTION:

Some products or treatments cannot be used for crops.

TABLE 3-59. SANITIZING GREENHOUSES AND PLANT BEDS

K. Ivors, Plant Pathologist, NCSU

Site	Material	Rate to Use		Relative Effectiveness						Use and Remarks
		Formulation	Application	Weeds	Nematodes	Insects	Bacteria	Fungi	Viruses	
SOILS and BEDS	dry heat	180° F for 30 min	Place small quantities in oven.	good	good	good	good	good	poor	
	Metam-sodium (Metam CLR, Sectagon, Vapam)	11 to 22 oz/100 sq ft (37.5 to 75 gal/acre)	Inject 4 to 6 in. deep, space chisels 6 in. apart. Cover with plastic 7 to 15 days. Aerate 2 to 4 weeks.	fair	good	good	fair	good	poor	All crops, all pests. Long waiting period after fumigating in cold soil (under 60°F).
		11 to 22 oz/100 sq ft (37.5 to 75 gal/acre)	Dilute with sufficient water and sprinkle uniformly to penetrate 2 in. into soil. A hose proportioner may be used. Cover with plastic 7 to 15 days. Aerate 2 to 4 weeks.							
	solarization	140° F, 4 to 8 hr/day for 7 days	Pots, benches, tools, shallow soil, structures	good	fair	good	fair	good	poor	Close greenhouse during hot, sunny days in summer for at least 1 week. Greenhouse must reach 140°F or higher each day. Remove debris and heat-sensitive materials and keep greenhouse and contents moist. Will not control TMV or pests 0.5 in. or deeper in soil.
	steam	Heat soil from 180° to 200° F (30 min) 6 in. deep	Perforated pipes on or in soil, cover with tarp	good	good	good	good	good	fair	All crops, most pests.
	Telone C-17 + herbicide	10.3 to 17.1 gal/acre See label for herbicide rates	Inject 10 to 12 in. deep with chisels spaced 12 in. apart. Seal the soil by packing, wetting, or covering with plastic mulch.	good	good	fair	fair	good	poor	Use higher rates for heavy soils. See label for organic soils.
	Telone II + herbicide	7 to 16 oz/100 sq ft (25 to 54 gal/acre) See label for herbicide rates	Inject 4 to 6 in. deep, space chisels 12 in. apart. Cover 1 week, aerate 3 weeks.	good	good	fair	poor	poor	poor	Not for greenhouse use.
TOOLS, EQUIPMENT, POTS, FLATS	alcohol (grain, rubbing, wood) (70% to 100%)	Full strength	Dip or swab; do not rinse.	poor	fair	poor	good	good	poor	Items that are being treated should be clean and moist and temperature should be above 60°F.
	deccosol-122	1 gal in 6 gal water (0.21% SOPP)	Brush, spray, or dip. Do not rinse.	poor	poor	poor	good	good	poor	For picking containers.
	sodium hypochlorite 5.25% (Clorox)	6 gal/100 gal	Dip 1 to 10 seconds, brush, spray, let drain, do not rinse.	poor	poor	poor	good	good	good	
	solarization	140° F, 4 to 8 hr/ day for 7 days	Place cleaned items on sunny driveway, cover tightly with clear plastic.	good	fair	good	fair	good	poor	See comments for solarization on previous page.
	steam	heat object 180° F	Cover or otherwise seal.	good	good	good	good	good	poor	Excellent

NOTE: *Follow manufacturer's label in all cases.*

TABLE 3-60. GENERIC FUNGICIDES FOR USE ON VEGETABLE CROPS

K. Seebold, Plant Pathologist, University of Kentucky

Common Name	Trade Name(s)
fosetyl-Al	Aliette WDG Fungicide *(Bayer)*
	Linebacker WDG *(NovaSource)*
chlorothalonil	Bravo Ultrex *(Syngenta)*
	Bravo Weather Stik *(Syngenta)*
	Bravo Zn *(Syngenta)*
	Chloronil 720 *(Syngenta)*
	Chlorothalonil 720 SC *(Arysta)*
	Echo 720 *(SipcamAdvan)*
	Echo 90DF *(SipcamAdvan)*
	Echo Zn *(SipcamAdvan)*
	Equus 500 Zn *(MANA)*
	Equus 720 SST *(MANA)*
	Equus DF *(MANA)*
	Initiate 720 *(Loveland Products)*
	Initiate ZN *(Loveland Products)*
copper hydroxide	Champ DP Dry Prill *(Nufarm)*
	Champ Formula 2 Flowable *(Nufarm)*
	Champ WG *(Nufarm)*
	Champion Wettable Powder *(Nufarm)*
	Kentan DF *(Isagro USA)*
	Kocide 2000 *(DuPont)*
	Kocide 3000 *(DuPont)*
	Nu Cop 3L *(Albaugh)*
	Nu Cop 50DF *(Albaugh)*
	Nu Cop 50WP *(Albaugh)*
	Nu Cop HB *(Albaugh)*
copper sulfate (basic)	Basic Copper 53 *(Albaugh)*
	Copper Z 4/4 *(Helena)*
	Cuprofix Ultra 40 Disperss *(UPI)*
	Cuproxat (NuFarm)
fludioxonil	Mamim 4FS *(Syngenta)*
	Spirato 480 FS *(Nufarm)*
iprodione	Enclosure 4 *(Devgen)*
	Iprodione 4L AG *(Arysta)*
	Meteor *(UPI)*
	Nevado 4F *(MANA)*
	Rovral 4 Flowable Fungicide *(Bayer)*
	Rovral 4 Flowable *(FMC)*
mancozeb	Dithane F-45 Rainshield *(Dow)*
	Dithane M-45 *(Dow)*
	Koverall *(Cheminova)*
	Manzate Flowable *(UPI)*
	Manzate Max *(UPI)*
	Manzate Pro-Stick *(UPI)*
	Penncozeb 4FL *(UPI)*
	Penncozeb 75DF *(UPI)*
	Penncozeb 80WP *(UPI)*
	Roper DF Rainshield *(Loveland Products)*
mefenoxam	Ridomil Gold GR *(Syngenta)*
	Ridomil Gold SL *(Syngenta)*
	Ultra Flourish *(Nufarm)*
myclobutanil	Rally 40WSP *(Dow)*
	Sonoma 25EW AG (*Albaugh*)
	Sonoma 40WSP *(Albaugh)*
pentachloronitro-benzene (PCNB)	Blocker 4F *(Amvac)*
	Blocker Flowable *(Amvac)*
	Par-Flo 4F *(Amvac)*
phosphite, potassium	Helena Prophyt *(Helena)*
	Confine Extra (*Winfield Solutions*)
	Reveille *(Helena)*
phosphite (mono- and dibasic salts)	Phostrol *(Nufarm)*
phosphorous acid (mono- and dipotassium salts)	Alude *(Cleary)*
	Fosphite Fungicide *(JK Biotech)*
	Fungi-Phite *(Plant Protectants)*
	K-Phite 7LP AG *(Plant Food Systems)*
	Rampart *(Loveland Products)*
propamocarb hydrochloride	Previcur Flex *(Bayer)*
	Promess *(Agriphar)*
propiconazole	AmTide Propiconazole 41.8% EC *(AmTide)*
	Bumper 41.8 EC *(MANA)*
	Bumper ES *(MANA)*
	Fitness *(Loveland Products)*
	Propi-star EC *(Albaugh)*
	Propicure 3.6F (*Direct Ag Source*)
	Propimax EC (*Dow AgroSciences*)
	Shar-Shield PPZ (*Sharda USA*)
	Tilt *(Syngenta)*
	Topaz *(Winfield Solutions)*
	Willowood Propicon 3.6EC *(Willowood USA)*
sulfur	Cosavet-DF *(Sulphur Mills Limited)*
	CSC 80% Thiosperse *(Martin Resources)*
	CSC Dusting Sulfur *(Martin Resources)*
	CSC Thioben 90 *(Martin Resources)*
	CSC Wettable Sulfur *(Martin Resources)*
	Dusting Sulfur *(Loveland Products Wilbur-Ellis)*
	First Choice Dusting Sulfur *(Loveland Products)*
	IAP Dusting Sulfur *(Independent Agribusiness Professionals)*
	InteGro Magic Sulfur Dust (*InteGro Inc.*)
	Kumulus DF *(Arysta)*
sulfur (cont'd)	Liquid Sulfur Six *(Helena)*
	Micro Sulf *(Nufarm)*
	Microfine Sulfur *(Loveland Products)*
	Microthiol Disperss *(UPI)*
	Special Electric Sulfur *(Wilbur-Ellis)*
	Spray Sulfur *(Wilbur-Ellis)*
	Sulfur 6L *(Arysta)*
	Sulfur 90W *(Drexel)*
	Sulfur DF *(Wilbur-Ellis)*
	That Flowable Sulfur *(Stoller Enterprises)*
	Thiolux (*Loveland Products*)
	Wettable Sulfur *(Helena)*
	Yellow Jacket Dusting Sulfur *(Georgia Gulf Sulfur)*
	Yellow Jacket Wettable Sulfur *(Georgia Gulf Sulfur)*
tebuconazole	AmTide TEBU 3.6F *(AmTide)*
	Barrier (*Real Farm Technologies*)
	Folicur *(Bayer)*
	Monsoon *(Loveland Products)*
	Onset 3.6 L *(Winfield Solutions)*
	Orius 3.6 F *(MANA)*
	Solera Tebuconazole 3.6F *(Solera)*
	Tebu-Crop 3.6F (*Sharda USA*)
	Tebucon 3.6F (*Repar Corp.*)
	TebuStar 3.6L *(Albaugh)*
	Tebuzol 3.6F *(UPI)*
	Toledo 3.6F *(Rotam)*
thiophanate-methyl	Incognito 4.5 F *(MANA)*
	Incognito 85 WDG *(MANA)*
	Thiophanate Methyl 85 WDG *(MANA)*
	T-Methyl 4.5F *(Nufarm)*
	T-Methyl 70W WSB *(Nufarm)*
	Topsin 4.5FL *(UPI)*
	Topsin M 70 WDG *(UPI)*
	Topsin M 70WP *(UPI)*
	Topsin M WSB *(UPI)*

TABLE 3-61. FUNGICIDES REGISTERED FOR SEED TREATMENT

	42-S Thiram (thiram)	Allegiance (metalaxyl)[a]	Apron (mefenoxam)[a]	Captan 400 (captan)	Dividend Extreme (difenoconazole + mefenoxam)	Dynasty (azoxystrobin)	Evolve (thiophanate methyl + mancozeb + cymoxanil)	Kodiak (*Bacillus subtilis* GB03)	Maxim (fludioxonil)	Maxim MZ (fludioxonil + mancozeb)	Moncoat MZ (flutolanil + mancozeb)	Potato Seed Treater (EBDC)	Pro-Gro (thiram + carboxin)	Tops MZ (thiophanate-methyl + mancozeb)	Trilex AL (trifloxystrobin + metalaxyl)	Yield Shield (*Bacillus pumilus* GB34)
FRAC Group(s)*	M3	4	4	M3	3+4	11	1+M3+27	NC	12	12+ M3	7+ M3	M3	M3	1+ M3	11+ 4	NC
Beans, Snap	X	X	X	X		X		X	X						X	X
Beans, Lima	X	X	X	X		X		X	X						X	X
Beets	X	X	X	X					X							
Broccoli	X		X	X					X							
Carrots	X	X	X						X							
Celery			X						X							
Chinese Cabbage	X		X						X							
Cole Crops	X		X	X					X							
Cucumbers	X	X	X	X					X							
Eggplants	X		X						X							
Garlic			X						X							
Greens, Mustard	X		X	X					X							
Greens, Turnip	X		X	X					X							
Horseradish			X						X							
Leeks			X						X							
Lettuce	X		X						X							
Muskmelons	X		X	X					X							
Okra	X								X							
Onions, Dry	X		X						X				X			
Onions, Green	X		X						X				X			
Parsley			X						X							
Parsnips			X						X							
Peas	X	X	X	X				X	X						X	X
Peppers	X		X	X					X							
Pumpkins/winter squash	X		X	X					X							
Radish	X		X	X					X							
Spinach	X		X	X					X							
Squash, Summer	X		X	X					X							
Sweet Corn	X	X	X	X	X	X		X	X							
Sweet Potatoes			X						X							
Tomatoes	X		X						X							
Watermelon	X		X	X					X							
White Potatoes (Irish)				X			X		X	X	X	X		X		

* Numbers and Letters indicate fungicide FRAC group. Bold numbers in shaded fungicide boxes identify those fungicides (FRAC groups) that have a higher potential for fungicide resistance to develop if the fungicide is used on a continuous basis. These fungicides should be alternated with a labeled fungicide from another FRAC group. 1-benzimidazole; 4-acylalanine; 7-carboximide; 11-QoI inhibitor; 12-phenylpyrroles; 33-phosphonate; M3- dithiocarbamate; NC-not classified; mefenoxam and fludioxinil are also ingredients in CruiserMaxx and CruiserMaxx Potato. See labels for instructions, formulations, and for crops that have a label for these materials.

TABLE 3-62. BIOPESTICIDES AND FUNGICIDE ALTERNATIVES FOR VEGETABLES

K. Seebold, Plant Pathologist, University of Kentucky; and R. D. French-Monar, Plant Pathologist, TAMU

Active Ingredient	Product	Crops	Target Diseases/Pests	Greenhouse Use	OMRI-Listed	Comments
Acibenzolar-*S*-methyl	Actigard	chili pepper, cucurbits, lettuce, onion, spinach, tomato	bacterial blights, downy mildew, powdery mildew (crop dependent, see label)	No	No	Do not apply to plants stressed by heat, cold, or moisture extremes.
***Bacillus pumilus* 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	Yes	Ballad Plus can be used on sweet corn only.
***Bacillus subtilis* GB03**	Companion	most vegetables (see label)	root diseases	Yes	Yes	
***Bacillus subtilis* MBI 600**	Subtilex NG	cucurbits, eggplant, pepper, tomato	root diseases, powdery mildew	Yes	No	Apply to soil or potting medium; use as a foliar spray for powdery mildew.
***Bacillus subtilis* QST713**	Cease, Serenade Max	Cole crops, leafy vegetables, legumes, cucurbits, pepper, tomato	downy mildew, powdery mildew, leaf blights	Yes	Yes	
Coniothyrium minitans	Contans WG	most vegetables (see label)	*Sclerotinia sclerotiorum* (white mold, timber rot, drop)	Yes	Yes	Apply to soil or potting medium.
Gliocladium cantenulatum	PreStop Biofungicide	most vegetables (see label)	seed rots, root diseases, *Botrytis* stem canker	Yes		
***Gliocladium virens* GL-21**	SoilGard 12G	most vegetables (see label)	seed rots, root diseases	Yes	Yes	Do not apply in conjunction with chemical fungicides.
Hydrogen peroxide (Oxidate)	Oxidate, Terracide	most vegetables (see label)	root diseases, leaf blights	Yes	Yes	
Myrothecium verrucaria	DiTera DF	Cole crops, cucurbits, eggplant, leafy vegetables, legumes, pepper, root and tuber vegetables, tomato	nematodes	Yes	Yes	
Neem oil	Trilogy	vegetables	foliar diseases	Yes	Yes	May cause leaf burn; test a small number of plants before spraying entire crop.
Oils from cottonseed, corn, and garlic	Mildew Cure	tomato, cucurbits	powdery mildew	Yes		May cause leaf burn; test a small number of plants before spraying entire crop.
Oils from clove, rosemary, and thyme	Sporatec	most vegetables (see label)	powdery mildew, fungal leaf blights	Yes	Yes	Addition of a spray adjuvant (spreader or penetrant) is recommended.
Oil from soybean	Oleotrol-M	most vegetables (see label)	*Botrytis* gray bold, downy mildew, powdery mildew	Yes	Yes	Tank-mix with a spreader-sticker.
Paecilomyces lilacinus	MeloCon WG	most vegetables (see label)	nematodes	Yes	Yes	
Phage	AgriPhage	most vegetables (see label)	bacterial spot, speck	Yes	No	
Phosphorous compounds	Alude, Fosphite					
Fungi-Phite, Phostrol, ProPhyt, Rampart	most vegetables (see label)	downy mildew, powdery mildew, leaf blights	Yes	No		
Potassium bicarbonate	Armicarb, Kaligreen, Milstop	most vegetables (see label)	powdery mildew, fungal leaf blights	Yes	Yes (Kaligreen, Milstop)	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	Yes	Tank-mix with a non-ionic surfactant for best results.
Pseudomonas chloroaphis	Ateze	most vegetables (see label)	stem, root diseases	Yes	No	Greenhouse use only.
Reynoutria sachalinensis	Regalia	most vegetables (see label)	powdery mildew, fungal leaf blights	Yes	Yes	First application should be made before symptoms appear.
Streptomyces griseoviridis	Mycostop	most vegetables (see label)	seedling, root, and stem rots	Yes	Yes	Can be added to potting mix or applied in-furrow to field soil.
Streptomyces lydicus	Actinovate AG	most vegetables (see label)	seedling, root, and stem rots; foliar blights	Yes	Yes	Can be used as a soil or foliar treatment.
***Streptomyces lydicus* + iron, molybdenum, and humic acid**	Actino-Iron	most vegetables (see label)	seedling, root, and stem rots	Yes	Yes	Soil treatment
Trichoderma harzianum	T-22, RootShield, PlantShield	Cole crops, eggplant, leafy vegetables, pepper, tomato	seedling, root, and stem rots	Yes	Yes	Can be added to potting mix or applied in-furrow to field soil.
Trichoderma viride	Binab	most vegetables	seedling, root, and stem rots	Yes	No	

Chemical Weed Control in Vegetable Crops

NOTE: A mode of action code (MOA) has been added to the Herbicide and Formulation column in this table.

Use MOA codes for herbicide resistance.

TABLE 4-1. CHEMICAL WEED CONTROL ASPARAGUS

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
ASPARAGUS (seeded and new crown plantings), Preemergence				
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone Inteon) 2 SL	 1.7 to 2.7 pt 2.5 to 4 pt	0.6 to 1	Apply to emerged weeds in a minimum of 20 gal spray mix per acre before crop emergence as a broadcast or band treatment over a preformed row. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Perennial weeds may require higher rates. The need for an adjuvant depends on brand used.
Annual grasses and small-seeded broadleaf weeds	linuron, MOA 7 (Lorox DF) 50 WDG	 1 to 2 lb	0.5 to 1	***Preemergence application***. Plant seed 0.5 in. deep in coarse soils. Apply to soil surface. See label for further instruction. ***Postemergence application***. Apply when ferns are 6 to 18 in. tall. Make one or two applications, but do not exceed 2 lb active ingredient total per acre. Do not use surfactant or crop oil, as injury will occur. Use the lower rate on coarse soils. Not recommended on sand or loamy sand soils.
ASPARAGUS (seeded and new crown plantings), Postemergence				
Annual and perennial grasses	clethodim, MOA 1 (Intensity One, Select Max) 1 EC (Arrow) 2 EC	 9 to 16 oz 6 to 8 oz	 0.07 to 0.125 0.094 to 0.125	Apply to emerged grasses. Consult the manufacturer's label for best times to treat specific grasses. For Select Max, add 2 pt nonionic surfactant per 100 gal spray mixture. With sethoxydim, add 1 qt crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. With fluazifop, add 1 qt of nonionic surfactant or 1 gal crop oil concentrate per 100 gal of spray mix.
	fluazifop, MOA 1 (Fusilade DX) 2 EC	 6 to 16 oz	0.1 to 0.25	
	sethoxydim, MOA 1 (Poast) 1.5 EC	 1.5 to 2.5 pt	0.3 to 0.5	
ASPARAGUS, (established at least 2 yr old) Preemergence				
Annual grasses and small-seeded broadleaf weeds	linuron, MOA 7 (Lorox DF) 50 WDG	 1 to 2 lb	0.5 to 1	Apply before spear emergence or immediately after a cutting. Do not use a surfactant or fertilizer solution in spray mixture. Use the lower rates on coarse soils. Not recommended for sand or loamy sand soils. Repeat applications may be made but do not exceed 4 lb per acre per year. Lorox can also be applied as a directed spray to the base of the ferns. Make one application of 2 lb active ingredient per acre. Lorox will also control emerged annual broadleaf weeds up to 3 in. in height. Do not apply within 1 day of harvest.
	napropamide, MOA 15 (Devrinol, Devrinol DF-XT) 50 DF (Devrinol 2-XT) 2 EC	 8 lb 2 gallons		Apply to the soil surface in spring before weed and spear emergence. Do not exceed 8 lb per acre per year. See XT labels for information regarding delay in irrigation event.
	trifluralin, MOA 3 (Treflan, Trilin, Treflan HFP, Treflan) 4 EC	 1 to 4 pt	0.5 to 2	In winter or early spring, apply to dormant asparagus after ferns are removed but before spear emergence, or apply after harvest in late spring or early summer. In a calendar year, the maximum rate is 2 pints per acre for coarse soils, 3 pints on medium soils and 4 pints on fine soils. See label for further restrictions on rates for soil types.

TABLE 4-1. CHEMICAL WEED CONTROL ASPARAGUS (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
ASPARAGUS, (established at least 2 yr old) Preemergence (cont'd)				
Annual broadleaf and grass weeds	diuron, MOA 7 (Karmex) 80 DF (Karmex) 80 XP (Direx) 4 L	 1 to 4 lb 1 to 4 lb 0.8 to 3.2 qt	0.8 to 3.2	Apply in spring before spear emergence but no *earlier* than 4 weeks before spear emergence. A second application may be made immediately after last harvest. Diuron also controls small emerged weeds but less effectively.
	flumioxazin, MOA 14 (Chateau) 51 SW	 6 oz	0.188	Apply only to dormant asparagus no sooner than 14 days before spears emerge or after the last harvest. Do not apply more than 6 oz per acre during a single growing season. Provides residual weed control. Can be tank mixed with paraquat for control of emerged weeds. Apply in a minimum of 15-gal spray mix per acre. Add a nonionic surfactant at 1 qt per 100 gal of spray mix. A spray-grade nitrogen source (either ammonium sulfate at 2 to 2.5 lb per acre or 28 to 32 percent nitrogen solutions at 1 to 2 qt per acre) may be added to increase herbicidal activity.
	metribuzin, MOA 5 (Metribuzin) 75 WDG (TriCor DF) 75 WDG (Metri) 4 F	 1.3 to 2.67 lb 2 to 4 pt	1 to 2	Make a single application to small emerged weeds and the soil surface in early spring before spear emergence. Do not apply within 14 days of harvest or after spear emergence. Do not make postharvest applications until after the last harvest of spears. A split application can be used. See label for rates.
	terbacil, MOA 5 (Sinbar) 80 WP	 0.25 to 0.5 lb	0.2 to 0.4	Apply in spring before weed emergence and spear emergence or immediately after last clean-cut harvest. Use the lower rate on sandy soils and the higher rate on silty or clay soils. Do not use on soils containing less than 1% organic matter nor on gravelly soils or eroded areas where subsoil or roots are exposed. Do not harvest within 5 days after application. See label about rotation restrictions.
ASPARAGUS (established at least 2 years old), Postemergence				
Broadleaf weeds including trumpetcreeper	2,4-D, MOA 4 (Amine 4 and various other brands) 4 SL	 1.5 to 2 qt	1.5 to 2	Apply in spring before spear emergence or immediately following a clean cutting. Make no more than two applications during the harvest season and these should be spaced at least 1 month apart. Postharvest sprays should be directed under ferns, avoiding contact with ferns, stems, or emerging spears. Add a nonionic surfactant at a rate of 1 qt per 100 gal spray mix. **Do not apply if sensitive crops are planted nearby or if conditions favor drift.**
	dicamba, diglycolamine salt, MOA 4 (Clarity) 4 L	 8 to 16 oz	0.25 to 0.5	Apply to emerged and actively growing weeds in 40 to 60 gallons of diluted spray per treated acre immediately after cutting in the field but at least 24 hours before the next cutting. If spray contacts emerged spears, twisting of spears may occur. Discard twisted spears. See label for more information. **Follow precautions on label concerning drift to sensitive crops.**
Contact kill of emerged annual weeds, suppression of emerged perennial weeds, and contact kill of volunteer ferns	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	 1.7 to 2.7 pt 2.5 to 4 pt	0.6 to 1	Apply to control emerged weeds (including volunteer ferns). Apply in a minimum of 20 gal spray mix per acre to control weeds before spears emerge or after last harvest. Do not apply within 6 days of harvest. Use a nonionic surfactant at a rate of 1 qt per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Volunteer ferns (seedling) and certain broadleaf weeds	linuron, MOA 7 (Lorox DF) 50 WDG	 2 lb	1	Apply before cutting season or immediately after. Do not apply within 1 day of harvest. Lorox will also control emerged annual broadleaf weeds that are up to 3 in. in height.
Annual and perennial grass and broadleaf weeds; Established volunteer ferns	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds up to 1 week before spear emergence or immediately after last cutting has removed all above-ground parts or as a directed spray under mature fern. Avoid contact with the stem to reduce risk of injury. Perennial weeds may require higher rates of glyphosate. For spot treatment, apply immediately after cutting but prior to emergence of new spears. Certain glyphosate formulations may require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Yellow and purple nutsedge, wild radish, non-ALS resistant pigweed, cocklebur, ragweed and other broadleaf weeds	halosulfuron, MOA 2 (Profine 75) 75 DF (Sandea) 75 DF	 0.5 to 1.5 oz	0.024 to 0.072	**Postemergence and post-transplant.** Apply before or during harvesting season. **Do not use nonionic surfactant or crop oil because unacceptable crop injury may occur.** Without the addition of a nonionic surfactant, postemergence weed control may be reduced. Do not exceed 1 oz per acre per year. Do not harvest within 24 hours of application. **Postharvest.** Apply after final harvest with drop nozzles to limit contact with crop. Contact with the fern may result in temporary yellowing. Add a nonionic surfactant at 1 qt per 100 gal of spray mixture. Under heavy nutsedge pressure, split applications will be more effective; see label for details. Do not exceed 1 oz per acre per year.
Annual and perennial grasses	clethodim, MOA 1 (Intenstiy One, Select Max) 1 EC (Arrow) 2 EC	 9 to 16 oz 6 to 8 oz	 0.07 to 0.125 0.094 to 0.125	For Select Max, add 2 pt nonionic surfactant per 100 gal spray mixture. **DO NOT USE CLETHODIM WITHIN 1 DAY OF HARVEST.**
	fluazifop, MOA 1 (Fusilade DX) 2 EC	 6 to 16 oz	0.1 to 0.25	Apply to emerged grasses. Consult the manufacturer's label for best times to treat specific grasses. With sethoxydim, add 1 qt crop oil concentrate per acre. With fluazifop, add 1 qt nonionic surfactant or 1 gal crop oil concentrate per 100 gal of spray mix. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperature. **DO NOT USE FLUAZIFOP OR SETHOXYDIM WITHIN 1 DAY OF HARVEST.**
	sethoxydim, MOA 1 (Poast) 1.5 EC	 1.5 to 2.5 pt	0.3 to 0.5	

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-2. CHEMICAL WEED CONTROL IN BEANS

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
BEANS, Preplant and Preemergence				
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	 1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	**Lima or snap beans only.** Apply in a minimum of 10 gal spray mix per acre to emerged weeds before crop emergence as a broadcast or band treatment over a pre-formed row. Use sufficient water to give thorough coverage. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	**Edamame, kidney bean, lima bean, pinto bean, snap bean, soybean, and wax bean only.** Apply prior to or no later than one day after planting. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Various beans are covered.** Apply to emerged weeds before crop emergence. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations may require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and small-seeded broadleaf weeds	ethalfluralin, MOA 3 (Sonalan HFP) 3 EC	1.5 to 3 pt	0.6 to 1.1	**Dry beans only.** See label for specific bean. Apply preplant and incorporate into the soil 2 to 3 in. deep using a rototiller or tandem disk. If groundcherry or nightshade is a problem, the rate range can be increased to 3 to 4.5 pt per acre. For broader spectrum control, Sonalan may be tank mixed with Eptam or Dual. Read the combination product label for directions, cautions, and limitations before use.
	dimethenamid, MOA 15 (Outlook) 6.0 EC	12 to 18 oz	0.55 to 0.85	**Dry beans only.** See label for specific bean. Apply preplant incorporated, preemergence to the soil surface after planting, or early postemergence (first to third trifoliate stage). Dry beans may be harvested 70 or more days after Outlook application. See label for further instructions including those for tank mixtures.
	trifluralin, MOA 3 (Treflan, Trifluralin, Trifluralin HF, and other brands) 4 EC	1 to 1.5 pt	0.5 to 0.75	**Dry, lima, or snap beans only.** See label for specific bean. Apply preplant and incorporate into the soil 2 to 3 in. deep within 8 hr. Incorporate with a power-driven rototiller or by cross disking.
	pendimethalin, MOA 3 (Prowl H_20) 3.8 AS	1.5 to 3 pt	0.75 to 1.5	**Dry, lima, or snap beans only.** See label for specific bean. Apply preplant and incorporate into the soil 2 to 3 in. using a power-driven rototiller or by cross disking. **DO NOT APPLY AFTER SEEDING.**
	S-metolachlor, MOA 15 (Brawl, Dual Magnum, Medal) 7.62 EC (Brawl II, Dual II Magnum, Medal II) 7.64 EC	1 to 2 pt	0.95 to 1.91	**Dry, lima, or snap beans only.** See label for specific bean. Apply preplant incorporated or preemergence to the soil surface after planting.
Annual grasses and broadleaf weeds	clomazone, MOA 13 (Command) 3ME	0.4 to 0.67 pt	0.15 to 0.25	**Succulent beans only.** Apply to the soil surface immediately after seeding. Offers weak control of pigweed. See label for further instructions.
Yellow and purple nutsedge, grasses and some small-seeded broadleaf weeds	EPTC, MOA 8 (Eptam) 7 EC	2.25 to 3.5 pt	2 to 3	**Dry or snap beans only.** See label for specific bean. Apply preplant and incorporate immediately to a depth of 3 in. or may be applied at lay-by as a directed application before bean pods start to form to control late season weeds. See label for instructions on incorporation. May be tank mixed with Prowl.
Many broadleaf weeds	fomesafen, MOA 14 (Reflex 2 EC)	1 to 1.5 pt	0.25 to 0.375	**Dry bean and snap beans only.** Apply preplant surface or preemergence. Total use per year cannot exceed 1.5 pt per acre. See label for further instructions and precautions.
Yellow and purple nutsedge, common cocklebur, and other broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 0.75 oz	0.024 to 0.036	**Dry beans and succulent snap beans including lima beans, only.** Apply after seeding but prior to cracking. Do not apply more than 0.67 oz product per acre to dry bean. Data are lacking on runner-type snap beans. See label for other instructions.
Broadleaf weeds including morningglory, pigweed, smartweed, and purslane	imazethapyr, MOA 2 (Pursuit) 2 EC	1.5 oz	0.023	**Dry beans and lima beans only.** See label for specific bean. Apply preemergence or preplant incorporated. Pursuit should be applied with a registered preemergence grass herbicide. **Snap beans only.** Apply preemergence or preplant incorporated. For preplant incorporated application, apply within 1 week of planting. May be used with a registered grass herbicide. Reduced crop growth, quality, yield, and/or delayed crop maturation may result.

TABLE 4-2. CHEMICAL WEED CONTROL IN BEANS (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
BEANS, Postemergence				
Annual broadleaf weeds and yellow nutsedge	bentazon, MOA 6 (Basagran) 4 SL	1 to 2 pt	0.5 to 1	**Dry, lima, or snap beans only.** Apply overtop of beans and weeds when beans have one to two expanded trifoliate leaves. Two applications spaced 7 to 10 days apart may be made for nutsedge control. Do not apply more than 2 qt per season or within 30 days of harvest. Use of crop oil as an adjuvant will improve weed control but will likely increase crop injury. See label regarding crop oil concentrate use.
Many broadleaf weeds	fomesafen, MOA 14 (Reflex 2 EC)	0.75 to 1 pt	0.188 to 0.25	**Dry or snap beans only.** See label for specific bean. Apply postemergence to dry beans or snap beans that have at least one expanded trifoliate leaf. Include a nonionic surfactant at 1 qt per 100 gal spray mixture. Total use per year cannot exceed 1.5 pt per acre. Do not apply within 45 days of dry bean harvest or 30 days of snap bean harvest. **Postemergence application of fomesafen can cause significant injury to the crop.** See label for further information.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter. Does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	**Edamame, kidney bean, lima bean, pinto bean, snap bean and wax bean only.** Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Yellow and purple nutsedge	EPTC, MOA 8 (Eptam) 7 EC	3.5 pt	3	**Green or dry beans only.** See label for specific bean. Do not use on lima bean or pea. Apply and incorporate at last cultivation as a directed spray to soil at the base of crop plants before pods start to form.
Yellow and purple nutsedge, common cocklebur, and other broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 0.66 oz	0.024 to 0.031	**Succulent snap beans, including lima beans.** Apply after crop has reached 2-to 4-trifoliate leaf stage but prior to flowering. Postemergence application may cause significant but temporary stunting and may delay crop maturation. Do not apply within 30 days of harvest. See label for further precautions. Data lacking on runner-type snap beans.
Annual broadleaf weeds, including morningglory, pigweed, smartweed, and purslane	imazethapyr, MOA 2 (Pursuit) 2 EC	1.5 to 3 oz	0.023 to 0.047	**Dry beans and snap beans only.** See label for specific bean. Use only 1.5 oz EC formulation on snap bean and up to 3 oz on dry beans. Apply postemergence to 1- to 3-in. weeds (one to four leaves) when dry beans have at least one fully expanded trifoliate leaf. Add nonionic surfactant at 2 pt per 100 gal of spray mixture with all postemergence applications. For snap beans, allow at least 30 days between application and harvest. For dry bean, do not apply within 60 days of harvest. See label for instructions on use.
Most emerged weeds	glyphosate, MOA 9 (Roundup PowerMax) 5.5L (Roundup WeatherMax) 5.5L	11 to 22 oz	0.5 to 0.94	**Row middles only.** See label for specific bean. Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. Spot treatment is allowed in some bean crops. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Annual and perennial grasses	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	**Dry or snap beans only.** Sethoxydim is also labeled for lima bean; quizalofop is not. Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. With sethoxydim, add 1 qt of crop oil concentrate per acre. With quizalofop, add 1 gal oil concentrate or 1 qt nonionic surfactant per 100 gal spray. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply on days that are unusually hot and humid. Do not apply within 15 days and 30 days of harvest for succulent and dry beans, respectively.
	quizalofop p-ethyl, MOA 1 (Assure II) 0.88 EC (Targa) 0.88 EC	6 to 12 oz	0.04 to 0.08	
	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Intensity One, Select Max) 1 EC	6 to 16 oz 9 to 16 oz	0.094 to 0.25 0.07 to 0.125	**Dry or succulent beans.** See label for specific bean. Select is registered for dry beans only. Apply postemergence for control of emerged grasses. See label for specific rate for crop. For Arrow, Clethodim, or Select, add a crop oil concentrate at 1 qt per acre. For Select Max or Intensity One, add 2 pt nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. See label for minimum time from application to harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-3. CHEMICAL WEED CONTROL IN BEETS

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
BEETS (Garden or Table), Preplant				
Annual and perennial grasses and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Garden beets only.** Apply to emerged weeds before seeding or after seeding but before crop emergence. Perennial weeds may require higher rates. Certain glyphosate formulations may require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
BEETS (Garden or Table), Preemergence				
Broadleaf weeds only including common ragweed, smartweed, and wild mustard	pyrazon, MOA 6 (Pyramin) 65 DF	4.6 to 5.4 lb	3.1 to 3.7	Do not use on light sandy soils as severe injury may occur. Apply to the soil surface immediately after planting. If rain does not occur within 5 to 10 days after application, beets should be irrigated.
BEETS (Garden or Table), Postemergence				
Broadleaf weeds including sowthistle clover, cocklebur, jimsonweed, and ragweed	clopyralid, MOA 4 (Solix 3, Stinger) 3EC	0.25 to 0.5 pt	0.093 to 0.187	Apply to beets having 2 to 8 leaves when weeds are small and actively growing. Will control most legumes. Do not apply within 30 days of harvest. Do not apply more than 0.5 pt per acre per year. See label for information regarding rotational restrictions.
Broadleaf weeds including wild mustard, common lambsquarters, common chickweed, purslane suppression	phenmedipham, MOA 6 (Spin-Aid) 1.3 EC	3 to 6 pt	0.5 to 1	Apply postemergence when beets are past the 4- to 6-true leaf stage and when weeds are in cotyledon to 2-leaf stage. See label for further information regarding spraying beets prior to the 4-leaf stage. Do not add spray adjuvant. Do not apply within 60 days of harvest.
Annual and perennial grasses	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 60 days of harvest.
	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max, Intensity One) 1 EC	6 to 8 oz 9 to 16 oz	0.094 to 0.125 0.07 to 0.125	Apply postemergence for annual grasses at 6 to 8 oz per acre or bermudagrass and johnsongrass at 8 oz per acre. For Arrow, Clethodim, or Select, add a crop oil concentrate at 1 gal per acre. For Select Max, add 2 pt nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. Do not apply within 30 days of harvest.
BEETS (Garden or Table), Row Middles Only				
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. The need for an adjuvant depends on brand used. Do not apply within 14 days of harvest.
Annual broadleaf weeds including morningglory, spiderwort, and very small pigweed	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a crop oil concentrate or a nonionic surfactant with Aim. See label for directions. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.

* Mode of action (MOA) code developed by the Weed Science Society of America.

BROCCOLI – SEE COLE CROPS

CABBAGE – SEE COLE CROPS

TABLE 4-4. CHEMICAL WEED CONTROL IN CANTALOUPES (MUSKMELONS)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CANTALOUPES (MUSKMELONS), Preplant and Preemergence				
Suppression or control of most annual grasses and broadleaf weeds, full rate required for nutsedge control	metam sodium (Vapam HL) 42%	37.5 to 75 gal	15.7 to 31.5	Rates are dependent on soil type and weeds present. Apply when soil moisture is at field capacity (100 to 125%). Apply through soil injection using a rotary tiller or inject with knives no more than 4 in. apart; follow immediately with a roller to smooth and compact the soil surface or with mulch. May apply through drip irrigation prior to planting a second crop on mulch. Plant back interval is often 14 to 21 days and can be 30 days in some environments. See label for all restrictions and additional information.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	**Transplants:** Apply no later than one day before transplanting crop. **Seeded:** Apply no later than 7 days before seeding crop. Use a crop oil at up to 1 gal per 100 gal of spray solution or a nonionic surfactant at 2 pt per 100 gal of spray solution. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 10 gal spray mix per acre to emerged weeds before crop emerges or before transplanting as a broadcast or band treatment over a preformed row. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations	See labels	See labels	Apply to emerged weeds at least 3 days before seeding or transplanting. Perennial weeds may require higher rates of glyphosate. Consult manufacturer's label for rates for specific weeds. When applying Roundup before transplanting crops into plastic mulch, carefully remove residues of this product from the plastic prior to transplanting. To prevent crop injury, residues can be removed by 0.5 in. rainfall or by applying water via a sprinkler system. Certain glyphosate formulations may require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and small-seeded broadleaf weeds	bensulide, MOA 8 (Prefar) 4 EC	5 to 6 qt	5 to 6	Apply preplant and incorporate into the soil 1 to 2 in. (1 in. incorporation is optimum) with a rototiller or tandem disk, or apply preemergence after seeding and follow with irrigation. Check re-plant restrictions for small grains and other crops on label.
Annual grasses and broadleaf weeds; weak on pigweed and morningglory	clomazone, MOA 13 (Command) 3 ME	0.4 to 0.67 pt	0.15 to 0.25	Apply immediately after seeding or just prior to transplanting with transplanted crop. Roots of transplants must be below the chemical barrier when planting. See label for further instruction.
Annual grasses and some small-seeded broadleaf weeds	ethalfluralin, MOA 3 (Curbit) 3 EC	3 to 4.5 pt	1.1 to 1.7	Apply to soil surface immediately after seeding. May also be used as a BANDED spray BETWEEN rows of plastic mulch. See label for timing. Shallow cultivation, irrigation, or rainfall within 5 days needed for good weed control. Do not use under mulches, row covers, or hot caps. Under conditions of unusually cold or wet soil and air temperatures, crop stunting and injury may occur. Crop injury can occur if seeding depth is too shallow.
Annual grasses and broadleaf weeds	ethalfluralin, MOA 3 + clomazone, MOA 13 (Strategy) 2.1 L	2 to 6 pt	0.4 to 1.2 + 0.125 to 0.375	Apply to the soil surface immediately after seeding crop for preemergence control of weeds. **DO NOT APPLY PRIOR TO PLANTING CROP. DO NOT SOIL INCORPORATE.** May also be used as a banded treatment between rows after crop emergence or transplanting. Do not apply over or under plastic mulch.
Yellow and purple nutsedge and broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 0.75 oz	0.024 to 0.036	Apply after seeding or prior to transplanting crop. For transplanted crop, do not transplant until 7 days after application. Rate can be increased to 1 ounce of product per acre to middles between rows. Do not apply within 57 days of harvest.
Annual grasses, some small-seeded broadleaf weeds	pendimethalin, MOA 3 (Prowl H_2O) 3.8 AS	Up to 2.1 pt	Up to 1	Row Middles only. May be applied sequentially in bareground and plasticulture production systems at a minimum of 21 days apart. Refer to label for specific instructions.
CANTALOUPES (MUSKMELONS), Postemergence				
Annual grasses and small-seeded broadleaf weeds	DCPA, MOA 3 (Dacthal) W-75 (Dacthal) 6 F	8 to 10 lb 6 to 10 pt	4.5 to 7.5	Not labeled for transplanted crop. To improve preemergence control of late emerging weeds. Apply only when crop has 4 to 5 true leaves, is well-established, and growing conditions are favorable. Will not control emerged weeds. Incorporation not recommended.
	trifluralin, MOA 3 (Treflan HFP, Trifluralin, Trifluralin HF) 4EC	1 to 2 pt	0.5 to 0.75	Row middles only. Apply after emergence when crop plants have reached the three to four true leaf stage of growth. Apply as a directed spray to soil between the rows. Avoid contacting foliage as slight crop injury may occur. Set incorporation equipment to move treated soil around base of crop plants. Do not apply within 30 days of harvest. Will not control emerged weeds.
Yellow and purple nutsedge and broadleaf weeds including cocklebur, galinsoga, smartweed, ragweed, wild radish, and pigweed	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 0.75 oz	0.024 to 0.036	Apply postemergence only after the crop has reached 3 to 5 true leaves but before first female flowers appear. Do not apply sooner than 14 days after transplanting. Use nonionic surfactant at 1 qt per 100 gal of spray solution with all postemergence applications. Avoid over-the-top applications during late summer when temperature and humidity are high. Do not apply within 57 days of harvest.

TABLE 4-4. CHEMICAL WEED CONTROL IN CANTALOUPES (MUSKMELONS) (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CANTALOUPES (MUSKMELONS), Postemergence (cont'd)				
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a crop oil concentrate or a nonionic surfactant with Aim. See label for directions. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Annual and perennial grasses only	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 3 days of harvest.
	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Intensity One, Select Max) 1 EC	6 to 8 oz 9 to 16 oz	0.094 to 0.125 0.07 to 0.125	Apply postemergence for control of grass in cantaloupes (muskmelons). For Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. For Select Max, add 2 pt nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. Do not apply within 14 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-5. CHEMICAL WEED CONTROL IN CARROTS

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CARROTS, Preplant				
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	 1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply to emerged weeds before crop emergence as a broadcast or band treatment over a preformed row. Use sufficient water to give thorough coverage. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before seeding or crop emergence. Perennial weeds may require higher rates. Certain glyphosate formulations require the addition of surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
CARROTS, Preplant incorporated (PPI)				
Annual grasses and small-seeded broadleaf weeds	trifluralin, MOA 3 (Treflan, Trifluralin) 4 EC	 1 to 2 pt	0.5 to 1	Apply preplant and incorporate into the soil 2 to 3 in. within 8 hr. Use lower rate on coarse soils with less than 2% organic matter.
CARROTS, Postemergence				
Annual grasses and broadleaf weeds	linuron, MOA 7 (Lorox DF) 50 WDG	 1.5 to 3 lb	0.75 to 1.5	Apply as a broadcast spray after carrots are at least 3 in. tall. If applied earlier crop injury may occur. Avoid spraying after three or more cloudy days. Repeat applications may be made, but do not exceed 4 lb of Lorox DF per acre per season. Do not use a surfactant or crop oil. See label for further directions.
Annual broadleaf weeds and some grasses	metribuzin, MOA 5 (Dimetric, Metribuzin, TriCor DF) 75 WDG (Metri, TriCor 4F) 4 F	 0.33 to 0.5 lb. 0.5 pt	 0.25 0.25	Apply overtop when weeds are less than 1 in. tall and carrots have 5 to 6 true leaves. A second application may be made in 3 weeks. Do not apply unless 3 sunny days precede application. Do not apply within 3 days of other pesticide applications. Preharvest interval is 60 days.
Annual and perennial grasses	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max) 1 EC	 6 to 8 oz 9 to 16 oz	 0.094 to 0.125 0.07 to 0.125	Apply to actively growing grasses not under drought stress. With Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. With Select Max, add 2 pt nonionic surfactant per 100 gal of spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Do not mix with other pesticides. Very effective in controlling annual bluegrass. Do not apply within 30 days of harvest.
	fluazifop, MOA 1 (Fusilade DX) 2 EC	6 to 16 oz	0.1 to 0.25	Apply to actively growing grasses not under drought stress. Up to 48 oz of Fusilade DX may be applied per year. See label for rates for specific weeds. Add 1 gal crop oil concentrate or 1 qt nonionic surfactant per 100 gal spray mix. Do not mix with other pesticides. Do not apply within 45 days of harvest.
	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to actively growing grasses not under drought stress. Consult manufacturer's label for specific rate and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Do not apply on days that are unusually hot and humid. Do not apply with other pesticides. Do not apply within 30 days of harvest.
CARROTS, Row Middles				
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	 Up to 2 oz	Up to 0.031	Apply as a hooded spray in row middles for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a crop oil concentrate or a nonionic surfactant with Aim. See label for directions. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots or stems, exposed roots, or fruit of crop. Do not apply within 14 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

CAULIFLOWER – SEE COLE CROPS

TABLE 4-6. CHEMICAL WEED CONTROL IN CELERY

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CELERY, Preplant				
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Perennial weeds may require higher rates. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Cutleaf evening primrose, Carolina geranium, henbit, and a few grasses	oxyfluorfen, MOA 14 (Goaltender) 4 F (Goal 2 XL) 2 EC	 Up to 1 pt Up to 2 pt	Up to 0.5	**Transplants only.** Apply to soil surface of pre-formed beds at least 30 days prior to transplanting.
CELERY, Preplant incorporate (PPI) or Preemergence (PRE)				
Annual grasses and small-seeded broadleaf weeds	trifluralin, MOA 3 (Treflan, Treflan HFP, Trifluralin) 4 EC	1 to 2 pt	0.5 to 1 lb	Apply incorporated to direct seeded or transplant celery before planting, at planting, or immediately after planting. Incorporate within 8 hours of application. Use lower rate on coarse soils with less than 2% organic matter.
	bensulide (Prefar) 4-E	5 to 6 qt	5 to 6	**Transplants only.** Apply after planting. Irrigate immediately after application. See label for rotation restrictions.
CELERY, Postemergence				
Annual broadleaf and grass weeds	linuron, MOA 7 (Lorox DF) 50 WDG	1.5 to 3 lb	0.75 to 1.5	Apply after celery is transplanted and established but before celery is 8 in. tall. Grasses should be less than 2 in. in height, and broadleaf weeds should be less than 6 in. tall. Do not tank mix with other products including surfactant or crop oil. Avoid spraying after 3 or more cloudy days or when temperature exceeds 85 F. Not recommended for sands or loamy sand soil. Preharvest interval is 45 days.
Annual and perennial grasses only	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max) 1 EC	6 to 8 oz 9 to 16 oz	0.094 to 0.125 0.07 to 0.125	Apply to actively growing grasses not under drought stress. With Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. With Select Max, add 2 pt of nonionic surfactant per 100 gal spray mixture. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. Adding crop oil may increase the likelihood of crop injury at high air temperature. Do not apply within 30 days of harvest.
	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to actively growing grasses not under drought stress. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 30 days of harvest.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl,MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a crop oil concentrate or a nonionic surfactant with Aim. See label for directions. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-7. CHEMICAL WEED CONTROL IN COLE CROPS: BROCCOLI, CABBAGE, CAULIFLOWER

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
COLE CROPS: BROCCOLI, CABBAGE, CAULIFLOWER — Preplant and Preemergence				
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	 1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 10 gal spray mix per acre to emerged weeds before crop emergence or transplanting as a broadcast or band treatment over a preformed row. Use sufficient water to give thorough coverage. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 2 EC	 Up to 2 oz	Up to 0.031	Apply no later than seven days before planting. See label for rate for crop oil or nonionic surfactant. Coverage is essential for good weed control. See label for more information.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	 See labels	See labels	Apply to emerged weeds before crop emergence or before transplanting. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. When applying Roundup before transplanting crops into plastic mulch, care must be taken to remove residues of this product from the plastic prior to transplanting. To prevent crop injury, residues can be removed by 0.5 in. natural rainfall or by applying water via a sprinkler system. Certain glyphosate formulations may require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and small-seeded broadleaf weeds	bensulide, MOA 8 (Prefar) 4 EC	 5 to 6 qt	5 to 6	Also labeled for Chinese broccoli, broccoli raab, Chinese cabbage (bok choy, Napa), Chinese mustard cabbage (gai choy), and kohlrabi. Apply preplant or preemergence after planting. With preemergence application, irrigate immediately after application. See label for more directions.
	trifluralin, MOA 3 (Treflan HFP, Trifluralin, Trifluralin HF) 4 EC	 1 to 1.5 pt	0.5 to 0.75	Also labeled for Brussels sprouts **Caution**: If soil conditions are cool and wet, reduced stands and stunting may occur.
	DCPA, MOA 3 (Dacthal) W-75 (Dacthal) 6 F	 8 to 10 lb 8 to 10 pt	6 to 7.5	Also labeled for Brussels sprouts, rape greens and mustard spinach. Apply immediately after seeding or transplanting. May also be incorporated.
Annual grasses and broadleaf weeds; weak on pigweed	*Direct-seeded Cabbage* clomazone, MOA 13 (Command) 3ME *Transplanted Cabbage* clomazone, MOA 13 (Command) 3ME	 0.67 pt 0.67 to 1.3 pt	 0.25 0.25 to 0.50	**Direct seeded cabbage only.** Apply to the soil surface immediately after seeding. Offers weak control of pigweed. See label for further instructions. **Transplanted cabbage only.** Apply broadcast to the soil prior to transplanting cabbage. See label for further instructions.
Hairy galinsoga, common lambsquarters, redroot pigweed, and Palmer amaranth	sulfentrazone, MOA 14 (Spartan) 4 F	 2.25 to 4.5 oz	0.07 to 0.14	**Processing cabbage only. Transplanted cabbage only.** May be applied 60 days prior to planting up to planting time.
Annual grasses and small-seeded broadleaf weeds, including galinsoga, common ragweed, and smartweed	napropamide, MOA 15 (Devrinol DF) 50 DF (Devrinol DF-XT) 50 DF (Devrinol 2-XT) 2 EC	 2 to 4 lb 4 lb 4 qt	 1 to 2 2 2	Includes Brussels sprouts. Apply to weed-free soil just after seeding or transplanting as a surface application. Light cultivations, rainfall, or irrigation will be necessary within 24 hr to activate this chemical.
Many broadleaf weeds, including galinsoga, common ragweed, and smartweed	oxyfluorfen, MOA 14 (Goal 2 XL, Galigan) 2 EC (GoalTender) 4 E	 1 to 2 pt 0.5 to 1 pt	0.25 to 0.5	**Transplants only.** Surface apply before transplanting. Do not incorporate or knock the bed off after application. ***Do not spray over the top of transplants.*** Oxyfluorfen is weak on grasses. Expect to see some temporary crop injury.
COLE CROPS: BROCCOLI, CABBAGE, CAULIFLOWER — Postemergence				
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	 Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use crop oil concentrate at up to 1 gal per 100 gal solution or a nonionic surfactant at 2 pt per 100 gal of spray solution. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Broadleaf weeds including sowthistle, clover, cocklebur, jimsonweed, and ragweed	clopyralid, MOA 4 (Stinger) 3 EC	 0.25 to 0.5 pt	0.09 to 0.187	Labeled for broccoli, cabbage, cauliflower, broccoli raab, Brussels sprouts, Cavalo broccoli, Chinese cabbage (bok choy), Chinese broccoli, Chinese mustard, and Chinese cabbage (Napa). Apply to crop when weeds are small and actively growing. Will control most legumes. Do not apply within 30 days of harvest.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	 See labels	See labels	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Annual and perennial grasses only	sethoxydim, MOA 1 (Poast) 1.5 EC	 1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. For sethoxydim, add 1 qt of crop oil concentrate per acre. For Arrow, Clethodim, or Select, add crop oil concentrate at 1 gal per 100 gal of spray solution. For Select Max, add 2 pt nonionic surfactant per 100 gal of spray mixture. Adding crop oil to Poast or Select may increase the likelihood of crop injury at high air temperature. Do not apply Poast or Select plus crop oil on days that are unusually hot and humid. Do not apply within 30 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-8. CHEMICAL WEED CONTROL IN CORN, SWEET

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CORN, SWEET, Preplant Burndown				
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply prior to planting or within 24 hours after planting. . Use a crop oil concentrate or a nonionic surfactant with Aim. See label for directions. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Contact kill of all green foliage, stale bed and minimum tillage application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	1.5 to 2.7 pt 2.4 to 4 pt	0.6 to 1	Apply in a minimum of 20 gal spray mix per acre to emerged weeds before crop emergence as a broadcast or band treatment over a preformed row. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Plant with a minimum of soil movement for best results. Use a nonionic surfactant at a rate of 16 to 32 oz per 100-gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix. May be tank mixed with atrazine or simazine. Check label for directions and specific rates.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Do not feed crop residue to livestock for 8 weeks following treatment. Perennial weeds may require higher rates of glyphosate. Consult manufacturer's label for rates for specific weeds. Check label for directions. Certain glyphosate formulations require addition of surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Broadleaf weeds	2,4-D amine 4, MOA 4 (various brands)	1 to 3 pt	0.5 to 1	May be tank mixed with glyphosate for broad spectrum weed control. See label for planting restrictions if applied prior to planting.
CORN, SWEET, Preemergence				
Most annual grass weeds, including fall panicum, broadleaf signalgrass, and small-seeded broadleaf weeds	alachlor, MOA 15 (Micro-Tech) 4 FME	2 to 4 qt	2 to 4	Apply to soil surface immediately after planting. Higher rates will improve control of ragweed and lambsquarter. May be tank mixed with atrazine, glyphosate, or simazine. Various other brands are available. Check label for directions.
	dimethenamid, MOA 15 (Outlook) 6.0 EC	12 to 21 oz	0.56 to 1.0	Apply to soil surface immediately after planting. May be tank mixed with atrazine, glyphosate, or paraquat.
	S-metolachlor, MOA 15 (Brawl II, Dual II Magnum, Medal II) 7.64 EC	1 to 2 pt	0.95 to 1.91	Apply to soil surface immediately after planting. May be tank mixed with atrazine, glyphosate, or simazine. Check label for directions. Rate is soil-texture and organic-matter dependent. See label for details.
Most annual broadleaf and grass weeds	atrazine, MOA 5 (various brands) 4 F (various brands) 90 WDG	1 to 2 qt 1.1 to 2.2 lb	1 to 2	Apply to soil surface immediately after planting. Shallow cultivations will improve control. Check label for restrictions on rotational crops. See label for reduced rate if soil coverage with plant residue is less than 30% at planting. Does not control fall panicum or smooth crabgrass. May be tank mixed with metolachlor, alachlor, glyphosate, paraquat, bentazon, or simazine. Check label for directions.
	alachlor, MOA 15 + atrazine, MOA 5 (Bullet or Lariat) 4 F	2.5 to 4.25 qt	1.56 to 2.7 + 0.94 to 1.6	Apply to soil surface immediately after planting. Soil texture and organic matter influence application rate. See label for further instruction.
Controls pigweed, common lambsquarters, jimsonweed, common ragweed, smartweed, velvetleaf, and nightshade. Does not control sicklepod or prickly sida. Not adequately effective on common cocklebur or morningglory.	mesotrione, MOA 27 (Callisto) 4 EC	6 to 7.7 oz	0.19 to 0.24	Callisto is generally more effective when applied postemergence. Can mix with various preemergence grass control herbicides or with atrazine or atrazine-containing products. See label for more information.
Most annual broadleaf and grass weeds	dimethenamid, MOA 15 + atrazine, MOA 5 (Guardsman Max) 5 F	2.5 to 4.6 pt	0.73 to 1.5 + 0.83 to 1.7	
	S-metolachlor, MOA 15 + atrazine, MOA 5 (Bicep II Magnum) 5.5 F	1.3 to 2.6 qt	1 to 2 + 0.78 to 1.56	
CORN, SWEET, Postemergence				
Most annual broadleaf and grass weeds	atrazine, MOA 5 (various brands) 4 L (various brands) 90 WDG	2 qt 2.2 lb	2	Apply overtop before weeds exceed 1.5 in. in height. See label for additional information in controlling larger weeds. See label for amount of oil concentrate to add to spray mix.
Annual grasses and broadleaf weeds	dimethenamid, MOA 15 (Outlook) 6.0 EC + atrazine, MOA 5 (AAtrex) 4 F or 90 WDG	8 to 21 oz + See label for rate	0.375 to 1 + See label for rate	Apply overtop corn (8 in. or less) before weeds exceed the two-leaf stage. Larger weeds will not be controlled. Good residual control of annual grass and broadleaf weeds. Also available as the commercial products Guardsman or LeadOff.

TABLE 4-8. CHEMICAL WEED CONTROL IN CORN, SWEET (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CORN, SWEET, Postemergence (cont'd)				
Annual grasses and broadleaf weeds (cont'd)	S-metolachlor, MOA 15 (Dual II Magnum) 7.64 EC + atrazine, MOA 5 (AAtrex) 4 F (AAtrex) 90 WDG	1 to 1.67 pt + 1 to 2 qt 1.3 to 2.2 lb	0.95 to 1.58 + 1 to 2	Apply overtop corn (5 in. or less) before weeds exceed the two-leaf stage. Larger weeds will not be controlled. Good residual control of annual grass and broadleaf weeds. Also available as Bicep II or Bicep II Magnum.
Cocklebur, common ragweed, jimsonweed, Pennsylvania smartweed, velvetleaf, yellow nutsedge, and morningglory	bentazon, MOA 6 (Basagran) 4 SL	0.75 to 1 qt	0.75 to 1	Apply early postemergence overtop when weeds are small and corn has one to five leaves. See label for rates according to weed size and special directions for annual morningglory and yellow nutsedge control. Use a crop oil at a rate of 1 qt per acre.
Many broadleaf weeds	mesotrione, MOA 27 (Callisto) 4 EC	3 oz	0.094	Apply overtop corn 30 in. or less or 8 leaves or less to control emerged broadleaf weeds. Use nonionic surfactant at 2 pt per 100 gal of spray solution. **DO NOT add VAN or AMS when making post application in sweet corn or severe injury will occur.** Most effective on small weeds, however, if weeds are greater than 5 in. or for improved control of certain weeds, certain atrazine formulations may be mixed with this herbicide. See label for further information. Do not apply within 45 days of harvest.
Annual broadleaf weeds and some grasses	tembotrione, MOA 27 (Laudis) 3.5 L	3 fl oz	0.082	Can be applied overtop or with drop nozzles to sweet corn from emergence up to V7 stage. Controls most broadleaf weeds. Does not control sicklepod or prickly sida and only suppresses morningglory. Controls or suppresses some grasses. See label for weeds controlled and recommended size for treatment. Herbicide sensitivity in all hybrids and inbreds of sweet corn has not been tested. See label for information on adjuvant use. See label for further restrictions and instructions.
	Topramezone, MOA 27 (Impact) 2.8 L	0.75 fl oz	0.016	Can be applied overtop or with drop nozzles to sweet corn from emergence until 45 days prior to harvest. Does not control sicklepod and only suppresses morningglory. Controls or suppresses some grasses. See label for weeds controlled and recommended size for treatment. This product has not been tested on all inbred line for tolerance. See label for information on adjuvant use. See label for further restrictions and instructions.
Velvetleaf, spreading dayflower, morningglory species, and redroot pigweed. Will not control grasses	fluthiacet-methyl, MOA 14 (Cadet) 0.91 L	0.6 to 0.9 oz	0.0042 to 0.06	**Processing sweet corn only.** Apply to small weeds, generally about 2 inches tall. Will control large velvetleaf. See label for information on adjuvant use. See label for further restrictions and instructions.
Velvetleaf, pigweed, nightshade, morningglory, common lambsquarters	carfentrazone-ethyl, MOA 14 (Aim) 2.0 EC	0.5 oz	0.008	Apply postemergence to actively growing weeds less than 4 in. high (rosettes less than 3 in. across) up to the 14-leaf collar stage of corn. Directed sprays will lessen the chance of crop injury and allow later application. Coverage of weeds is essential for control. Use nonionic surfactant (2 pt per 100 gal of spray) with all applications. Under dry conditions, the use of crop oil concentrate may improve weed control. Mix with atrazine to improve control of many broadleaf weeds. Limited information is available concerning the use of this product in sweet corn. Do not apply more than 2 oz per acre per season.
Broadleaf weeds including sowthistle, clover, cocklebur, jimsonweed, ragweed, Jerusalem artichoke, and thistle	clopyralid, MOA 4 (Stinger) 3 EC	0.25 to 0.67 pt	0.095 to 0.25	Apply to sweet corn when weeds are small (less than 5-leaf stage) and actively growing. Do not apply to sweet corn over 18 in. tall. Will control most legumes. Do not apply within 30 days of harvest.
Cocklebur, passionflower (maypop), pigweed, pokeweed, ragweed, smartweed (Pennsylvania), velvetleaf	halosulfuron-methyl, MOA 2 (Profine 75, Sandea) 75 WDG	0.67 oz	0.032	Apply over the top or with drop nozzles to sweet corn from spike to lay-by for control of emerged weeds. Add nonionic surfactant at 1 to 2 qt per 100 gal of spray solution. See label for all instructions and restrictions. Do not apply within 30 days of harvest.
Cocklebur, pigweed, lambs-quarters, morningglory, sicklepod, and many other annual broadleaf weeds	2,4-D amine, MOA 4 (various brands) 3.8 SL	0.5 to 1 pt	0.24 to 0.48	Use 0.25 lb of 2,4-D overtop when corn is 4 to 5 in. tall and weeds are small. Increase rate to 0.5 lb as corn reaches 8 in. Use drop nozzles and direct spray toward base if corn is over 8 in. tall. Do not cultivate for about 10 days after spraying as corn may be brittle. Reduce rate of 2,4-D if extremely hot and soil is wet. For better sicklepod and horsenettle control, add a nonionic surfactant when using a directed spray at a rate of 1 qt per 100 gal spray solution.
Annual grasses and broadleaf weeds	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	0.7 to 1.3 pt 1 to 2 pt	0.25 to 0.5	**DO NOT SPRAY OVERTOP OF CORN OR SEVERE INJURY WILL OCCUR**. Make a postdirected application in a minimum of 20 gal spray mix per acre to emerged weeds when the smallest corn is at least 10 in. tall. Use nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix. Use of a hooded or shielded sprayer will reduce crop injury.

TABLE 4-8. CHEMICAL WEED CONTROL IN CORN, SWEET (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CORN, SWEET, Postemergence (cont'd)				
Certain grasses, including barnyardgrass, foxtails, Texas panicum, and johnsongrass; and broadleaf weeds, including burcucumber, jimsonweed, pigweed, pokeweed, and smartweeds	nicosulfuron, MOA 2 (Accent) 75 WDG	0.67 oz	0.031	Apply to sweet corn up to 12 in. tall or up to and including 5 leaf collars. For corn 12 to 18 in. tall, apply only with drop nozzles. Sweet corn hybrids vary in their sensitivity to Accent. Do not apply to Merit sweet corn. Contact company representative for information on other local hybrids that have been evaluated with Accent. Accent may be applied to corn previously treated with Fortress, Aztec, or Force, or non-organophosphate soil insecticides regardless of soil type. See label for more information on use of soil insecticides with Accent. Label prohibits application of Accent to corn previously treated with Counter insecticide, and also indicates that applying Accent to corn previously treated with Counter 20 CR, Lorsban, or Thimet may result in unacceptable crop injury, especially on soils with less than 4% organic matter. See label for information on use of adjuvants.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-9. CHEMICAL WEED CONTROL IN CUCUMBER

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CUCUMBERS, Preplant and Preemergence				
Suppression or control of most annual grasses and broadleaf weeds, full rate required for nutsedge control	metam sodium (Vapam HL) 42%	37.5 to 75 gal	15.7 to 31.5	Rates are dependent on soil type and weeds present. Apply when soil moisture is at field capacity (100 to 125%). Apply through soil injection using a rotary tiller or inject with knives no more than 4 in. apart; follow immediately with a roller to smooth and compact the soil surface or with mulch. May apply through drip irrigation prior to planting a second crop on mulch. Plant back interval is often 14 to 21 days and can be 30 days in some environments. See label for all restrictions and additional information.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter, does not control grasses.	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	**Aim 1.9 EW is registered for application in transplant production systems only. Aim 2 EC is registered in seeded and transplant production systems.** Apply no later than one day before transplanting or no later than 7 days before seeding crop. See label for information about application timing. Use a crop oil at up to 1 gal per 100 gal of spray solution or a nonionic surfactant at 2 pt per 100 gal of spray solution. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 10 gal spray mix per acre to emerged weeds before crop emergence as a broadcast or band treatment over a preformed row. Use sufficient water to give thorough coverage. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds at least 3 days before seeding or transplanting. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. When applying Roundup before transplanting crops into plastic mulch, care must be taken to remove residues of this product from the plastic prior to transplanting. To prevent crop injury, residues can be removed by 0.5 in. natural rainfall or by applying water via a sprinkler system. Certain glyphosate formulations require the addition of surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and small-seeded broadleaf weeds	bensulide, MOA 8 (Prefar) 4 EC	5 to 6 qt	5 to 6	Apply preplant and incorporate into the soil 1 to 2 in. (1 in. incorporation is optimum) with a rototiller or tandem disk, or apply to the soil surface after seeding and follow with irrigation. Check re-plant restrictions for small grains on label.
Annual grasses and some small-seeded broadleaf weeds; weak on pigweed	clomazone, MOA 13 (Command) 3 ME	0.4 to 1 pt	0.15 to 0.375	Apply immediately after seeding. See label for further information.
Annual grasses and some small-seeded broadleaf weeds	ethalfluralin, MOA 3 (Curbit) 3 EC	3 to 4.5 pt	1.1 to 1.7	Apply to the soil surface immediately after seeding. **May also be used as a BANDED spray BETWEEN rows of plastic mulch.** See label for timing. Shallow cultivation, irrigation, or rainfall within 5 days is needed for good weed control. Do not use under mulches, row covers, or hot caps. Under conditions of unusually cold or wet soil and air temperatures, crop stunting or injury may occur. Crop injury can occur if seeding depth is too shallow.
Annual grasses and broadleaf weeds	ethalfuralin, MOA 3 + clomazone, MOA 13 (Strategy) 2.1 L	2 to 6 pt	0.4 to 1.2 + 0.125 to 0.375	Apply to the soil surface immediately after crop seeding for preemergence control of weeds. **DO NOT APPLY PRIOR TO PLANTING CROP. DO NOT SOIL INCORPORATE.** May also be used as a **banded** treatment **between** rows after crop emergence or transplanting. Do not apply over or under plastic mulch.
Yellow and purple nutsedge and broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 0.75 oz	0.024 to 0.036	Apply after seeding or prior to transplanting crop. For transplanting, do not transplant until 7 days after application. For seeded or transplanting cucumbers in plasticulture, do not plant within 7 days of Sandea application. Rate can be increased to 1 ounce of product per acre to middles between rows.

TABLE 4-9. CHEMICAL WEED CONTROL IN CUCUMBER (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
CUCUMBERS, Postemergence (cont'd)				
Annual grasses and small-seeded broadleaf weeds	trifluralin, MOA 3 (Treflan HFP, Trifluraline, Trifluralin HF) 4EC	1 to 2 pt	0.5 to 0.75	**Will not control emerged weeds. Row middles only.** To improve preemergence control of late emerging weeds. Apply after emergence when crop plants have reached the 3- to 4-true leaf stage. Apply as a directed spray to soil between the rows. Avoid contacting crop foliage as slight crop injury may occur. Set incorporation equipment to move treated soil around base of crop plants. Do not apply within 30 days of harvest.
Yellow and purple nutsedge and broadleaf weeds including cocklebur, galinsoga, smartweed, ragweed, wild radish and pigweed	halosulfuron-methyl, MOA 2 (Profine 75, Sandea) 75 DG	0.5 to 0.75 oz	0.024 to 0.036	Apply postemergence only after the crop has reached 3 to 5 true leaves but before first female flowers appear. Do not apply sooner than 14 days after transplanting. Use nonionic surfactant at 1 qt per 100 gal of spray solution with all postemergnce applications. Preharvest interval is 30 days.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use crop oil concentrate at up to 1 gal per 100 gal solution or a nonionic surfactant at 2 pt per 100 gal of spray solution. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Annual and perennial grasses only	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 14 days of harvest.
	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max, Intensity One) 1 EC	6 to 8 oz 9 to 16 oz	0.094 to 0.125 0.07 to 0.125	Control of emerged grasses. For Arrow, Clethodim, and Select, add 1 gal crop oil concentrate per 100 gal spray mix. For Select Max and Intensity One, add 2 pt nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. Do not apply within 14 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-10. CHEMICAL WEED CONTROL IN EGGPLANT

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
EGGPLANT, Preplant				
Suppression or control of most annual grasses and broadleaf weeds, full rate required for nutsedge control	metam sodium (Vapam HL) 42%	37.5 to 75 gal	15.7 to 31.5	Rates are dependent on soil type and weeds present. Apply when soil moisture is at field capacity (100 to 125%). Apply through soil injection using a rotary tiller or inject with knives no more than 4 in. apart; follow immediately with a roller to smooth and compact the soil surface or with mulch. May apply through drip irrigation prior to planting a second crop on mulch. Plant back interval is often 14 to 21 days and can be 30 days in some environments. See label for all restrictions and additional information. Chloropicrin (150lb/A broadcast) will also be needed when laying first crop mulch to control nutsedge.
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm) 3 SL (Parazone) 3 SL (Gramoxone SL) 2 SL	 1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 10 gal spray mix per acre to emerged weeds before transplanting as a broadcast or band treatment over a preformed row. Use sufficient water to give thorough coverage. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	**Aim 1.9 EW is registered for application in transplant production systems only. Aim 2 EC is registered in seeded and transplant production systems.** Apply no later than one day before transplanting crop or no later than 7 days before seeding crop. See label for information about application timing. Use a crop oil at up to 1 gal per 100 gal of spray solution or a nonionic surfactant at 2 pt per 100 gal of spray solution. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations	See labels	See labels	Apply to emerged weeds at least 3 days before seeding or transplanting. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. When applying Roundup before transplanting crops into plastic mulch, care must be taken to remove residues of this product from the plastic prior to transplanting. To prevent crop injury, residues can be removed by 0.5 in. natural rainfall or by applying water via a sprinkler system. Certain glyphosate formulations require the addition of surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
EGGPLANT, Preemergence				
Annual grasses and small-seeded broadleaf weeds	bensulide, MOA 8 (Prefar) 4 EC	5 to 6 qt	5 to 6	Apply preplant incorporated (1 in. incorporation is optimum) or preemergence after planting. With preemergence application, irrigate immediately after application. See label for more directions.
Annual grasses and some broadleaf weeds	napropamide, MOA 15 (Devrinol, Devrinol DF-XT) 50 DF (Devrinol 2-XT) 2 EC	 2 to 4 lb 2 to 4 qt	1 to 2	Apply preplant and incorporate into soil 1 to 2 in. using a rototiller or tandem disk. Shallow cultivations or irrigation will improve control. See label for small grains replanting restrictions. May also be applied in the row middles between plastic covered beds. See label for more information. See XT labels for information regarding delay in irrigation event.
EGGPLANT, Postemergence				
Annual grasses and small-seeded broadleaf weeds	DCPA, MOA 3 (Dacthal) W-75 (Dacthal) 6 F	 6 to 10 lb 6 to 10 pt	4.5 to 7.5	To improve preemergence control of late emerging weeds. Apply over the top of transplants only between 4 and 6 wk after.
Annual and perennial grasses only	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 20 days of harvest.
	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max, Intensity One) 1 EC	 6 to 8 oz 9 to 16 oz	 0.094 to 0.125 0.07 to 0.125	Apply postemergence for control of grasses. With Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. With Select Max, add 2 pt of nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperature. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. Do not apply within 20 days of harvest.
EGGPLANT, Row Middles				
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use crop oil concentrate at up to 1 gal per 100 gal solution or a nonionic surfactant at 2 pt per 100 gal of spray solution. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots or stems, exposed roots, or fruit of crop. Do not apply within 14 days of harvest.
Yellow and purple nutsedge and broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 1 oz	0.024 to 0.048	Apply to row middles as a postemergence spray. In plasticulture, do not allow spray to contact plastic. Early season application will give postemergence and preemergence control. For postemergence applications, use nonionic surfactant at 1 qt per 100 gal of spray solution. Preharvest interval is 30 days.
Contact kill of all green foliage	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	 1.3 pt 2 pt	0.5	Apply in 10 gal spray mix as a shielded spray to emerged weeds between rows of eggplant. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix. Do not allow spray to contact crop or injury will result.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-11. CHEMICAL WEED CONTROL IN GARLIC

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
GARLIC, Preplant or Preemergence				
Annual and perennial grass and broadleaf weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Stale bed application. Apply to emerged weeds at least 3 days before planting. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	 1.7 to 2.7 pt 2.5 to 4 pt	0.6 to 1	Apply in a minimum of 20 gal spray mix per acre to emerged weeds before crop emergence as a broadcast or band treatment over a preformed row. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix. Do not apply within 60 days of harvest.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 2.0 EC	0.5 oz	0.008	Apply no later than 30 days before planting. See label for proper adjuvant and rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual grasses and small-seeded broadleaf weeds	bensulide, MOA 8 (Prefar) 4 EC	5 to 6 qt	5 to 6	Apply preplant incorporated (1 in. incorporation is optimum) or preemergence after planting. With preemergence application, irrigate immediately after application. See label for more directions.
Annual broadleaf weeds	oxyfluorfen, MOA 14 (Galigan, Goal 2XL) 2 E	1 to 2 pt	0.25 to 0.5	**Transplanted garlic only.** For use on a fallow bed and garlic may be planted immediately following application.
GARLIC, Preemergence				
Annual grasses and small-seeded broadleaf weeds	dimethenamid-P, MOA 15 (Outlook) 6 EC	12 to 21 oz	0.6 to 1	For preemergence weed control. Apply after crop has reached 2 true leaves until a minimum of 30 days before harvest. If applications are made to transplanted crop, DO NOT apply until transplants are in the ground and soil has settled around transplants with several days to recover.
	flumioxazin, MOA 14 (Chateau) 51 SW	6 oz	0.188	For preemergence weed control. Apply prior to garlic and weed emergence. Application should be made within 3 days after planting garlic.
	pendimethalin, MOA 3 (Prowl) 3.3 EC (Prowl H_2O) 3.8 AS	 1.2 to 3.6 pt 1.5 to 3 pt	 0.5 to 1.5 0.75 to 1.5	For preemergence weed control. Apply preemergence after planting but prior to weed and crop emergence or postemergence to garlic in the 1 to 5 true leaf stage. Prowl can be applied sequentially by applying preemergence followed by a postemergence application. Preharvest interval is 45 days.
GARLIC, Postemergence				
Most annual broadleaf weeds	oxyfluorfen, MOA 14 (Galigan) 2 E (Goal 2 XL) 2 EC (GoalTender) 4 E	 0.5 pt 0.5 pt 0.25 pt	0.12	**Transplanted dry bulb only.** May be used as a postemergence spray to both the weeds and crop after the garlic has at least two fully developed true leaves. Some injury to garlic may result. Injury will be more severe if the chemical is applied during cool, wet weather. Weeds should be in the 2- to 4-leaf stage for best results. Preharvest interval is 60 days.
Annual and perennial grasses only	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max, Intensity One) 1 EC	 6 to 16 oz 9 to 32 oz	 0.09 to 0.25 0.07 to 0.25	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. With Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. With Select Max, add 2 pt of nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Do not apply Arrow, Clethodim, or Select on unusually hot and humid days. Do not apply within 45 days of harvest. Very effective in controlling annual bluegrass.
	fluazifop, MOA 1 (Fusilade DX) 2 EC	6 to 16 oz	0.1 to 0.25	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 gal crop oil concentrate or 1 qt nonionic surfactant per 100 gal spray mix. Do not apply on days that are unusually hot and humid. Do not apply within 45 days of harvest.
	sethoxydim, MOA 1 (Poast) 1.5 EC	1 pt	0.2	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 30 days of harvest.
Garlic, Row Middles				
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or post-harvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-12. CHEMICAL WEED CONTROL IN GREENS

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
GREENS (Collard, Kale, Mustard Greens, and Turnip Greens or roots), Preplant				
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm) 3 SL (Parazone) 3 SL (Gramoxone SL) 2 SL	 1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	**Collard and turnip only.** Apply in a minimum of 10 gal spray mix per acre to emerged weeds before crop emergence or transplanting as a broadcast or band treatment over a preformed row. Use sufficient water to give thorough coverage. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Do not feed crop residue to livestock for 8 weeks following treatment. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and small-seeded broadleaf weeds	trifluralin, MOA 3 (Treflan) 4 EC	 1 to 1.5 pt	0.5 to 0.75	Do not use on turnip greens for fresh market. Apply preplant and incorporate into the soil 2 to 3 in. within 8 hr using a rototiller or tandem disk. Do not use if turnip roots are to be consumed.
	bensulide, MOA 8 (Prefar) 4 EC	 5 to 6 qt	5 to 6	Also labeled for rape greens. Not labeled for turnip. Apply preplant or preemergence after planting. With preemergence application, irrigate immediately after application. See label for more directions.
	DCPA, MOA 3 (Dacthal) W-75 (Dacthal) 6 F	 6 to 10 lb 6 to 10 pt	4.5 to 7.5	Also labeled for broccoli raab (raab, raab salad), mizuna, and Hanover salad. Apply immediately after seeding. May also be incorporated.
GREENS (Collard, Kale, Mustard Greens, and Turnip Greens or roots), Postemergence				
Broadleaf weeds including sowthistle clover, cocklebur, jimsonweed, and ragweed	clopyralid, MOA 4 (Stinger) 3 EC	 0.3 to 0.5 pt	0.187	**Kale, collards, mustard, turnip, mizuna, mustard spinach, and rape only.** Apply to crop when weeds are small and actively growing. Will control most legumes. For kale, collards, mustard, and turnip (roots), do not apply within 30 days of harvest. For turnip tops, do not apply within 15 days of harvest. Mustard green injury has been observed in some research trials.
Annual and perennial grasses only	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max) 1 EC	 6 to 8 oz 9 to 16 oz	 0.094 to 0.125 0.07 to 0.125	Apply postemergence for control of grasses. With Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. With Select Max, add 2 pt nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. Do not apply within 14 days of harvest of green crops. Do not apply within 30 days of harvest of turnips grown for roots.
	sethoxydim, MOA 1 (Poast) 1.5 EC	 1 to 1.5 pt	0.2 to 0.3	**ALSO LABELED FOR RAPE GREENS**. Do not apply within 14 days of harvest of turnip and 30 days of harvest of other greens. Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply on unusually hot and humid days.
GREENS (Collard, Kale, Mustard Greens, and Turnip Greens or roots), Row middles				
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	 Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Not labeled for turnip greens.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots or stems, exposed roots, or fruit of crop. Do not apply within 14 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-13. CHEMICAL WEED CONTROL IN LETTUCE

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
LETTUCE, Preplant				
Suppression or control of most annual grasses and broadleaf weeds, full rate required for nutsedge control	metam sodium (Vapam HL) 42%	37.5 to 75 gal	15.7 to 31.5	Rates are dependent on soil type and weeds present. Apply when soil moisture is at field capacity (100 to 125%). Apply through soil injection using a rotary tiller or inject with knives no more than 4 in. apart; follow immediately with a roller to smooth and compact the soil surface or with mulch. May apply through drip irrigation prior to planting a second crop on mulch. Plant back interval is often 14 to 21 days and can be 30 days in some environments. See label for all restrictions and additional information.
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 10 gal spray mix per acre to emerged weeds before crop emerges as a broadcast or band treatment over a preformed row. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray solution or 1 gal approved crop oil concentrate per 100 gal spray mix.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Do not feed crop residue to livestock for 8 weeks following treatment. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
LETTUCE, Preplant or Preemergence				
Annual grasses and small-seeded broadleaf weeds	benefin, MOA 3 (Balan) 60 WDG	2 to 2.5 lb	1.2 to 1.5	Apply preplant and incorporate 2 to 3 in. deep with a rototiller or tandem disk before seeding or transplanting.
	bensulide, MOA 8 (Prefar) 4 EC	5 to 6 qt	5 to 6	Apply preplant incorporated (1 in. incorporation is optimum) or preemergence after planting. With preemergence application, irrigate immediately after application. See label for more directions.
Most annual grasses and broadleaf weeds	pronamide, MOA 3 (Kerb) 50 WP	2 to 4 lb	1 to 2 lb	**DO NOT APPLY TO LEAF LETTUCE.** Can be used preplant or preemergence. Application can also be made postemergence to head lettuce but should be made before weed germination if possible or before weeds are beyond the two-leaf stage. Moisture is necessary to activate. Do not apply within 55 days of harvest. Make only one application per crop. Consult label for planting restrictions for rotational crops.
LETTUCE, Postemergence				
Annual and perennial grasses only	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Arrow, Clethodim, and Select are only registered for leaf lettuce. Consult manufacturer's label for specific rates and best times to treat. For sethoxydim, add 1 qt of crop oil concentrate per acre. Use of Poast or clethodim with crop oil may increase the likelihood of crop injury at high air temperatures. For Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray solution. With Select Max, add 2 pt nonionic surfactant per 100 gal spray mixture. Do not apply on days that are unusually hot and humid. Do not apply sethoxydim within 30 days of harvest on head lettuce or within 15 days of harvest on leaf lettuce. For clethodim, do not apply within 14 days of harvest.
	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max, Intensity One) 1 EC	6 to 8 oz 9 to 16 oz	0.09 to 0.125 0.07 to 0.125	
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Row middles only. Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-14. CHEMICAL WEED CONTROL IN OKRA

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
OKRA, Preplant				
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Perennial weeds may require higher rates. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply no later than 1 day before transplanting crop. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual grasses and small-seeded broadleaf weeds	trifluralin, MOA 3 (Treflan, Treflan HFP, Trifluralin, Trilin) 4 EC	1 to 2 pt	0.5 to 1	Apply preplant and incorporate into the soil 2 to 3 in. within 8 hr using a rototiller or tandem disk.
Annual broadleaf weeds including pigweed spp.	mesotrione, MOA 27 (Callisto) 4 L	6	0.19	May be applied as a row middle or hooded POST-directed application but not both. For preemergence row middle application apply as a banded application to the row middles prior to weed emergence. Leave 1 ft. of untreated area over the okra row or 6 in. on each side of the planted row. Do not apply Callisto directly over the planted row or severe injury may occur. Injury risk is greatest on coarse textured soils (sand, sandy loam or loamy sand).
OKRA, Postemergence				
Annual and perennial grasses only	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.3 lb	Apply to actively growing grasses not under drought stress. Do not apply on days that are unusually hot and humid. Do not apply within 14 days of harvest.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots or stems, exposed roots, or fruit of crop. Do not apply within 14 days of harvest.
Annual broadleaf weeds including pigweed 3 in. or less	mesotrione, MOA 27 (Callisto) 4 L	3	0.10	May be applied as a row middle or hooded POST-directed application but not both. For postemergence hooded application, okra must be at least 3 in. tall. Minimize amount of Callisto that contacts okra foliage or crop injury will occur. Preharvest interval is 28 days.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-15. CHEMICAL WEED CONTROL IN ONIONS

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
ONIONS, Preplant and Preemergence				
Suppression or control of most annual grasses and broadleaf weeds, full rate required for nutsedge control	metam sodium (Vapam HL) 42%	37.5 to 75 gal	15.7 to 31.5	**Dry bulb and green onion.** Rates are dependent on soil type and weeds present. Apply when soil moisture is at field capacity (100 to 125%). Apply through soil injection using a rotary tiller or inject with knives no more than 4 in. apart; follow immediately with a roller to smooth and compact the soil surface or with mulch. May apply through drip irrigation prior to planting a second crop on mulch. Plant back interval is often 14 to 21 days and can be 30 days in some environments. See label for all restrictions and additional information.
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm) 3 SL (Parazone) 3 SL (Gramoxone SL) 2 SL	1.7 to 2.7 pt 2.5 to 4 pt	0.65 to 1	**Seeded onion only.** Apply in a minimum of 20 gal spray mix per acre to emerged weeds before crop emergence or transplanting as a broadcast or band treatment over a preformed row. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Annual and perennial grass and broadleaf weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Use on direct seeded onions only. Certain glyphosate formulations require the addition of surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 2.0 EC	0.5 oz	0.008	Apply no later than 30 days before planting. See label for proper adjuvant and rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual grasses and small-seeded broadleaf weeds	bensulide, MOA 8 (Prefar) 4 E	5 to 6 qt	5 to 6	**Dry bulb only.** Apply preplant incorporated (1 in. incorporation is optimum) or preemergence after planting. With preemergence application, irrigate immediately after application. See label for more directions.
	DCPA, MOA 3 (Dacthal) W-75 (Dacthal) 6 F	8 to 10 lb 8 to 10 pt	6 to 7.5	**Dry bulb and green.** Apply immediately after seeding or transplanting and/or at layby. See label for timing layby treatments.
Annual broadleaf weeds	oxyfluorfen, MOA 14 (Galigan) 2 E (Goal 2 XL) 2 EC (GoalTender) 4 E	 1 to 2 pt 1 to 2 pt 1 pt	 0.25 to 0.5 0.25 to 0.5 0.5	**Transplanted dry bulb only.** Apply as a single application immediately (within 2 days) after transplanting for preemergence control of weeds. See label for rates and instructions for use. Do not apply within 45 days of harvest.
Most annual grasses and some broadleaf weeds	pendimethalin, MOA 3 (Prowl) 3.3 EC (Prowl) 3.8 AS	1.2 to 3.6 pt 1.5 to 2 pt	0.5 to 1.5 0.75 to 1.5	**Dry bulb only.** For preemergence weed control. **MINERAL SOILS.** Apply when onions have two to nine true leaves but prior to weed emergence. **ALL SOILS.** Do not apply within 45 days of harvest.
	(Prowl) 3.3 EC (Prowl) 3.8 AS	2.4 to 4.8 pt 4 pt	1 to 2 2	**Dry bulb only.** For preemergence weed control. **MUCK SOILS.** Apply prior to onion emergence through the nine-leaf stage. See label for specific rate for crop growth stage and for all precautions. **ALL SOILS.** Do not apply within 45 days of harvest.
	dimethenamid-P, MOA 15 (Outlook) 6 EC	12 to 21 oz	0.6 to 1	**Dry bulb only.** For preemergence weed control. Apply after crop has reached 2 true leaves until a minimum of 30 days before harvest. If applications are made to transplanted crop, DO NOT apply until transplants are in the ground and soil has settled around transplants with several days to recover.
ONIONS, Postemergence				
Most annual broadleaf weeds	oxyfluorfen, MOA 14 (Galigan) 2 E (Goal 2 XL) 2 EC (GoalTender) 4 E	 0.5 pt 0.5 pt 0.25 pt	0.12	**Dry bulb only.** May be used as a postemergence spray to both the weeds and crop after the onions have at least two fully developed true leaves. Some injury to onions may result. Injury will be more severe if the chemical is applied during cool, wet weather. Weeds should be in the two- to fourleaf stage for best results. Do not make more than four applications per year. Do not apply within 45 days of harvest.
Many broadleaf weeds	flumioxazin, MOA 14 (Chateau) 51SW	2 oz	0.064	**Dry bulb only.** Apply to clean soil surface prior to germination of weeds. Apply to transplanted dry bulb onion between 2 and 6 leaf stage. Apply to directed seeded dry bulb onion between the 3 and 6 leaf stage.
Common lambsquarters, common chickweed, common purslane, black nightshade, ladysthumb, Pennsylvania smartweed, redroot pigweed, and some annual grasses	ethofumesate, MOA 8 (Nortron) 4 SC	16 to 32 oz	0.5 to 1	Apply at planting or just after planting prior to weed emergence. Rainfall of at least 0.5 inch is needed for activation.

TABLE 4-15. CHEMICAL WEED CONTROL IN ONIONS (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
ONIONS, Postemergence (cont'd)				
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Annual and perennial grasses only	fluazifop, MOA 1 (Fusilade DX) 2 EC	6 to 16 oz	0.1 to 0.25	**Dry bulb only.** Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 gal crop oil concentrate or 1 qt nonionic surfactant per 100 gal spray mix. Do not apply on days that are unusually hot and humid. Do not apply within 45 days of harvest.
	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	**Dry bulb and green.** Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 30 days of harvest.
	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Intensity One, Select Max) 1 EC	6 to16 oz 9 to 32 oz	0.09 to 0.25 0.07 to 0.25	**Dry bulb only.** Apply to emerged grasses. Consult the manufacturer's label for specific rates and best times to treat. With Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. With Select Max or Intensity One, add 2 pt nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Do not apply Select on unusually hot and humid days. Do not apply within 45 days of harvest. Very effective in controlling annual bluegrass.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-16. CHEMICAL WEED CONTROL IN PEAS

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PEAS, GREEN, Preplant and Preemergence				
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm,Parazone) 3 SL (Gramoxone SL) 2 SL	 1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 10 gal spray mix per acre to emerged weeds before crop emergence as a broadcast or band treatment over a preformed row. Use sufficient water to give thorough coverage. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply prior to planting or emergence of crop. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual and perennial grass and broadleaf weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Do not feed crop residue to livestock for 8 weeks following treatment. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and small-seeded broadleaf weeds	pendimethalin, MOA 3 (Prowl H_2O) 3.8 AS	1.5 to 3 pt	0.75 to 1.5	**Southern peas (cowpeas) and snap beans only.** Apply preplant and incorporate into the soil 2 to 3 in. using a power driven rototiller or by cross disking. **DO NOT APPLY AFTER SEEDING.**
	trifluralin, MOA 3 (Treflan, Trifluralin, Trifluralin HF, other brands) 4 EC	1 to 1.5 pt	0.5 to 0.75	Apply preplant and incorporate to a depth of 2 to 3 in. within 8 hr with a rototiller or tandem disk.
Annual grasses and broadleaf weeds; weak on pigweed	clomazone, MOA 13 (Command) 3ME	1.3 pt	0.5	Apply to the soil surface immediately after seeding. See label for further instruction.
Annual grasses, small-seeded broadleaf weeds, and suppression of yellow nutsedge	*S*-metolachlor, MOA 15 (Brawl, Dual Magnum, Medal) 7.62 EC (Brawl II, Dual II Magnum, Medal II) 7.64 EC	1 to 2 pt	0.95 to 1.91	Apply to soil surface immediately after seeding. Shallow cultivations will improve control. See label for specific rate.
Annual broadleaf weeds including morningglory, pigweed, smartweed, and purslane	imazethapyr, MOA 2 (Pursuit) 2 EC	Up to 3 oz	Up to 0.047	**English peas only.** Apply preplant incorporated or to soil surface immediately after planting.
PEAS, GREEN, Postemergence				
Annual broadleaf weeds and yellow nutsedge	bentazon, MOA 6 (Basagran) 4 SL	1 to 2 pt	0.5 to 1	Apply overtop of peas when weeds are small and peas have at least three pairs of leaves (four nodes). **DO NOT ADD CROP OIL CONCENTRATE TO SPRAY MIX**. Do not apply within 10 days of harvest. Do not apply when peas are in bloom.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See Label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels 0.5 to 0.94	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or post-harvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots or stems, exposed roots, or fruit of crop. Do not apply within 14 days of harvest.
Annual and perennial grasses	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. With sethoxydim, add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast or Assure II may increase the likelihood of crop injury at high air temperatures. With quizalofop, add 1 gal oil concentrate or 1 qt nonionic surfactant per 100 gal spray. Do not apply Poast or Assure II on days that are unusually hot and humid. Do not apply sethoxydim within 15 days or Assure within 30 days of harvest.
	quizalofop p-ethyl, MOA 1 (Assure II) 0.88 EC (Targa) 0.88 EC	6 to 12 oz	0.04 to 0.08	
Annual broadleaf weeds including morningglory, pigweed, smartweed, and purslane	imazethapyr, MOA 2 (Pursuit) 2 EC	Up to 3 oz	Up to 0.047	**See label for pea type.** Apply postemergence to 1- to 3-in. weeds (one to four leaves) when peas are at least 3 in. high but prior to five nodes. Add nonionic surfactant at 2 pt per 100 gal of spray mix.

TABLE 4-16. CHEMICAL WEED CONTROL IN PEAS (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PEAS, SOUTHERN (Cowpeas, Blackeyed peas), Preplant or Preemergence				
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 20 gal spray solution to emerged weeds before crop emergence as a broadcast or band treatment over a preformed row. Use sufficient water to give thorough coverage. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply prior to planting or emergence of crop. Use a nonionic surfactant or crop oil with Aim. See Label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual and perennial grass and broadleaf weeds, stale bed application.	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Do not feed crop residue to livestock for 8 weeks following treatment. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and small-seeded broadleaf weeds	pendimethalin, MOA 3 (Prowl H_2O) 3.8 AS	1.5 to 3 pt	0.75 to 1.5	**NOT LABELED IN BLACKEYED PEAS.** Apply preplant and incorporate into the soil 2 to 3 in. using a power driven rototiller or by cross disking. **DO NOT APPLY AFTER SEEDING.**
	trifluralin, MOA 3 (Treflan HFP, Trifluralin, Trifluralin HF) 4 EC	1 to 2 pt	0.5 to 1	Apply preplant and incorporate into the soil 2 to 3 in. deep within 8 hr with a rototiller or tandem disk.
Annual grasses and broadleaf weeds	clomazone, MOA 13 (Command) 3ME	0.4 to 0.67 pt	0.15 to 0.25	Apply to the soil surface immediately after seeding. Offers weak control of pigweed. See label for further instruction.
Annual grasses, small-seeded broadleaf weeds, and suppression of yellow nutsedge	*S*-metolachlor, MOA 15 (Brawl, Dual Magnum, Medal) 7.62 EC (Brawl II, Dual II Magnum, Medal II) 7.64 EC	1 to 2 pt	0.95 to 1.91	Apply to soil surface immediately after planting. Shallow cultivations will improve control. May also be soil incorporated before planting.
Annual grasses and broadleaf weeds including morningglory, pigweed, smartweed, and purslane	imazethapyr, MOA 2 (Pursuit) 2 EC	Up to 4 oz	Up to 0.063	Apply preemergence or preplant incorporated. See label for rate for specific pea species.
PEAS, SOUTHERN, Postemergence				
Annual broadleaf weeds and yellow nutsedge	bentazon, MOA 6 (Basagran) 4 SL	1 to 2 pt	0.5 to 1	Apply overtop of peas when weeds are small and peas have at least three pairs of leaves (four nodes). **DO NOT ADD CROP OIL CONCENTRATE TO SPRAY MIX.** Do not apply within 30 days of harvest. Do not apply when peas are in bloom.
Annual broadleaf weeds including morningglory, pigweed, smartweed, and purslane	imazethapyr, MOA 2 (Pursuit) 2 EC	Up to 4 oz	Up to 0.063	**Southern peas and certain dry peas.** Apply postemergence to 1- to 3-in. weeds (one to four leaves) when peas are at least 3 in. in height but prior to five nodes and flowering. Add nonionic surfactant at 2 pt per 100 gal of spray mixture with all postemergence applications. Do not apply within 30 days of harvest. See label for rate for specific pea species.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or post-harvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Annual and perennial grasses	quizalofop p-ethyl, MOA 1 (Assure II, Targa) 0.88 EC	6 to 12 oz	0.04 to 0.08	**Apply to emerged grasses.** Consult manufacturer's label for specific rates and best times to treat. With sethoxydim, add 1 qt of crop oil concentrate per acre. With quizalofop, add 1 gal oil concentrate or 1 qt nonionic surfactant per 100 gal spray. Adding crop oil to Assure II or Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Assure II or Poast on days that are unusually hot and humid. With sethoxydim, do not apply within 15 days and 30 days of harvest for succulent and dry peas, respectively. With quizalofop, do not apply within 30 days of harvest of dry Southern peas.
	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	
	clethodim, MOA 1 (Intensity One, Select Max) 1 EC	9 to 16 oz	0.07 to 0.125 lb	For Select Max or Intensity One, add 2 pt. nonionic surfactant per 100-gal spray mixture. Apply before bloom. Do not make more than one application per acre per season. Do not apply clethodim within 21 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-17. CHEMICAL WEED CONTROL IN PEPPERS

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PEPPERS, Preplant				
Suppression or control of most annual grasses and broadleaf weeds, full rate required for nutsedge control	metam sodium (Vapam HL) 42%	37.5 to 75 gal	15.7 to 31.5	Rates are dependent on soil type and weeds present. Apply when soil moisture is at field capacity (100 to 125%). Apply through soil injection using a rotary tiller or inject with knives no more than 4 in. apart; follow immediately with a roller to smooth and compact the soil surface or with mulch. May apply through drip irrigation prior to planting a second crop on mulch however adhere to label guidelines on crop plant-back interval. Plant back interval is often 14 to 21 days and can be 30 days in some environments. See label for all restrictions and additional information. Chloropicrin (150lb/A broadcast) will also be needed when laying first crop mulch to control nutsedge.
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 10 gal of spray mix per acre to emerged weeds before transplanting as a broadcast or band treatment over a preformed row. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	**Transplanted crop. Apply no later than 1 day before transplanting crop.** **Seeded crop. Apply no later than 7 days before planting seeded crop.** Use a nonionic surfactant or crop oil. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds at least 3 days before seeding or transplanting. When applying Roundup before transplanting crops into plastic mulch, care must be taken to remove residues of this product from the plastic prior to transplanting. To prevent crop injury, residues can be removed by 0.5 in. natural rainfall or by applying water via a sprinkler system. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for specific weeds. Certain glyphosate formulations require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Broadleaf weeds including Carolina geranium and cutleaf eveningprimrose and a few annual grasses	oxyfluorfen, MOA 14 (Goal) 2XL (GoalTender) 4 F	Up to 2 pt Up to 1 pt	0.5 lb	**Plasticulture only.** Apply to soil surface of pre-formed beds at least 30 days prior to transplanting crop. While incorporation is not necessary, it may result in less crop injury. Plastic mulch can be applied any time after application but best results are likely if applied soon after application.
Palmer amaranth, redroot pigweed, smooth pigweed, *Galinsoga* sp., black nightshade, Eastern black nightshade, common purslane, partial control of yellow nutsedge	fomesafen, MOA 14 (Reflex) 2 EC	1 to 1.5 pt	0.25 to 0.375	***This is a Section 24(c) special local needs label for transplanted pepper in NC. Growers must obtain the label at www.farmassist.com prior to making an application of Reflex.*** **See label for further instructions.** **Plasticulture In-row Application for Transplanted Pepper.** Apply after final bed formation and the drip tape is laid but prior to laying plastic mulch. Avoid soil disturbance after application. Unless restricted by other products such as fumigants, pepper may be transplanted immediately following the application of Reflex and the application of the mulch. **Bareground for Transplanted Pepper.** Apply pretransplant up to 7 days prior to transplanting pepper. Weed control will be reduced if soil is disturbed after application. During the transplanting operation make sure the soil in the transplant hole settles flush or above the surrounding soil surface. Avoid cultural practices that may concentrate Reflex-treated soil around the transplant root ball. An overhead irrigation or rainfall event between Reflex herbicide application and transplanting will ensure herbicide activation and will likely reduce the potential for crop injury due to splashing. **Plasticulture Row Middle Application.** Apply to row middles with a hooded or shielded sprayer. Avoid drift of herbicide on mulch. If drift occurs, 0.5 inch of rain or irrigation must occur prior to transplanting. **Carryover is a large concern; see label for more information.**
PEPPERS, Preplant and Preemergence				
Annual grasses and small-seeded broadleaf weeds	clomazone, MOA 13 (Command) 3 ME	0.67 to 2.67 pt	0.25 to 1	**Not labeled for banana pepper.** Apply preplant before transplanting. Weak on pigweed. See label for instructions on use.
	napropamide, MOA 15 (Devrinol, Devrinol DF-XT) 50 DF (Devrinol, Devrinol 2-XT) 2 EC	2 to 4 lb 2 to 4 qt	1 to 2 1 to 2	**Bareground:** Apply preplant and incorporate into the soil 1 to 2 in. as soon as possible with a rototiller or tandem disk. Can be used on direct-seeded or transplanted peppers. See label for instructions on use. **Plasticulture:** Apply to a weed-free soil before laying plastic mulch. Soil should be well worked yet moist enough to permit a thorough incorporation to a depth of 2 inches. Mechanically incorporate or irrigate within 24 hours after application. If weed pressure is from small seeded annuals, apply to the surface of the bed immediately in front of the laying of plastic mulch. If soil is dry, water or sprinkle irrigate with sufficient water to wet to a depth of 2 to 4 inches before covering with plastic mulch. **Between rows:** Apply to a weed free soil surface between the rows (bareground or plastic mulch). Mechanically incorporate or irrigate Devrinol into the soil to a depth of 1 to 2 inches within 24 hours of application. See XT labels for information regarding delay in irrigation event.

TABLE 4-17. CHEMICAL WEED CONTROL IN PEPPERS (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PEPPERS, Preplant and Preemergence (cont'd)				
Annual grasses and small-seeded broadleaf weeds (cont'd)	pendimethalin, MOA 3 (Prowl H_2O) 3.8 AS	1 to 3 pt	0.5 to 1.5	May be applied in chili pepper, cooking pepper, pimento, Jalapeno, and sweet pepper. Do not apply more than 3 pt per acre per season. See label for specific use rate for your soil type. Avoid direct contact with pepper foliage or stems. Do not apply within 70 days of harvest. See label for further instructions and precautions. **Between rows.** Can be applied as a post-directed spray on the soil at the base of the plant beneath plants and between rows. **In-row.** May be applied as a broadcast preplant incorporated surface application prior to transplanting peppers.
	trifluralin, MOA 3 (Treflan, Treflan HFP, Trifluralin HF) 4 EC	1 to 2 pt	0.5 to 1	Apply pre-transplant, and incorporate to a depth of 2 to 3 in. within 8 hr with a rototiller or tandem disk.
	bensulide, MOA 8 (Prefar) 4 EC	5 to 6 qt	5 to 6	Apply preplant incorporated (1 in. incorporation is optimum) or preemergence. With preemergence application, irrigate immediately after application. See label for directions.
PEPPERS, Preplant or Postemergence				
Annual grass and broadleaf weeds, yellow nutsedge suppression	*S*-metolachlor, MOA 15 (Dual Magnum) 7.62 EC	8 to 12 oz	0.47 to 0.7	**Bell pepper transplants only.** ***This is a Section 24(c) special local needs label. Growers must obtain label prior to making Dual Magnum applications. Growers must obtain label at www.farmassist.com*** ***Option 1:*** Apply 8 to 12 oz to the soil surface of pre-formed beds prior to laying plastic. Insure the plastic laying process does not incorporate or disturb the treated bed. ***Option 2:*** Apply 12 oz overtop of bell pepper between 1 and 3 weeks after planting. Does not control emerged weeds. Limited data are available for NC. Do not apply more than 12 oz/A as it is likely that injury will occur including decreased crop vigor. Read label for further instructions.
PEPPERS, Postemergence				
Annual and perennial grasses only	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 7 days of harvest.
	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max, Intensity One) 1 EC	6 to 8 oz 9 to 16 oz	0.094 to 0.125 0.07 to 0.125	Apply postemergence to control grasses. With Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. With Select Max, add 2 pt nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. Do not apply within 20 days of harvest.
PEPPERS, Row Middles				
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayer for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Yellow and purple nutsedge and broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75, Sandea) 75 DG	0.5 to 1 oz	0.024 to 0.048 lb	Apply to row middles as a postemergence spray. In plasticulture, do not allow spray to contact plastic. Early season application will give postemergence and preemergence control. Do not apply within 30 days of harvest. For postemergence applications, use nonionic surfactant at 1 qt per 100 gal of spray solution.
Contact kill of all green foliage	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	1.3 pt 2 pt	0.5	Apply in a minimum of 20 gal spray mix per acre as a shielded spray to emerged weeds between rows of peppers. Use a nonionic surfactant at a rate of 16 oz per 100 gal spray mix.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-18. CHEMICAL WEED CONTROL IN POTATOES, IRISH

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
POTATOES, IRISH, Preplant and Preemergence				
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	0.7 to 1.3 pt 1 to 2 pt	0.25 to 0.5	Apply in a minimum of 20 gal spray mix per acre to emerged weeds up to ground cracking before crop emergence. May be used instead of the drag-off operation to kill emerged weeds before the application of preemergence herbicides. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply prior to planting or emergence of crop. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Do not feed crop residue to livestock for 8 weeks following treatment. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and small-seeded broadleaf weeds	pendimethalin, MOA 3 (Prowl) 3.3 EC (Prowl H_2O) 3.8 AS	1.8 to 3.6 pt 1.5 to 3 pt	0.75 to 1.5 0.75 to 1.5	Apply just after planting or drag-off to weed-free soil before crop emerges or from emergence until crop reaches 6 in. tall.
Annual grasses and small-seeded broadleaf weeds, plus yellow nutsedge suppression	*S*-metolachlor, MOA 15 (Brawl, Dual Magnum, Medal) 7.62 EC (Brawl II, Dual II Magnum, Medal II) 7.64 EC	1 to 2 pt	0.95 to1.91	Apply just after planting or drag-off to weed-free soil before crop emerges. Dual Magnum can also be applied at lay-by for control of late season weeds. See label for further instruction.
	dimethenamid-P, MOA 15 (Outlook) 6 EC	12 to 21 oz	0.6 to 1	Apply just after planting or drag-off to weed-free soil before crop emerges. See label for further instruction.
Annual grasses, most broadleaf weeds, plus yellow and purple nutsedge suppression	EPTC, MOA 8 (Eptam) 7 EC	3.5 pt	3	Apply preplant and incorporate into the soil 2 to 3 in. with a rototiller or tandem disk. The variety "Superior" has been shown to be sensitive to Eptam. See label for specific methods of incorporation. For late season preemergence nutsedge control, apply and incorporate as a directed spray to the soil on both sides of the crop row.
Most annual broadleaf weeds and some annual grasses	flumioxazin, MOA 14 (Chateau) 51 SW	1.5 oz	0.047	Apply immediately after hilling. A minimum of 2 in. of soil must cover the vegetative portion of the potato plant at the time of application of Chateau. **Do NOT apply to emerged potatoes. DO NOT incorporate Chateau or weed control will be reduced.** Can be tank mixed with burndown herbicides if weeds are present at application. See label for further instructions.
	linuron, MOA 7 (Lorox DF) 50 WDG	1.5 to 3 lb	0.75 to 1.5	Apply just after planting or drag-off or hilling but before crop emerges. If emerged weeds are present, add 1 pt surfactant for each 25 gal spray mixture. Weeds may be up to 3 in. tall at time of application.
	metribuzin, MOA 5 (TriCor DF, Metri DF) 75 WDG	0.3 to 1.3 lb	0.23 to 1	Apply just after planting or drag-off but before crop emerges. Weeds may be emerged at time of application. On sand soils or sensitive varieties, do not exceed 0.67 lb per acre. See label for list of sensitive varieties.
	rimsulfuron, MOA 2 (Matrix, Pruvin) 25 WDG	1 to 1.5 oz	0.016 to 0.023	Apply after drag-off or hilling but before potatoes and weeds emerge. If emerged weeds are present, add surfactant. See label for rate. Can be tank mixed with Eptam, Prowl, Sencor, Lorox, or Dual Magnum. See label for further instructions.
POTATOES, IRISH, Postemergence				
Most annual broadleaf weeds and some annual grasses	metribuzin, MOA 5 (TriCor DF, Metri DF) 75 WDG	0.33 to 0.67 lb	0.25 to 0.5	Do not use on early maturing smooth-skinned white or red-skinned varieties. Apply only if there have been at least three successive days of sunny weather before application. Treat before weeds are 1 in. tall. Treatment may cause some chlorosis or minor necrosis. Do not apply within 60 days of harvest.
	rimsulfuron, MOA 2 (Matrix, Pruvin) 25 WDG (Pruvin) 25 WDG	1 to 1.5 oz	0.016 to 0.023	Apply to young actively growing weeds after crop emergence but before the crop exceeds 14 in. tall. More effective on small weeds. Add nonionic surfactant at 1 to 2 pt per 100 gal water. Can be tank mixed with Eptam or Sencor or some foliar fungicides. See label for further instructions.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Annual and perennial grasses only	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select 2 EC (Intensity One, Select Max) 1 EC	6 to 8 oz 9 to 32 oz	0.094 to 0.125 0.07 to 0.25	Apply postemergence for control of grasses. With Arrow, Clethodim, Intensity or Select, add 1 qt crop of oil concentrate per acre. With Intensity One or Select Max, nonionic surfactant of 2 pt per 100 gal spray mixture can be used instead of crop oil concentrate. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. Do not apply within 30 days of harvest.
	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply on days that are unusually hot and humid. Do not apply within 30 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-19. CHEMICAL WEED CONTROL IN PUMPKINS

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
PUMPKINS, Preplant and Preemergence				
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	 1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 20 gal spray mix per acre to emerged weeds before crop emergence or transplanting as a band or broadcast treatment over a preformed row. Use sufficient water to give thorough coverage. Row should be formed several days ahead of planting or treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray solution or 1 gal approved crop oil concentrate per 100 gal spray mix.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	**Not registered for use on seeded crop.** Apply prior to transplanting crop. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds at least 3 days before seeding or transplanting. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and some small-seeded broadleaf weeds	bensulide, MOA 8 (Prefar) 4 EC	5 to 6 qt	5 to 6	Apply preplant and incorporate into the soil 1 to 2 in. (1 in. incorporation is optimum) with a rototiller or tandem disk, or apply to the soil surface after seeding and follow with irrigation. Check re-plant restrictions for small grains on label. See label for use rate if Prefar 4 EC is used.
	ethalfluralin, MOA 3 (Curbit) 3 EC	3 to 4.5 pt	1.1 to 1.7	Apply to the soil surface immediately after seeding. May also be used as a BANDED spray between rows of pumpkin. See label for timing. Shallow cultivation, irrigation, or rainfall within 5 days is needed for good weed control. Do not use under mulches, row covers, or hot caps. Under conditions of unusually cold or wet soil and air temperatures, crop stunting or injury may occur. Crop injury can occur if seeding depth is too shallow.
	ethalfluralin, MOA 3 + clomazone, MOA 13 (Strategy) 2.1 L	2 to 6 pt	0.4 to 1.2 + 0.125 to 0.375	Apply to the soil surface immediately after crop seeding for preemergence control of weeds. **DO NOT APPLY PRIOR TO PLANTING CROP. DO NOT SOIL INCORPORATE.** May also be used as a **banded** treatment **between** rows after crop emergence or transplanting.
Yellow and purple nutsedge suppression, non-ALS resistant pigweed, wild radish, and ragweed	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 1 oz	0.024 to 0.048 lb	In bareground production, apply after seeding but prior to soil cracking; wait 7 d after application before transplanting. In plasticulture, apply 7 d prior to transplanting or seeding. Application may be made to preformed beds prior to laying plastic, do not disturb bed when laying plastic. Stunting will likely occur; on sandy soils delayed maturity is often noted. Use lower rates in conditions or on sandy soils. Do not apply more than 1 oz/A/crop cycle and year (includes POST and hooded applications). Rotational restrictions are a significant concern, see label.
PUMPKINS, Postemergence				
Annual and perennial grasses only	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Intensity One, Select Max) 1 EC (Select Max) 1 EC	6 to 8 oz 9 to 16 oz	0.094 to 0.125 0.07 to 0.125	Apply postemergence for control of grasses. With Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. With Select Max or Intensity One, add 2 pt of nonionic surfactant per 100 gal spray mixture. Adding crop oil concentrate may increase the likelihood of crop injury at high air temperatures. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. Do not apply within 14 days of harvest.
	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Crop oil may increase the likelihood of crop injury at high temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 14 days of harvest.
PUMPKINS, Row Middles				
Annual grasses and some small-seeded broadleaf weeds	trifluralin, MOA 3 (Treflan) 4 EC (Treflan HFP) 4 EC	1 to 1.5 pt	0.5 to 0.75	**Row middles only.** To improve preemergence control of late emerging weeds. Apply after emergence when crop plants have reached the three to four true leaf stage of growth. Apply as a directed spray to soil between the rows. Avoid contacting foliage as slight crop injury may occur. Set incorporation equipment to move treated soil around base of crop plants. Do not apply within 30 days of harvest.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or post-harvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Yellow and purple nutsedge and broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 1 oz	0.024 to 0.048 lb	**Row middles only.** Apply to row middles as a postemergence spray. In plasticulture, do not allow spray to contact plastic. Early season application will give postemergence and preemergence control. Do not apply within 30 days of harvest. For postemergence applications, use nonionic surfactant at 1 qt per 100 gal of spray solution.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-20. CHEMICAL WEED CONTROL IN RADISH

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
RADISH, Preplant				
Annual and perennial grass and broadleaf weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before planting. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations may require addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and broadleaf weeds	trifluralin, MOA 3 (Treflan, Treflan HFP, Trifluralin, Trifluralin HF) 4 EC	1 to 1.5 pt	0.5 to 0.75	Apply preplant and incorporate immediately after application for preemergence weed control. Low rate should be used on coarse-textured soil.
RADISH, Postemergence				
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Annual and perennial grasses	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max, Intensity One) 1 EC	6 to 8 oz 9 to 16 oz	0.94 to 0.125 0.07 to 0.125	Apply postemergence to emerged grasses. See label for rates for specific grasses. With Arrow, Clethodim, or Select, add crop oil concentrate at 1 gal per 100 gal of spray solution. With Select Max, add nonionic surfactant at 2 pt per 100 gal spray mixture. Do not spray within 15 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-21. CHEMICAL WEED CONTROL IN SPINACH

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
SPINACH, Preemergence				
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before crop emergence. Do not feed residue to livestock for 8 weeks. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and broadleaf weeds	cyclohexylethylthio-carbamate, MOA 3 (Ro-Neet) 6E	2 qt	3	Use on sandy mineral soils only. Read label for further instructions.
SPINACH, Postemergence				
Broadleaf weeds including sowthistle clover, cocklebur, jimsonweed, and ragweed	clopyralid, MOA 4 (Stinger) 3 EC	0.17 to 0.33 pt	0.0625 to 0.125 lb	Apply to spinach in the 2- to 5-leaf stage when weeds are small and actively growing. Will control most legumes. See label for more precautions. Do not apply within 21 days of harvest.
Broadleaf weeds	phenmedipham, MOA 6 (Spin-aid) 1.3 EC	3 to 6 pt	0.5 to 1	For processing spinach only. Do not use when expected high temperatures will be above 75 degrees F. For best results, spray when weeds are in the two-leaf stage. Use the 6-pt rate only on well-established crops that are not under stress. Do not apply within 40 days of harvest. Spinach plants must have more than six true leaves.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Row middles only. Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or post-harvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Annual and perennial grasses only	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. For sethoxydim, add 1 qt of crop oil concentrate per acre. For Arrow, Clethodim, or Select, add 1 gal of crop oil concentrate per 100 gal spray solution. For Select Max, add nonionic surfactant at 2 pt per 100 gal of spray mixture. Adding crop oil to Poast or Select may increase the likelihood of crop injury at high air temperatures. Do not apply Poast, Arrow, Clethodim, or Select on days that are unusually hot and humid. Do not apply sethoxydim within 15 days of harvest or clethodim within 14 days of harvest.
	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Intensity One, Select Max) 1 EC	6 to 8 oz 9 to 16 oz	0.094 to 0.125 0.07 to 0.125	

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-22. CHEMICAL WEED CONTROL IN SQUASH

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
SQUASH, Preplant and Preemergence				
Suppression or control of most annual grasses and broadleaf weeds, full rate required for nutsedge control	metam sodium (Vapam HL) 42%	37.5 to 75 gal	15.7 to 31.5	Rates are dependent on soil type and weeds present. Apply when soil moisture is at field capacity (100 to 125%). Apply through soil injection using a rotary tiller or inject with knives no more than 4 in. apart; follow immediately with a roller to smooth and compact the soil surface or with mulch. May apply through drip irrigation prior to planting a second crop on mulch. Plant back interval is often 14 to 21 days and can be 30 days in some environments. See label for all restrictions and additional information.
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 10 gal spray mix per acre to emerged weeds before transplanting or crop emergence as a band or broadcast treatment over a preformed row. Use sufficient water to give thorough coverage. Row should be formed several days ahead of planting or treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Not registered for seeded crop. Apply prior to transplanting crop. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds at least 3 days before seeding or transplanting. When applying Roundup before transplanting crops into plastic mulch, care must be taken to remove residues of this product from the plastic prior to transplanting. To prevent crop injury, residues can be removed by 0.5 in. natural rainfall or by applying water via a sprinkler system. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses and small-seeded broadleaf weeds	bensulide, MOA 8 (Prefar) 4 EC	5 to 6 qt	5 to 6	Apply preplant and incorporate into the soil 1 to 2 in. (1 in. incorporation is optimum) with a rototiller or tandem disk, or apply to the soil surface after seeding and follow by irrigation. Check re-plant restrictions for small grains on label.
	Bareground ethalfluralin, MOA 3 (Curbit) 3 EC	1.5 to 2 pt	0.56 to .75	**For squash grown on bareground only.** Apply to the soil surface immediately after seeding. Seed must be covered with soil to prevent crop injury. For coarse-textured soils, use lowest rate of rate range. Shallow cultivation, irrigation, or rainfall within 5 days is needed for good weed control. If weather is unusually cold or soil wet and cold, crop stunting or injury may occur. Crop injury can also occur if seeding depth is too shallow. See label for further precautions and instruction.
	Plasticulture ethalfluralin, MOA 3 (Curbit) 3 EC	3 to 4.5 pt	1.1 to 1.7	**For squash grown on plastic only**. Apply to soil surface between the rows of black plastic immediately after seeding or transplanting. **Do not use under mulches, row covers, or hot caps.** Do not apply prior to planting or over plastic. See label for further instruction.
Annual grasses and broadleaf weeds	ethalfluralin, MOA 3 + clomazone, 13 (Strategy) 2.1 L	2 to 6 pt	0.4 to 1.2 + 0.125 to 0.375	Apply to the soil surface immediately after crop seeding for preemergence control of weeds. **DO NOT APPLY PRIOR TO PLANTING CROP. DO NOT SOIL INCORPORATE.** May also be used as a **banded** treatment **between** rows after crop emergence or transplanting.
Suppression of annual grasses and broadleaf weeds; weak on pigweed and morningglory	clomazone, MOA 13 (Command) 3 ME	0.67 to 1.3 pt	0.25 to 0.48	Apply immediately after seeding or prior to transplanting. Seeds and roots of transplants must be below the chemical barriers when planting. Command should only be applied between rows when squash is grown on plastic. Some cultivars may be sensitive to Command. Use lower rates on coarse soils. See label about rotation restrictions.
Yellow and purple nutsedge and broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 1 oz	0.024 to 0.048 lb	**Row middles only.** Apply to row middles as preemergence spray. In plasticulture, do not allow spray to contact plastic. Early season application will give postemergence and preemergence control. Do not apply within 30 days of harvest. For postemergence applications, use nonionic surfactant at 1 qt per 100 gal of spray solution.
SQUASH, Postemergence				
Annual grasses and small-seeded broadleaf weeds	trifluralin, MOA 3 (Treflan) 4 EC (Treflan HFP) 4 EC	1 to 1.5 pt	0.5 to 0.75	**Row middles only.** To improve preemergence control of late emerging weeds. Apply after emergence when crop plants have reached the 3- to 4-true leaf stage of growth. Apply as a directed spray to soil between the rows. Avoid contacting foliage as slight crop injury may occur. Set incorporation equipment to move treated soil around base of crop plants. Do not apply within 30 days of harvest. Will not control emerged weeds.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	**Row middles only.** Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or post-harvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.

TABLE 4-22. CHEMICAL WEED CONTROL IN SQUASH (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
SQUASH, Postemergence (cont'd)				
Yellow and purple nutsedge and broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 1 oz	0.024 to 0.048 lb	**Row middles only.** Apply to row middles as postemergence spray. In plasticulture, do not allow spray to contact plastic. Early season application will give postemergence and preemergence control. Do not apply within 30 days of harvest. For postemergence applications, use nonionic surfactant at 1 qt per 100 gal of spray solution.
Annual and perennial grasses only	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Intensity One, Select Max) 1 EC	6 to 8 oz 9 to 16 oz	0.094 to 0.125 0.07 to 0.125	**Apply postemergence for control of grasses.** With Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. With Select Max or Intensity One, add 2 pt nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase likelihood of crop injury at high air temperatures. Very effective control of annual bluegrass. Apply to actively growing grasses not under drought stress. Do not apply within 14 days of harvest.
	sethoxydim, MOA 1 (Poast)1.5 EC	1 to 1.5 pt	0.2 to 0.3	**Apply to emerged grasses.** Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 14 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-23. CHEMICAL WEED CONTROL IN SWEETPOTATOES

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
SWEETPOTATO, Preplant				
Annual and perennial grass and broadleaf weeds, stale seed bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds before transplanting. Perennial weeds may require higher glyphosate rates. Consult label for rates for specific weeds. Certain glyphosate formulations may require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Suppression or control of most annual grasses and broadleaf weeds, full rate required for nutsedge control	metam sodium (Vapam HL) 42%	37.5 to 75 gal	15.7 to 31.5	Rates are dependent on soil type and weeds present. Plant back interval is often 14 to 21 days and can be 30 days in some environments. See label for all restrictions and additional information.
Annual broadleaf weeds including Palmer amaranth and other pigweeds, smartweed, morningglory, wild mustard, wild radish, common purslane, common lambsquarters	flumioxazin, MOA 14 (Valor SX) 51 WDG	3 oz	0.094	Apply 2 to 5 days prior to transplanting crop for control of many annual broadleaf weeds and annual sedges. Movement of soil during transplanting should not occur or reduced weed control may result. Do not use on greenhouse-grown transplants. Do not apply postemergence or serious crop injury will occur. Do not use on transplants harvested more than 2 days prior to transplanting. Do not use on transplant propagation beds. See label for further instructions.
SWEETPOTATO, Preemergence				
Annual grass and broadleaf weeds, Palmer amaranth, yellow nutsedge suppression	*S*-metolachlor, MOA 15 (Dual Magnum) 7.62 EC	0.75 pt	1.0	This is a Section 24(c) special local needs label. Growers must check *www.farmassist.com* website to make sure Dual Magnum is registered for use in their state. Obtain label from *www.farmassist.com* prior to making Dual Magnum applications. Apply over top of sweetpotatoes after transplanting but prior to weed emergence. Do not apply preplant. Do not incorporate after application. Injury potential is greatest when applied to sands or loamy sands especially if a heavy rainfall event occurs following application. See label for further information.
Annual grasses such as large crabgrass and broadleaf weeds including velvetleaf, purslane, prickly sida	clomazone, MOA 13 (Command) 3 ME	Up to 2 pt	Up to 0.75	**Posttransplant.** Apply within 5 days after transplanting for preemergence control. Weak on pigweed. See label for other instructions and precautions.
Annual grasses including large crabgrass and broadleaf weeds including purslane, Florida pusley, common lambsquarters	DCPA, MOA 3 (Dacthal) W-75 (Dacthal) 6 F	8 to 10 lb 8 to 10 pt	6 to 7.5	Apply to the soil surface immediately after transplanting. May also be applied at layby for preemergence weed control late in the growing season. Do not apply in plant beds or crop injury will occur.
Annual grasses including crabgrass, foxtail, goosegrass, fall panicum and broadleaf weeds including pigweed, Florida pusley, purslane	napropamide, MOA 15 (Devrinol, Devrinol DF-XT) 50 DF (Devrinol, Devrinol 2-XT) 2 EC	2 to 4 lb 2 to 4 qt	1 to 2	**PLANT BEDS.** Apply to the soil surface after sweetpotato roots are covered with soil but prior to soil cracking and sweetpotato plant emergence. Does not control emerged weeds. Check label for more information. **PRODUCTION FIELDS.** Apply to the soil surface immediately after transplanting. If rainfall does not occur within 24 hr, shallow incorporate or irrigate with sufficient water to wet the soil to a depth of 2 to 4 in. Check label for more information. See XT labels for information regarding delay in irrigation event.

TABLE 4-23. CHEMICAL WEED CONTROL IN SWEETPOTATOES (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
SWEETPOTATO, Postemergence				
Annual and perennial grasses only	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max, Intensity One) 1 EC	6 to 16 oz 9 to 32 oz	0.094 to 0.25 0.07 to 0.25	Apply to actively growing grasses not under drought stress. For Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. For Select Max, add 2 pt nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Very effective in controlling annual bluegrass. Do not apply within 30 days of harvest.
	fluazifop, MOA 1 (Fusilade DX) 2 EC	6 to 16 oz	0.1 to 0.25	Apply to actively growing grasses not under drought stress. Consult manufacturer's label for specific rates and best times to treat. Add 1 gal crop oil concentrate or 1 qt nonionic surfactant per 100 gal spray mix. Do not apply Fusilade on days that are unusually hot and humid. Do not apply within 55 days of harvest.
	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to actively growing grasses not under drought stress. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 30 days of harvest.
SWEETPOTATO, Row Middles				
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. May cause cracking of sweetpotato storage roots if spray solution comes in contact with sweetpotato foliage. Do not apply within 14 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-24. CHEMICAL WEED CONTROL IN TOMATOES

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
TOMATOES, Preplant				
Suppression or control of most annual grasses and broadleaf weeds, full rate required for nutsedge control	metam sodium (Vapam HL) 42%	37.5 to 75 gal	15.7 to 31.5	Rates are dependent on soil type and weeds present. Apply when soil moisture is at field capacity (100 to 125%). Apply through soil injection using a rotary tiller or inject with knives no more than 4 in. apart; follow immediately with a roller to smooth and compact the soil surface or with mulch. May apply through drip irrigation prior to planting a second crop on mulch; however, adhere to label guidelines on crop plant back interval. Plant back interval is often 14 to 21 days and can be 30 days in some environments. See label for all restrictions and additional information. Chloropicrin (150 lb/A broadcast) will also be needed when laying first crop mulch to control nutsedge.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	**Transplanted crop. Apply no later than 1 day before transplanting.** **Seeded crop. Apply no later than 7 days before planting seeded crop.** Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply to emerged weeds in a minimum of 20 gal spray mix per acre before crop emergence as a broadcast or band treatment over a preformed row. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Broadleaf weeds including Carolina geranium and cutleaf eveningprimrose and a few annual grasses	oxyfluorfen, MOA 14 (Goal) 2 XL (Goaltender) 4 F	Up to 2 pt Up to 1 pt	0.5 lb	**Plasticulture only.** Apply to soil surface of pre-formed beds at least 30days30 days prior to transplanting crop. While incorporation is not necessary, it may result in less crop injury. Plastic mulch can be applied any time after application but best results are likely if applied soon after application.

TABLE 4-24. CHEMICAL WEED CONTROL IN TOMATOES (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
TOMATOES, Preplant (cont'd)				
Annual grasses and small-seeded broadleaf weeds including common lambsquarters, pigweed, carpetweed, and common purslane	napropamide, MOA 15 (Devrinol, Devrinol DF-XT) 50 DF (Devrinol, Devrinol 2-XT) 2 EC	 2 to 4 lb 2 to 4 qt	1 to 2	**Bareground:** Apply preplant and incorporate into the soil 1 to 2 in. as soon as possible with a rototiller or tandem disk. Can be used on direct-seeded or transplanted tomatoes. See label for instructions on use. **Plasticulture:** Apply to a weed-free soil before laying plastic mulch. Soil should be well worked yet moist enough to permit a thorough incorporation to a depth of 2 inches. Mechanically incorporate or irrigate within 24 hours after application. If weed pressure is from small seeded annuals, apply to the surface of the bed immediately in front of the laying of plastic mulch. If soil is dry, water or sprinkle irrigate with sufficient water to wet to a depth of 2 to 4 inches before covering with plastic mulch. **Between rows:** Apply to a weed free soil surface between the rows (bareground or plastic mulch). Mechanically incorporate or irrigate Devrinol into the soil to a depth of 1 to 2 inches within 24 hours of application. See XT labels for information regarding delay in irrigation event.
Annual grasses and small-seeded broadleaf weeds including common lambsquarters, pigweed, carpetweed, and common purslane	pendimethalin, MOA 3 (Prowl H_2O) 3.8 AS	1 to 3 pt	0.5 to 1.5	**Plasticulture In-row.** May be applied as a preplant surface application or a preplant incorporated application prior to transplanting tomato. **Bareground In-row.** May be applied as a broadcast preplant surface application or preplant incorporated application prior to transplanting tomato. Do not apply more than 3 pt per acre per season. See label for specific use rate for your soil type. Emerged weeds will not be controlled. Prowl can be applied as a post directed spray on the soil at the base of the plant, beneath plants, and between rows. Avoid direct contact with tomato foliage or stems. Do not apply over the top of tomato. Do not apply within 21 days of harvest. See label for further instructions and precautions.
	trifluralin, MOA 3 (Treflan HFP, Trifluralin, Trifluralin HF, various other trade names) 4 EC	1 pt	0.5	Apply pretransplant and incorporate into the soil 2 to 3 in. within 8 hr using a rototiller or tandem disk
Yellow and purple nutsedge and broadleaf weeds including pigweed, wild radish, common ragweed, suppression of purslane	halosulfuron-methyl, MOA 2 (Profine, Sandea) 75 DG	0.5 to 1 oz	0.024 to 0.048	For pretransplant application under plastic mulch, apply to pre-formed bed just prior to plastic mulch application and delay transplanting at least 7 days. Early season application will give postemergence and preemergence control. The 1 oz rate is for preemergence and postemergence control in row middles. For postemergence applications, use nonionic surfactant at 1 qt per 100 gal of spray solution. Do not apply within 30 days of harvest.
Yellow nutsedge, annual grasses, and broadleaf weeds including pigweed, Palmer amaranth, Florida pusley, Hairy galinsoga, Eastern black nightshade, and carpetweed	*S*-metolachlor, MOA 15 (Brawl, Dual Magnum, Medal) 7.62 EC	1 to 2 pt	0.95 to 1.50 lb	Apply preplant or postdirected to transplants after the first settling rain or irrigation. In plasticulture, apply to preformed beds just prior to applying plastic mulch. Lower rates of rate range for S-metolachlor are safest to tomato. May also be used to treat row middles in bedded tomato. Minimize contact with crop. Do not apply within 90 days of harvest. Also registered for use in row middles, and in seeded crop. See label for further instructions.
Palmer amaranth, redroot pigweed, smooth pigweed, *Galinsoga* sp., black nightshade, Eastern black nightshade, common purslane, partial control of yellow nutsedge	fomesafen, MOA 14 (Reflex) 2 EC	1 to 1.5 pt	0.25 to 0.375	***This is a Section 24(c) special local needs label for transplanted tomato in NC. Growers must obtain the label at Farmassist.com prior to making an application of Reflex.*** **See label for further instructions.** **Plasticulture In-row Application for Transplanted Tomato.** Apply after final bed formation and the drip tape is laid but prior to laying plastic mulch. Avoid soil disturbance after application. Unless restricted by other products such as fumigants, tomato may be transplanted immediately following the application of Reflex and the application of the mulch. **Bareground for Transplanted Tomato.** Apply pretransplant up to 7 days prior to transplanting tomato. Weed control will be reduced if soil is disturbed after application. During the transplanting operation, make sure the soil in the transplant hole settles flush or above the surrounding soil surface. Avoid cultural practices that may concentrate Reflex-treated soil around the transplant root ball. An overhead irrigation or rainfall event between Reflex herbicide application and transplanting will ensure herbicide activation and will likely reduce the potential for crop injury due to splashing. **Plasticulture Row Middle Application.** Apply to row middles with a hooded or shielded sprayer. Avoid drift of herbicide on mulch. If drift occurs, 0.5 inch of rain or irrigation must occur prior to transplanting. **Carryover is a large concern; see label for more information.**
Annual grasses and broadleaf weeds including jimsonweed, common ragweed, smartweed, and velvetleaf	metribuzin, MOA 5 (TriCor DF, Metribuzin) 75 WDG (Metri) 4 F	 0.33 to 0.67 lb 0.5 to 1 pt	0.25 to 0.5	Apply to soil surface and incorporate 2 to 4 in. deep before transplanting. See label for instructions.
Annual grasses and broadleaf weeds, including cocklebur, common ragweed, smartweed, and velvetleaf	trifluralin, MOA 3 (Trifluralin) 4 EC + metribuzin, MOA 5 (Metri DF) 75 WDG	1 pt + 0.33 to 0.67 lb	0.5 + 0.25 to 0.5	Apply pretransplant and incorporate to a depth of 2 to 3 in. within 8 hr, using a rototiller or tandem disk. See label for further instructions.

TABLE 4-24. CHEMICAL WEED CONTROL IN TOMATOES (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
TOMATOES, Postemergence				
Annual grasses and small-seeded broadleaf weeds	DCPA, MOA 3 (Dacthal) W-75 (Dacthal) 6 F	 6 to 10 lb 6 to 10 pt	4.5 to 7.5	Apply over the top of transplants only between 4 to 6 wk after transplanting to improve preemergence control of late emerging weeds. Will not control emerged weeds.
Yellow and purple nutsedge and broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75) 75 DG (Sandea) 75 DG	0.5 to 1 oz	0.024 to 0.048 lb	Apply no sooner than 14 days after transplanting For postemergence applications, use nonionic surfactant at 1 qt per 100 gal of spray solution. Some weeds, such as nutsedge, may require two applications of Sandea; if a second application is needed, spot-treat only weed-infested areas. Do not apply within 30 days of harvest. See label for further instructions.
Annual grasses and broadleaf weeds, including cocklebur, common ragweed, smartweed, velvetleaf, jimsonweed, yellow nutsedge, and morningglory	metribuzin, MOA 5 (TriCor DF, Metribuzin) 75 WDG (Metri) 4 F	 0.33 to 1.33 lb 0.5 to 2 pt	0.25 to 1	Use either as a broadcast or directed spray but do not exceed 0.5 lb a.i. with a broadcast spray. Do not apply within 7 days of harvest. Do not exceed 1 lb a.i. per year. Do not apply as a broadcast spray unless 3 sunny days precede application.
Most broadleaf weeds including wild radish, common purslane, redroot and smooth pigweed	rimsulfuron, MOA 2 (Matrix) 25 WDG (Pruvin) 25 WDG	 1 to 2 oz	0.25 to 0.5 oz	Apply in tomatoes after the crop has at least two true leaves and weeds are small (1 in. or less) and actively growing. Add nonionic surfactant at 1 qt per 100 gal of spray solution. Do not apply within 45 days of tomato harvest. See label for further instruction.
Yellow nutsedge, morningglory, common cocklebur, common lambsquarters, and other broadleaf weeds	trifloxysulfuron-sodium, MOA 2 (Envoke) 75 DG	 0.1 to 0.2 oz	0.0047 to 0.0094	Apply post-directed to tomato grown on plastic for control of nutsedge and certain broadleaf weeds. Crop should be transplanted at least 14 days prior to application. The application should be made prior to fruit set and at least 45 days prior to harvest. Use nonionic surfactant at 1 qt per 100 gal spray solution with all applications.
Annual and perennial grasses only	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Select Max, Intensity One) 1 EC	 6 to 16 fl oz 9 to 32 oz	 0.094 to 0.25 0.07 to 0.25	Apply to actively growing grasses not suffering from drought stress. With Arrow, Clethodim, or Select, add a crop oil concentrate at 1% by volume (1 gal per 100 gal spray mix). With Select Max, add 2 pt of nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Do not apply on unusually hot and humid days. Very effective in controlling annual bluegrass. Do not apply within 20 days of harvest.
	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to actively growing grasses not under drought stress. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 20 days of harvest.
TOMATOES, Row Middles				
Yellow nutsedge, morningglory, common cocklebur, common lambsquarters, and other broadleaf weeds	trifloxysulfuron-sodium, MOA 2 (Envoke) 75 DG	0.1 to 0.2 oz	0.0047 to 0.0094	Crop should be transplanted at least 14 days prior to application. Use nonionic surfactant at 1 qt per 100 gal spray solution with all applications. See label for information on registered tank mixes. Tank mixtures with Select or Poast may reduce grass control. See label for more information.
Yellow and purple nutsedge and broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine, Sandea) 75 DG)	0.5 to 1 oz	0.024 to 0.048 lb	For postemergence applications, use nonionic surfactant at 1 qt per 100 gal of spray solution. Some weeds, such as nutsedge, may require two applications of Sandea; if a second application is needed, spot-treat only weed-infested areas. Do not apply within 30 days of harvest. See label for further instructions.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. .Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Annual grasses and small-seeded broadleaf weeds	napropamide, MOA 15 (Devrinol, Devrinol DF-XT) 50 DF (Devrinol, Devrinol 2-XT) 2 EC	 2 to 4 lb 2 to 4 qt	1 to 2	**Plasticulture.** Apply to a weed-free soil surface. Apply within 24 hours of rainfall, or mechanically incorporate or irrigate into the soil to a depth of 1 to 2 in.
	pendimethalin, MOA 3 (Prowl H_2O) 3.8 AS	1 to 3 pt	0.5 to 1.5	Do not apply more than 3 pt per acre per season. See label for specific use rate for your soil type. Emerged weeds will not be controlled. Avoid direct contact with tomato foliage or stems. Do not apply within 70 days of harvest. See label for further instructions and precautions.
Contact kill of all green foliage	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	 1.3 pt 2 pt	0.5 to 1	Apply for control of emerged weeds between rows of tomatoes. Do not allow spray to contract crop or injury will occur. Do not make more than 3 applications per season. Do not apply within 30 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

TABLE 4-25. CHEMICAL WEED CONTROL IN WATERMELONS

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
WATERMELONS, Preplant				
Suppression or control of most annual grasses and broadleaf weeds, full rate required for nutsedge control	metam sodium (Vapam HL) 42%	37.5 to 75 gal	15.7 to 31.5	Rates are dependent on soil type and weeds present. Apply when soil moisture is at field capacity (100 to 125%). Apply through soil injection using a rotary tiller or inject with knives no more than 4 in. apart; follow immediately with a roller to smooth and compact the soil surface or with mulch. May apply through drip irrigation prior to planting a second crop on mulch. Plant back interval is often 14 to 21 days and can be 30 days in some environments. See label for all restrictions and additional information.
Contact kill of all green foliage, stale bed application	paraquat, MOA 22 (Firestorm, Parazone) 3 SL (Gramoxone SL) 2 SL	1.3 to 2.7 pt 2 to 4 pt	0.5 to 1	Apply in a minimum of 10 gal spray mix per acre to emerged weeds before crop emergence or transplanting as a broadcast or band treatment over a preformed row. Row should be formed several days ahead of planting and treating to allow maximum weed emergence. Plant with a minimum of soil movement for best results. Use a nonionic surfactant at a rate of 16 to 32 oz per 100 gal spray mix or 1 gal approved crop oil concentrate per 100 gal spray mix.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	**Transplants only.** Apply prior to transplanting of crop. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered burndown herbicides.
Annual and perennial grass and broadleaf weeds, stale bed application	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply to emerged weeds at least 3 days before seeding or transplanting. When applying Roundup before transplanting crops into plastic mulch, care must be taken to remove residues of this product from the plastic prior to transplanting. To prevent crop injury, residues can be removed by 0.5 in. natural rainfall or by applying water via a sprinkler system. Perennial weeds may require higher rates of glyphosate. Consult the manufacturer's label for rates for specific weeds. Certain glyphosate formulations require the addition of a surfactant. Adding nonionic surfactant to glyphosate formulated with nonionic surfactant may result in reduced weed control.
Annual grasses	bensulide, MOA 8 (Prefar) 4 E	5 to 6 qt	5 to 6	Apply preplant and incorporate into the soil 1 to 2 in. (1 in. incorporation is optimum) with a rototiller or tandem disk, or apply to the soil surface after seeding and follow with irrigation. Check replant restrictions for small grains on label.
WATERMELONS, Preemergence				
Annual grasses and broadleaf weeds	clomazone, MOA 13 (Command) 3 ME	0.4 to 0.67 pt	0.15 to 0.25	Apply immediately after seeding, or just prior to transplanting. Roots of transplants must be below the chemical barrier when planting. Offers weak control of pigweed. See label for further instructions.
Annual grasses and some small-seeded broadleaf weeds	ethalfluralin, MOA 3 (Curbit) 3 EC	3 to 4.5 pt	1.1 to 1.7	Apply to the soil surface immediately after seeding. May also be used as a banded spray between rows of plastic mulch. See label for timing. Shallow cultivation, irrigation, or rainfall within 5 days is needed for good weed control. Do not use under mulches, row covers, or hot caps. Under conditions of unusually cold or wet soil and air temperatures, crop stunting or injury may occur. Crop injury can occur if seeding depth is too shallow.
Annual grasses and broadleaf weeds	ethalfluralin, MOA 3 + clomazone, MOA 13 (Strategy) 2.1 L	2 to 6 pt	0.4 to 1.2 + 0.125 to 0.375	Apply to the soil surface immediately after crop seeding for preemergence control of weeds. **DO NOT APPLY PRIOR TO PLANTING. DO NOT INCORPORATE. DO NOT APPLY UNDER MULCH.** May also be used as a banded treatment between rows after crop emergence or transplanting.
Broadleaf weeds	terbacil, MOA 5 (Sinbar) 80 WP	2 to 4 oz	0.1 to 0.2	Apply after seeding but before crop emerges, or prior to transplanting crop. With plasticulture, Sinbar may be applied preemergence under plastic mulch or to row middles. May be applied over plastic mulch prior to transplanting, or prior to punching holes into the plastic mulch for transplanting. Sinbar must be washed off the surface of the plastic mulch with a minimum of 0.5 in. of rainfall or irritation prior to punching transplant holes or transplanting watermelon. Do not apply within 70 days of harvest. See label for further instructions.
Yellow and purple nutsedge suppression, pigweed and ragweed control	*Bareground/Plasticulture* halosulfuron-methyl, MOA 2 (Profine 75, Sandea) 75 DG	0.5 to 0.75 oz	0.024 to 0.036	**Bareground.** Apply after seeding but before cracking or prior to transplanting crop. **Plasticulture.** Application may be made to preformed beds prior to laying plastic. If application is made prior to planting, wait 7 days after application to seed or transplant. Stunting may occur but should be short lived with no negative effects on yield or maturity in favorable growing conditions. **SEE LABEL FOR INFORMATION ON ROTATION RESTRICTIONS AND OTHER RESTRICTIONS.**
	Row Middles Only halosulfuron-methyl, MOA 2 (Profine 75, Sandea) 75 DG	0.5 to 1 oz	0.024 to 0.048	**Row middles only.** Apply to row middles as a preemergence spray. In plasticulture, do not allow spray to contact plastic. Early season application will give postemergence and preemergence control. Do not apply within 57 days of harvest. For postemergence applications, use nonionic surfactant at 1 qt per 100 gal of spray solution.

TABLE 4-25. CHEMICAL WEED CONTROL IN WATERMELONS (cont'd)

Weed	Herbicide, Mode of Action Code* and Formulation	Amount of Formulation Per Acre	Pounds Active Ingredient Per Acre	Precautions and Remarks
WATERMELONS, Postemergence				
Annual grasses and some small seeded broadleaf weeds	DCPA, MOA 3 (Dacthal) W-75 (Dacthal) 6 F	 8 to 10 lb 8 to 10 pt	6 to 7.5	**Not labeled for transplanted crop.** To improve preemergence control of late emerging weeds, apply only when crop has 4 to 5 true leaves, is well-established, and growing conditions are favorable. Will not control emerged weeds. Incorporation not recommended.
Annual and perennial grasses only	clethodim, MOA 1 (Arrow, Clethodim, Intensity, Select) 2 EC (Intensity One, Select Max) 1 EC	 6 to 8 oz 9 to 16 oz	 0.094 to 0.125 0.07 to 0.125	Apply postemergence for control of grasses. With Arrow, Clethodim, or Select, add 1 gal crop oil concentrate per 100 gal spray mix. With Select Max, add 2 pt nonionic surfactant per 100 gal spray mixture. Adding crop oil may increase the likelihood of crop injury at high air temperatures. Very effective in controlling annual bluegrass. Apply to actively growing grasses not under drought stress. Do not apply within 14 days of harvest.
	sethoxydim, MOA 1 (Poast) 1.5 EC	1 to 1.5 pt	0.2 to 0.3	Apply to emerged grasses. Consult manufacturer's label for specific rates and best times to treat. Add 1 qt of crop oil concentrate per acre. Adding crop oil to Poast may increase the likelihood of crop injury at high air temperatures. Do not apply Poast on days that are unusually hot and humid. Do not apply within 14 days of harvest.
WATERMELONS, Row Middles				
Annual grasses and some small-seeded broadleaf weeds	trifluralin, MOA 3 (Treflan HFP, Trifluralin, Trifluralin HF) 4 EC	1 to 2 pt	0.5 to 0.75	To improve preemergence control of late emerging weeds. Apply after emergence when crop plants have reached the three to four true leaf stage of growth. Apply as a directed spray to soil between the rows. Avoid contacting foliage as slight crop injury may occur. Set incorporation equipment to move treated soil around base of crop plants. Do not apply within 60 days of harvest. Will not control emerged weeds.
	pendimethalin, MOA 3 (Prowl H_2O) 3.8 AS	Up to 2.1 pt	Up to 1	May be applied sequentially in bareground and plasticulture production systems at a minimum of 21 days apart. Refer to label for specific instructions.
Broadleaf weeds	terbacil, MOA 5 (Sinbar) 80 WP	2 to 4 oz	0.1 to 0.2	With plasticulture, Sinbar may be applied to row middles. Do not apply within 70 days of harvest. See label for further instructions.
Most broadleaf weeds less than 4 in. tall or rosettes less than 3 in. in diameter; does not control grasses	carfentrazone-ethyl, MOA 14 (Aim) 1.9 EW or 2 EC	Up to 2 oz	Up to 0.031	Apply post-directed using hooded sprayers for control of emerged weeds. If crop is contacted, burning of contacted area will occur. Use a nonionic surfactant or crop oil with Aim. See label for rate. Coverage is essential for good weed control. Can be tank mixed with other registered herbicides.
Most emerged weeds	glyphosate, MOA 9 (numerous brands and formulations)	See labels	See labels	Apply as a hooded spray in row middles, as shielded spray in row middles, as wiper applications in row middles, or postharvest. To avoid severe injury to crop, do not allow herbicide to contact foliage, green shoots, stems, exposed, roots, or fruit of crop. Do not apply within 14 days of harvest.
Yellow and purple nutsedge and broadleaf weeds	halosulfuron-methyl, MOA 2 (Profine 75, Sandea) 75 DG	0.5 to 1 oz	0.024 to 0.048	Apply to row middles as a postemergence spray. In plasticulture, do not allow spray to contact plastic. Early season application will give postemergence and preemergence control. For postemergence applications, use nonionic surfactant at 1 qt per 100 gal of spray solution. Do not apply within 57 days of harvest.

* Mode of action (MOA) code developed by the Weed Science Society of America.

Emergency Numbers by State

POISON CONTROL CENTERS

Poison Centers maintain a 24-hour consultant service in diagnosis and treatment of human illness resulting from toxic substances. Make sure that your physician knows tthe Poison Center's telephone number and do not hesitate to call in case of an emergency.

Alabama Poison Control Center
1-800-222-1222

Florida
1-800-222-1222

Georgia
1-800-222-1222

Kentucky
1-800-222-1222

Louisiana Poison Control Center
1-800-222-1222

Mississippi AgroMedicine Program
1-800-738-9898 or (601) 354-7660

North Carolina – Carolinas Poison Center
1-800-222-1222

Oklahoma Poison Control Center
1-800-222-1222

South Carolina – Palmetto Poison Center
1-800-222-1222

Tennessee Poison Control Center
1-800-222-1222

Texas Poison Control Network
1-800-222-1222

Virginia Poison Control Center
1-800-222-1222

PESTICIDE SPILLS

Alabama – CHEMTREC
1-800-424-9300 (24 hours)

Florida
1-800-424-9300 (24 hours)

Georgia
1-800-241-4113 (24 hours)

Kentucky – CHEMTREC
1-800-424-9300 (24 hours)

Louisiana
1-855-452-5323

Mississippi – CHEMTREC
1-800-424-9300 (24 hours)

North Carolina
1-800-262-8200 (24 hours)

South Carolina – SCDHEC
1-888-481-0125 (24 hours)

Oklahoma - DEQ
1-800-522-0206

Tennessee – CHEMTREC
1-800-262-3300

Texas – CHEMTREC
1-800-424-9300 (24 hours)

Virginia – CHEMTREC
1-800-424-9300 (24 hours)

HAZARDOUS MATERIAL CLEANUP

Alabama
(334) 260-2700 after 5 pm (334) 242-4378

Florida – Florida Highway Patrol
(850) 617-2000

Georgia – Georgia Highway Patrol
*GSP (*477)

Kentucky
1-800-928-2380

Louisiana
1-855-452-5323

Mississippi Highway Patrol
(601) 352-9100

North Carolina – NC Highway Patrol
1-800-662-7956

South Carolina – SCDHEC
1-888-481-0125 (24 Hours)

Oklahoma – Oklahoma Highway Patrol
*55 (or DEQ Land Protection Div. (405) 702-5100)

Tennessee
1-800-262-3300

Texas
1-800-424-9300 (24 hours)

Virginia
1-800-424-8802

PESTICIDE CONTAINER RECYCLING

Alabama
(334) 242-2640

Florida
(352) 392-4721

Georgia
(404) 656-4958

Kentucky
1-800-205-6543

Louisiana
1-855-452-5323

Mississippi
(601) 961-5171

North Carolina
(919) 733-3556

South Carolina
1-800-654-3145

Oklahoma
(405) 744-5531

Tennessee
1-800-654-3145

Texas
See note below*

Virginia
(804) 371-6560

MISUSE OF PESTICIDES

It is a violation of law to use any pesticide in a manner not permitted by its labeling. To protect yourself, never apply any pesticide in a manner or for a purpose other than as instructed on the label or in labeling accompanying the pesticide product that you purchase. Do not ignore the instructions for use of protective clothing and devices and for storage and disposal of pesticide wastes, including containers. All recommendations for pesticide use included in this manual were legal at the time of publication, but the status of registration and use patterns are subject to change by actions of state and federal regulatory agencies.

* In Texas, pesticide container recycling is not required as according to state law "properly rinsed agricultural chemical containers are not classified as hazardous waste."

Recommendations for the use of agricultural chemicals and other products are included in this publication as a convenience to the reader. The use of brand names and any mention or listing of commercial products or services in this publication does not imply endorsement by Auburn University, Clemson University, Louisiana State University, Mississippi State University, North Carolina State University, Oklahoma State University, Texas A&M, University of Florida, University of Georgia, University of Kentucky, University of Tennessee, and Virginia Tech nor discrimination against similar products or services not mentioned. Recommendations and labels will vary from state to state, and we have made every attempt to assure that these exceptions are noted. However, individuals who use agricultural chemicals are responsible for ensuring that the intended use complies with current regulations and conforms to the product label in their respective home state. Be sure to obtain current information about usage regulations and examine a current product label before applying any chemical. For assistance, contact your county Cooperative Extension Service agent.

NC STATE UNIVERSITY

TEXAS A&M AGRILIFE EXTENSION

AUBURN UNIVERSITY

UF | IFAS Extension
UNIVERSITY of FLORIDA

CLEMSON UNIVERSITY
SOUTH CAROLINA
1889

University of Georgia
1785

LSU AgCenter
Research & Extension

UK
UNIVERSITY OF KENTUCKY

MISSISSIPPI STATE UNIVERSITY

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Mississippi Fruit and Vegetable Growers Association

LOUISIANA
FRUIT AND VEGETABLE GROWERS ASSOCIATION

North Carolina
Vegetable Growers Association

South Carolina
FRUIT, VEGETABLE & SPECIALTY CROP ASSOCIATION