

Commercial Vegetable Production Recommendations

Delaware

2008



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NOT TO BE USED BY HOME GARDENERS

The use of any pesticide inconsistent with the label directions is a violation of Federal law.

Preface

This copy of the *Delaware Commercial Vegetable Production Recommendations for 2008*, replaces all previous editions. Information presented in this publication is based on research results from University of Delaware; University of Maryland; The Pennsylvania State University; Rutgers, The State University of New Jersey; Virginia Polytechnic Institute and State University; and the U.S. Department of Agriculture, combined with industry and grower knowledge and experience.

This vegetable production guide is intended for the commercial vegetable grower who has to make numerous managerial decisions. Although the proper choice of the variety, pesticide, application, equipment, fertilizer, and cultural practice is the individual vegetable grower's responsibility, these recommendations should facilitate decision-making. Recommended planting dates will vary across the five-state region. Local weather conditions, grower experience, and variety may facilitate successful harvest on crops planted outside the planting dates listed in this guide. This can be evaluated in consultation with the local county agents and state specialists. Government agencies and other organizations administering crop insurance programs or other support programs should contact the local county agents and/or state vegetable specialists for guidance.

The publication will be revised annually to include new information that evolves in the rapidly changing vegetable industry. Your county agricultural agent will send you important changes in recommendations as they occur during the year. Also, he or she will answer any questions you may have regarding specific recommendations.

The authors welcome constructive criticism and suggestions from growers and industry personnel who may wish to help improve future editions of this publication.

Days Wait between Last Pesticide Application and Harvest

Minimum days between last application and harvest for insecticides and fungicides are listed in tables at the end of the Insect Control section for each crop. *The minimum number of days between last application of herbicide and harvest is listed in Table E-3.* **To avoid deleterious chemical residues from occurring on harvested crops, heed this warning.**

Trade or Brand Names

The trade or brand names given herein are supplied with the understanding that no discrimination is intended and no endorsement by the Delaware Cooperative Extension is implied.

Pesticide-User Responsibility

Always follow the label and use pesticides safely. For special Local-Needs Label [24(c)] registrations or Section 18 exemptions, do not use the material without a copy of the special label or written instructions from your Rutgers Cooperative Research & Extension agent or another recognized authority. Remember, the user is always responsible for the proper use of pesticides, residues on crops, storage and disposal, as well as for damage caused by drift.

State and federal pesticide regulations are presently being revised. Be sure to determine if these changes apply to your situation. Using the material inconsistent with label directions is illegal.

Pest Management

Guidelines and information about current pest activity are provided in pest management hot-line reports. These reports furnish accurate information for the timing of pesticide applications, aiding in more effective control. To receive this report, contact your state Extension pest management specialist. Toll-free telephone number is 1-800/345-7544; out of state, call 302/831-8851.

See Table D-6 for Reentry Information Listed under Toxicity of Chemicals.

See Poison Control Centers Listed on Back Cover.

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Pesticide Precautionary Statement

The pesticides recommended in this publication are designed to be toxic to target pests. They can be hazardous to human health and the environment if used improperly. Follow all label directions, precautions, and restrictions. Remember, any use of a pesticide that is inconsistent with its label is a violation of federal law, and the user can be liable for injury and damages resulting from misuse.

State and federal pesticide regulations are presently being revised. Be sure to determine if these changes apply to your situation. Using the material inconsistent with label directions is illegal.

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ABBREVIATIONS

A	- acre(s)	Committee	pt	- pint(s)	
/A	- per acre	FR 0,1,2	- <i>Fusarium</i> wilt resistance to race 0,1,2	PT	- <i>Phytophthora</i> tolerant
AFR	- anthracnose and <i>Fusarium</i> wilt resistant	FR 2	- <i>Fusarium</i> wilt resistance to race 2	P ₂ O ₅	- available phosphoric acid
ai	- active ingredient	FS	- <i>Fusarium</i> and <i>Stemphylium</i> wilt resistant	PVX	- potato virus X
ALS	- acetolactate synthase	ft	- foot (feet)	PVY	- potato virus Y
ALSR	- angular leaf spot resistant	FT	- <i>Fusarium</i> tolerant	Py	- premature yellow
AMV	- alfalfa mosaic virus	g	- gram	PYO	- pick-your-own
AR	- anthracnose resistant	G	- granule(s)	qt	- quart(s)
ASC	- <i>Alternaria</i> stem canker resistant	gal	- gallon(s)	RKR	- root-knot nematode resistant
BAW	- beet armyworm	GMO	- genetically modified organism	RR	- rust resistant
BLSR	- bacterial leaf spot resistance	GPA	- green peach aphid	RSR	- red stele resistant
BRR	- black rot resistant	gpm	- gallons per minute	S	- sprayable
BRT	- black rot tolerant	GS	- green stem	S	- <i>Stemphylium</i>
BSP	- bacterial speck resistant	ICW	- imported cabbageworm	SB	- sap beetle
<i>Bt or B.t.</i>	- <i>Bacillus thuringiensis</i>	in	- inch(es)	SC	- spray concentrate, soluble concentrate
Btu	- British thermal unit	INSV	- impatiens necrotic spot virus	SG	- soluble granules
bu	- bushel(s)	IRAC	- Insecticide Resistance Action Committee	SMR	- scab and mosaic resistant
BV-1	- bean common mosaic virus resistant or tolerant	K	- potassium	SmR	- smut resistant
BV-2	- bean yellow mosaic virus resistant or tolerant	K ₂ O	- available potash	SMV	- squash mosaic virus
BWMS	- bacterial wilt moderately susceptible	L	- liquid	SP	- soluble powder
BWR	- bacterial wilt resistant	lb	- pound(s)	SpR	- split resistance
BWS	- bacterial wilt susceptible	LBR	- leaf blight resistant	sq ft	- square foot (feet)
°C	- degrees Celsius	LBT	- leaf blight tolerant	SR	- scab resistant
cc	- cubic centimeter(s)	LC	- liquid concentrate	SWV	- spotted wilt virus resistant
CEC	- cation exchange capacity	LF	- liquid flowable	T	- trial
CEW	- corn earworm	LMV	- lettuce mosaic virus	TAW	- true armyworm
CL	- cabbage looper	LR	- leaf roll resistant	TBR	- tipburn resistant
CMS	- cucumber mosaic susceptible	MA	- melon aphid	tbs	- tablespoon(s)
CMV	- cucumber mosaic virus	MDMR	- maize dwarf mosaic resistant	TEV	- tobacco etch virus
CPB	- Colorado potato beetle	ME	- microencapsulated	TMV	- tobacco mosaic virus
CRR	- corky root resistant	min	- minimum	tsp	- teaspoon(s)
cu ft	- cubic foot (feet)	MMR	- mildew and mosaic resistant	TSSM	- two-spotted spider mite
cu yd	- cubic yard(s)	mph	- miles per hour	TSWV	- tomato spotted wilt virus
cwt	- hundredweight	MoA	- mode of action	TuMV	- turnip mosaic virus
D	- dust	MR	- mosaic resistant	VF	- <i>Verticillium</i> and <i>Fusarium</i> wilt resistant
DBM	- diamondback moth	MT	- mosaic tested	VFN	- <i>Verticillium</i> , <i>Fusarium</i> , and nematode resistant
DF	- dry flowable	N	- nitrogen	VFFN	- <i>Verticillium</i> , <i>Fusarium</i> race, 0, 1, nematodes
DMR	- downy mildew resistant	NTL	- no time limitation	VFS	- <i>Verticillium</i> , <i>Fusarium</i> , and <i>Stemphylium</i> wilt resistant
DMMR	- downy mildew moderate resistance	NY-15	- resistant or tolerant to NY-15 strain of bean common mosaic virus	VR	- <i>Verticillium</i> wilt resistant
DP	- dry prill	OF	- oil formulation	VS	- <i>Verticillium</i> wilt susceptible
DS	- dry salt	OLF	- other labeled formulations	W	- wettable
E	- emulsion	opt	- optimum	WBE	- water-based emulsion
EBR	- early blight resistant	OS	- ozone sensitive	WDG	- water dispersible granules
EC	- emulsifiable concentrate	OT	- ozone tolerant	WDL	- water-dispersible liquid
ES	- emulsifiable suspension	oz	- ounce(s)	wk	- week(s)
EVR	- enation virus resistant or tolerant	%	- percent	WMV	- watermelon mosaic virus
EW	- emulsion in water	P	- phosphorus	WMV2	- watermelon mosaic virus race 2
F	- flowable	PGR	- plant growth regulator	WP	- wettable powder
°F	- degrees Fahrenheit	PHI	- preharvest interval	WRR	- white rust resistant
F ₁	- hybrid	POA	- potato aphid	WRT	- white rust tolerant
FAW	- fall armyworm	pl	- plant(s)	WSB	- water-soluble bag
FB	- flea beetle	PMR	- powdery mildew resistant	WSP	- water-soluble packet
FC	- flowable concentrate	PMT	- powdery mildew tolerant	yr	- year(s)
fl	- fluid	ppi	- preplant incorporated	YR	- yellows resistant
FM	- flowable microencapsulated	ppm	- parts per million	ZYMV	- zucchini yellow mosaic virus
FR	- <i>Fusarium</i> wilt resistant	Pr	- processing	ZYMVR	- zucchini yellow mosaic virus resistant
FRAC	- Fungicide Resistance Action	PR	- <i>Phytophthora</i> resistant		
		PRR	- pink root resistant		
		PRSV	- papaya ring spot virus		
		PRT	- pink rot tolerant		
		psi	- pounds per square inch		

2008 REVISIONS

(Attach changes, local-use information, and corrections here.)

GENERAL PRODUCTION RECOMMENDATIONS

VARIETIES

New varieties and strains 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. Varieties are listed in the specific crop in Section F, either alphabetically or in order of relative time to maturity from early to late (see table footnotes). These varieties are believed to be suitable for commercial production under most conditions common to the mid-atlantic U.S. production region. The variety tables in Section F also indicate if these are geographical differences in varietal performance within the Mid-Atlantic Region. 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. A small trial planting for several years is suggested for any variety or strain not previously grown. For a true comparison, always include a standard variety in the same field or planting.

Plant Resistance or Tolerance

Genetic disease resistance or tolerance is a common feature of varieties of vegetable crops. The response of a crop to a disease may deviate from the predicted response. This deviation may be due to different strains and races of disease-causing organisms and environmental conditions that favor the organism or reduce natural plant resistance. Letters in parentheses () appearing after the variety names refer to the genes for disease resistance or tolerance they contain and are coded in the "Abbreviations" section in the front of this book.

SEED STORAGE AND HANDLING

Both high temperature and relative humidity will reduce seed germination and vigor. Do not store seed in storage areas that have a combined temperature and humidity value greater than 110 (i.e., 50°F [12.8°C] + 60 percent relative humidity). Ideal storage conditions for most seed are at a temperature of 32°F (0°C) and less than 40 percent relative humidity. In addition, primed seeds pretreated with salt water do not store well after shipment to the buyer. Seed pelleting may or may not affect germination. Therefore, if you do not use all the pelleted seed ordered in the same season, perform a germination test to assess viability before using in subsequent seasons.

Corn, pea, and bean seed are especially susceptible to mechanical damage due to rough handling. Seed containers of these crops should not be dropped or thrown since the seed coats and embryos can crack, resulting in a nonviable seed. If you plan to treat these seed with a fungicide, inoculum, or other chemical application, use only gentle agitation to avoid seed damage.

SPECIALTY VEGETABLES

Highly perishable specialty or "gourmet" vegetables offer promise for increased local production. Before planting the crop, however, **growers must determine that specific retail, wholesale, restaurant, or processing markets exist.** Specialty vegetables often require investment in specific types of equipment, and new field preparation or management techniques.

Growers should also be aware that a very limited number of pesticides is registered for many specialty vegetables and herbs. Successful pest control in these crops is mostly dependent on sanitation, seed treatment, crop rotation, planting site, mechanical cultivation, and the use of resistant varieties. Other methods include the release of biological control agents, conservation of natural and introduced biological control agents through strip cropping, intercropping, and borders with habitats, physical exclusion or repulsion of pests, trap crops, and mechanical cultivation.

Promising perishable crops are asparagus, Belgium endive, dandelion (blanched), greens (collard, kale, mustard, turnip, and tyfon), herbs, oriental vegetables, red leaf lettuce types, romaine lettuce (red and green types), scallions, snap beans (small sieve, harvested less mature), snap peas, snow peas, and sweet corn types with enhanced sugar and high quality.

Less perishable types that offer promise are bok choy, Chinese cabbage, endive and escarole (blanched), garlic (pink skin), leeks, pak choi, red radicchio, rhubarb, sweet onions, and sweet potatoes (moist types with unusual color).

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

Varieties of vegetables and types of commodities that cater to the special needs of ethnic groups have also expanded in popularity.

ORGANIC PRODUCTION

Vegetable growers may wish to consider organic production. Initial investment is high, partially related to certification costs and increased time and labor for management. However, returns can be higher than conventionally produced products, provided that a market exists. The USDA regulates the term 'organic' to protect the sector from profiteers. To become certified organic, growers must follow production and handling practices contained in the National Organic Standards (NOS) and be certified by a USDA accredited certifying agency such as the Northeast Organic Farmers Association (NOFA). Growers whose annual gross income from organic products is \$5,000 or less can be exempted from certification. In this case growers must continue to use production and handling practices in accordance with the NOS and some restrictions regarding

labeling and combination with other organic products apply. Certified organic production is typically preceded by a three-year transition phase during which the farming system undergoes many changes.

Growers should recognize that successful organic production is a long-term proposition. It usually takes a couple of years, and may take as many as four years, for a site managed organically to reach a level of production equivalent or superior to conventional practices. Organic production is management-intensive, and requires careful attention to the maintenance of a biological equilibrium favorable for crop production. Organic certification gives growers increased market access, but requires learning new production methods and documenting production practices through careful record keeping. However, when implemented well, organic methods can improve soil fertility and tilth through increased soil microorganisms and improved organic matter recycling. Benefits from organic production can also include increased crop resistance to environmental stresses and improved produce quality.

Growers may wish to consider the following questions before initiating organic production.

- Does a market for organic vegetables exist?
- Are adequate resources available?
- Would you be able to ride out possible reduced yields without premium prices during 3 or more years of the transition phase?
- Are you willing to devote more time to monitoring pests?
- Are you willing to devote more time to managing soil fertility?
- Are you willing to devote more time to record keeping?

If you answered “yes” to all of the above questions, then organic production may be for you.

Growers who are beginning the transition phase from non-organic to organic production may wish to consider a pre-transition phase if pest pressures are high in the planting area. A pre-transition phase is intermediate between organic and non-organic production. During the pretransition phase conventional pest management tactics are used along with organic tactics to reduce pest pressures. Once pest pressures are reduced organic pest management tactics are used exclusively.

TRANSPLANT GROWING

These recommendations apply only to plants grown under controlled conditions in greenhouses or hotbeds. Field-grown plants are covered under the specific crop in Section F. A transplants are affected by such factors as temperature, fertilization, water, and spacing. A good transplant is grown under the best possible conditions. A poor transplant usually results in poor crop performance. In certain instances, the exposure of transplants to specific stresses can enhance later performance by the crop in the field.

Table A-1 presents optimum and minimum temperatures for seed germination and plant growing, the time and spacing (area) required to produce a desirable transplant, and number of plants per square foot.

Table A-1. Optimum and Minimum Temperatures and Planting Recommendations for Transplant Production

Crop	°F Opt. Day	°F Min. Night	Weeks to Grow	Sq In per Plant	Plants per Sq Ft
Broccoli	65-70	60	6-7	3	48
Cabbage	65	60	6-7	3	48
Cauliflower	65-70	60	6-8	3	48
Celery	65-70	60	9-12	3	48
Cucumber ¹	70-75	65	2-3	4	36
Eggplants	70-85	65	7-9	6-9	24
Endive, Escarole	70-75	70	5-7	2	72
Lettuce	60-65	40	5-6	1	144
Melons ¹	70-75	65	2-3	6	24
Onions	65-70	60	9-12	--	--
Peppers	70-75	60	8-9	4-6	36
Summer squash ¹	70-75	65	2-3	4	36
Sweet potatoes	75-85		4-5	in bed	in bed
Tomatoes	65-75	60	5-6	6-9	24

¹ Seed directly in container; do not transplant prior to setting in the field.

Plant-Growing Mix. A good, lightweight, disease-free, plant-growing material can be made from a mixture of peat and vermiculite. The formula for a very simple mix is given in Table A-2, but a preferred formulation is shown in Table A-3. If plants are to be grown in mix longer than 8 weeks, use the formula in Table A-3.

Table A-2. Simple Plant-Growing Mix

Materials	Cubic Yard (22 Bushels)	2 Bushels
Shredded sphagnum peat moss	11 bu	1 bu (10 gal)
No. 2, 3, or 4 domestic or African vermiculite ¹ or horticultural grade (dust-screened)	11 bu	1 bu (10 gal)
Pulverized limestone		
use <i>dolomitic</i> lime for mixes made with <i>domestic</i> vermiculite	10 lb	1 lb (1¼ cups)
or use <i>calcitic</i> lime mixes made with <i>African</i> vermiculite	6 lb	9 oz (¾ cup)
Superphosphate (20% P ₂ O ₅) or Triple superphosphate (46% P ₂ O ₅)	2½ lb	4 oz (½ cup)
Fertilizer (5-10-10)	1¼ lb	2 oz (¼ cup)
	5 lb	8 oz (1 cup)

¹ Vermiculite should be pea-sized and relatively free of fines and dust. Final mix should have a pH of 6.0-6.5.

Notes. Good results for growing lettuce and cabbage transplants have been obtained by diluting this mix with an equal part of sand.

This mix will only get the seedlings up. Supplemental fertilizing will be needed to grow plants to transplant size. About 3 weeks after seeding, begin liquid fertilizing the plants with a soluble fertilizer, such as a 20-20-20, at the rate of 2-3 teaspoons per gallon of water. This rate should be applied at least weekly. More frequent applications may be desirable.

Table A-3. Preferred Plant-Growing Mix

Materials	Cubic Yard	
	(22 Bushels)	2 Bushels
Shredded sphagnum peat moss	11 bu	1 bu (10 gal)
No. 2, 3, or 4 domestic vermiculite ¹ or horticultural grade (dust-screened) <i>or</i>	11 bu	1 bu (10 gal)
African vermiculite ¹	11 bu	1 bu (10 gal)
Pulverized limestone use <i>dolomitic</i> lime for mixes made with <i>domestic</i> vermiculite <i>or</i> use <i>calcitic</i> lime mixes made with <i>African</i> vermiculite	10 lb	1 lb (1¼ cups)
Superphosphate (20% P ₂ O ₅) or Triple superphosphate (46% P ₂ O ₅)	6 lb	9 oz (¾ cup)
Sulfate or muriate of potash (50%-60% K ₂ O)	2½ lb	4 oz (½ cup)
Osmocote ² (18-6-12)	¼ lb	2 oz (¼ cup)
Tomatoes	½ lb	1 oz (2 tbs)
Eggplants	4 lb	6 oz (¾ cup)
Peppers	8 lb	12 oz (1½ cups)
Micronutrient mix	8 lb	12 oz (1½ cups)
Wetting agent (such as Aqua-Gro granular)	Use according to mfr.'s recommendations	
	1½ pt	1 oz (4 tbs)

¹ Vermiculite should be approximately pea-sized and relatively free of fines and dust. Final mix should have a pH of 6.0-6.5.

² Osmocote is a slow-release fertilizer. Use a formula that will release nutrients over a period of 8 to 9 months. Therefore, mixes should be made just prior to seeding. Plants grown in mixes containing Osmocote must be carefully watered and the temperature carefully controlled prior to field planting. Reduced rates are suggested to control plant height when using small cells.

Regardless of which formula is chosen, unless good mixing procedures are used, the results will be less than optimal. For best mixing, use a horizontal-type paddle mixer that folds or blends the components, such as lime and fertilizer, evenly throughout the mix. With tilted or other types of mixers, the components tend to segregate or separate out, resulting in erratic performance of the mix.

Good procedures to follow when preparing a mix are:

1. Use a respirator to prevent inhalation of dust when mixing peat, vermiculite and additives.
2. For small quantities of mix preparation--1 cubic yard or less--place 4 to 5 inches of vermiculite in the bottom of a 5-gallon pail. Add all the additives (lime, fertilizer, micronutrient, etc.) to the vermiculite in the pail and mix thoroughly.
3. Fluff the recommended amount of peat. Start mixer and begin blending the peat.
4. While blending, add water according to the dampness of the peat. You will need approximately 1 gallon of water per bushel of peat in the mix.
5. While blending, slowly pour the additives, which you have already mixed thoroughly with a small amount of vermiculite, into the mixer and blend for 3 to 5 minutes.
6. Add the recommended amount of vermiculite after the other ingredients and blend for 1 minute or less, depending on the consistency of the vermiculite. It

should be mixed thoroughly without breaking down. Soon after mixing, use the mix for growing your plants. It is not a good practice to stockpile the mix in large piles for long periods of time.

Remember, the success of using the mix and obtaining excellent plants is very dependent upon good mixing procedures. Also, read all labels of the ingredients used, and heed all warnings that may be marked on the labels or bags.

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, which may hold excessive water and have poor aeration. **Have media formulations tested by your state soil test laboratory to determine the pH and nutrient levels in the media before planting.**

If plants are yellow, growing slowly, or stunted due to high pH (7.0 or higher) in the growing medium, drench seedlings in trays with a solution containing 1 to 1.5 pounds iron sulfate (FeSO₄) per 100 gallons of water. Rinse seedlings after drenching.

Treatment of Flats and Trays. Flats used in the production of transplants should be new to avoid pathogens that cause damping-off and other disease problems. If flats and trays are to be reused, they should be thoroughly cleaned after use and disinfected as described below. Permit flats to dry completely prior to use. One of the following methods of disinfestation should be used:

Chlorine bleach. Dip in the chlorine bleach solution several times. Cover treated flats and trays with a tarp to keep them wet overnight. Wash flats and trays with clean water or a Q-salt to eliminate the chlorine. It is important that the bleach solution remains below pH 6.8 and that new solutions be made up every 2 hours or whenever it becomes dirty. Organic matter will remove the active ingredients quickly.

Q-salts (Quaternary ammonium chloride salts). Compounds such as Greenshield, Physan and Prevent can be applied in the final wash of flats and trays during the chlorine treatment. Additionally, they can be used to wash exposed surfaces (benches, frames, etc.) in greenhouses.

Plant Containers. Individual plant-growing containers should be used for vine crops and early market crops of tomatoes, peppers, and eggplant. Various types of fiber or plastic pots or cubes are available for this purpose. If plastic pots are reused, disinfest as described for flats.

Seed Germination. Seed that is sown in flats to be "pricked out" at a later date should be germinated in straight vermiculite (horticultural grade, coarse sand size) or a plant growing mix. However, it is recommended that no fertilizer be included in the mix or the vermiculite 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 below.

Seedlings can be held for 3 to 4 weeks 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.

For earlier, more uniform emergence, germinate and grow seedlings on benches or in a floor-heated greenhouse. If floor heat or benches are not available, seed the trays, water, and stack them off the floor during germination. **Caution:** be sure to unstack trays before seedlings emerge from the soil surface.

Plant Growing Facilities. Good plant-growing facilities (greenhouses) provide maximum light to the seedling crop. The glass or plastic glazing should be clean, clear, and in good repair. The ideal greenhouse will also have soil-heating capabilities, either on the benches or on the floor, and provide good heating and ventilation systems for effective environmental control. Proper soil temperature ensures uniformity of crop throughout the greenhouse by moderating normal temperature variations experienced with hot air heating systems. Soil heating and growing the crops on the floor provide for a significant energy savings because the greenhouse does not have to be operated 10°F higher than the required soil temperatures for good germination and seedling growth. Heating units are best located in sheds or a headhouse outside the growing area to minimize the chance for aerial pollution adversely affecting the seedlings. Units located inside the greenhouse must be vented and have an outside fresh-air intake to provide air to the heater. The heating and ventilation thermostats must have a wide difference in temperature setting to insure that the exhaust fans do not operate when the heating units are running. Improperly designed ventilation systems that draw in exhaust gases from internal combustion engines can cause yellowing, stunting, and death of the seedlings. Ventilation units must be adequate in size, providing 1.2 to 1.4 sq ft of opening for each 1,000 cubic feet per minute (cfm) fan capacity. Seedlings should not be grown or held in areas where pesticides are stored.

Liquid Feeding. If nutrients are needed, 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 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 should be 100 percent water soluble.

When using starter solutions for field transplanting, follow manufacturer's recommendation. **Caution.** High rates of starter solution can become concentrated and burn transplant roots when the soil becomes dry.

Watering. Keep mix 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.

Hardening. Reducing the amount of water used, lowering temperatures, and limiting fertilizers cause a check in growth (hardening) to prepare plants for field setting. When hardening vine crops, tomatoes, peppers, or eggplants, do not lower temperature more than 5°F (3°C) below the

recommended minimum growing temperatures listed in Table A-1. Low temperature causes chilling that can injure plants and delay regrowth after transplanting. Do not harden rosette vegetables (e.g. endive, escarole, celery) by lowering the temperature because low temperature increases early bolting. Avoid overhardening or underhardening.

Grafting Vegetables: Utilizing rootstocks for grafting has resulted in increased yields, fruit quality, and tolerance to abiotic and biotic stresses. The technique can also help meet the challenge from new strains of soil-borne disease pathogens. There has been limited research on annual vegetable crops until the last decade when the grafting movement started in Asia and Europe. Japan now utilizes extensive grafting in the production watermelon, cucumber, melon, tomato and eggplant. Grafting can overcome tissue damage and/or plant mortality caused by the soil-borne diseases Fusarium and Verticillium wilt, bacterial wilt and nematodes. Grafting may reduce or eliminate the use of certain pesticides (especially fumigants) because the rootstocks will provide tolerance to many soil insect and disease pests.

NO-TILL CROP PRODUCTION

No-till crop production practices are beneficial for a variety of reasons. Soil compaction is reduced. Water infiltration is improved, and soil erosion from wind and water run-off is reduced. Contamination of waterways with nutrients and pesticide residues is reduced by eliminating or curtailing water run-off and soil erosion. Crop and cover crop residue on the soil surface can provide mulch that moderates soil temperature, reduces soil moisture loss, and may suppress weeds; however, no-till crop production systems do not necessarily make weed control easier or simpler.

Weeds are plants growing where they are not wanted. They are controlled using biological, cultural, mechanical, or chemical practices.

These options are available for weed management in no-till production systems. Biological weed control options have been very successful suppressing or controlling certain weed species, especially in rangeland and along roadsides where other control measures would be difficult or too costly to use. A low level of the weed can often be tolerated, and may be needed to sustain the control organism. Biological control measures have not provided the high level of broad spectrum season long weed control needed to grow vegetable crops. Too often a domesticated version of a weed or a close relative is grown as a crop in the region. This excludes the introduction of a biological control agent for the weed.

Cultural weed control techniques are important, and have the potential to reduce weed populations over time (years), or to avoid or reduce the impact of specific problem weeds. Cultural control measures do not provide the high level of broad spectrum season long weed control needed to grow vegetable crops when used exclusively, but are very effective when used in combination with other weed control techniques.

The mechanical or physical elimination of unwanted vegetation (weeds) has been a primary reason to till soil for thousands of years. Throughout the centuries, farmers have recognized the importance of mechanical weed control in crop production, and have continually developed new and improved tillage equipment. The immediate benefit of weed control provided by tillage must be balanced with the long-term adverse effects tillage can have on soil productivity. Tillage exposes soil to erosion by wind and water, and encourages the loss of soil organic matter by oxidation. The loss of organic matter causes soil structure to break down, which reduces the soil's ability to absorb and hold water.

Chemical weed control ideally kills weeds without harming crops. At present, chemical weed control is more effective and less costly than other alternative weed control measures.

No-till weed crop production systems eliminate the mechanical weed control option for managing unwanted vegetation in a field. This places greater reliance on the other methods of weed control, especially cultural and chemical control methods. Chemical control methods are often relied on more heavily in no-till systems, and are usually the only control measure available after the crop has emerged if pre-plant cultural control measures fail. Heavy reliance on chemical weed control options in no-till systems increases the possibility that herbicide resistance will develop within existing weed populations.

No-till weed crop production systems are not likely to make weed control easier or less complicated. Expect to exert more time and energy, and to spend more money controlling weeds in no-till crop production systems than in conventional systems that can utilize mechanical tillage options.

MULCHES AND ROW COVERS

An ideal environment for a plant's root system can be achieved with the use of plastic mulches and trickle irrigation. Early in the season, additional advantages can be obtained by the use of row covers, which increase the daytime air temperature and hold ground heat at night. This improvement in temperature early in the plant's life cycle can speed plant growth, resulting in earlier harvest. Mulches also discourage weeds and, depending on the type used, insect pests.

Mulches. The most popular mulches are clear and black polyethylene film (1 to 1¼ mil). Clear polyethylene is used primarily on cucumbers, melons, eggplants, and sweet corn. With the exception of sweet corn, soil fumigation is used in conjunction with clear plastic for weed, disease, and insect control. This increases the cost of using clear plastic when compared with black plastic. However, clear plastic will result in higher soil temperatures, which usually results in greater yields. Green 'IRT' types of plastic mulch increase soil temperatures more than black plastic and also suppress most weed growth. The greatest advantage in using green and clear plastic is generally with the earliest plantings. To

obtain the maximum increase in soil temperature, apply mulch films 10-30 days before planting. Allow 21 days for fumigants to dissipate before planting.

For later plantings, black plastic mulch may result in greater net returns than clear plastic. Black polyethylene is used on melons, eggplants, peppers, and tomatoes. Specific crops may respond to specific mulch colors. Tomatoes often yield more on red compared to black plastic, whereas cucumbers may yield more on blue than black. Cantaloupes may produce higher yields on blue or IRT than black plastic and late-planted peppers may yield more on silver than black plastic. June plantings of tomato may benefit from the use of white plastic to moderate root zone temperatures. Aluminized plastic mulch is used on fall squash and Chinese cabbage because it repels aphids which spread mosaic virus. Yellow mulches attract cucumber beetles and may attract other insect pests. Note that planting date and environmental conditions influence crop responses to color of mulch films.

In a typical operation, a 4-foot-wide mulch and drip irrigation are laid at the same time. Row length varies according to the design of the drip irrigation tubing and field topography. On steep terrain, row lengths may be limited to 300 feet. Under ideal conditions, row lengths of 600 feet or greater are possible. Mulch can be used for either seeded or transplanted crops. Transplanters are available or can be designed to plant through the plastic mulch.

Fertilization. Before considering a fertilization program for mulched crops, the grower should 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. If the pH is outside of this range, nutrients may be present but not available to the plants.

Calculating Fertilizer Rates Applied in Strips Where Plastic Mulch will be Laid. When using plastic mulch **without** trickle irrigation, the total amount of plant nutrients recommended for standard cultural practices should be incorporated in the top 5 to 6 inches of soil before laying the mulch. If equipment is available, apply all the fertilizer required to grow the crop to the soil area that will be covered with mulch. This is more efficient than a broadcast application over the entire field. Growers applying fertilizer in strips where the plastic mulch will be laid should reduce the amount that would be applied on a whole acre by a percentage that is equivalent to the coverage of the plastic. For example, if the plastic is covering 3 feet and are placed on 6-foot centers, then the area covered is 50 percent. (In this example, 4-foot wide plastic was used, but 6 inches of each side are buried. Consequently, the coverage is only 3 foot wide).

Table A-4 below illustrates the reduction in fertilizer that should be calculated for 3 feet of mulch coverage on 5-, 6-, and 8-foot centers when considering applications of fertilizers per unit acre.

Table A-4 Conversion of Pounds of Fertilizer per Acre to Pounds per Mulched Acre at Different Row Spacings.

Pounds Fertilizer per Field Acre	Pounds per Mulched Acre		
	5-foot Centers (60% of total)	6-foot Centers (50% of total)	8-foot Centers (37.5% of total)
100	60	50	37.5
150	90	75	56
200	120	100	75
250	150	125	94
300	180	150	113
350	210	175	131
400	240	200	150
450	270	225	169
500	300	250	188
550	330	275	206
600	360	300	225
700	420	350	263

All essential plant nutrients, including major nutrients (N, P, K) as well as secondary and micronutrients, should be applied according to soil test results and incorporated in the manner described above. Placing some of the required N under the mulch and then sidedressing the remainder of the needed N along the edge of the mulch or in the row alleys after the crop becomes established has been determined to be an inefficient use of applied N. When trickle irrigation is used, see "Drip/Trickle Fertilization" in the specific crops sections (i.e., eggplants, muskmelons, peppers, tomatoes, and watermelons) of Section F.

Before any mulch is applied, it is extremely important that the soil moisture level be near field capacity. This moisture is critical for early growth of the crop plants, because soil moisture cannot be effectively supplied by rain or overhead irrigation to small plants growing on plastic mulch.

Degradable mulches. Photodegradable and biodegradable plastic mulches are available, but usually cost more than conventional films. This additional expense is offset 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 and they continue 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 tucks buried in the soil. It is recommended that biodegradable mulch be incorporated into the soil at the end of the harvest or growing season.

Row covers. These are being used to hasten the maturity of the crop and also to effectively exclude certain insect pests. Currently, vented clear and translucent plastic covers

are being used. Row covers are supported by wire hoops placed at 5- to 6-foot intervals in the row. Porous floating row covers are made of lightweight spun fibers or plastic placed loosely over the plants without wire supports. Floating covers are more applicable to the low-growing vine crops than upright plants like tomatoes and peppers. Upright plants have been injured by abrasion when the floating row cover rubs against the plant.

The 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. Heat injury has not been observed with the translucent materials.

Row covers are usually put out over plastic mulch using a combination of mechanical application and hand labor. Research and development is under way on equipment that will cover the rows in one operation. However, farmer-made equipment in conjunction with hand labor is currently the most prevalent system.

Each grower considering mulches, drip irrigation, and/or row covers must weigh the economics involved. Does the potential increase in return justify the additional costs? Are the odds in the grower's favor of getting the most benefit in terms of earliness and yield from the mulch, drip irrigation, or row covers? Does the market usually offer price incentives for early produce or, as a result of harvesting early; are you competing against produce from other regions? Polyethylene films, used for mulch have risen dramatically in cost because they originate from petroleum. Consult your dealer for current prices. Each grower must obtain the costs for his situation, calculate the potential return, and come to a decision.

Mulch removal. Several methods of removing the plastic have been tried, but on small acreages it is removed by hand by running a coulter down the center of the row and picking it up from each side. Commercial tractor mounted mulch removal equipment is also available.

High-quality, black plastic mulch can be used for two successive crops during the same season when care is taken to avoid damage to the mulch film. Thin wall (4 to 8 mil) trickle irrigation cannot be removed and reused. However, high-quality, 16-mil trickle tubing can be used a second season provided that damage is minimal and pores are open when carefully removed and stored indoors.

Desiccation. Crop foliage and weeds may increase the difficulty of mulch removal. Eliminate vegetation prior to replanting or removing mulch. Broadcast Gramoxone with nonionic surfactant according to labeled direction to desiccate weeds and crop foliage, or delay removal until after frost.

Disposal. Dispose of used plastic in an environmentally responsible manner. Regulations on disposal vary. Contact your local solid waste authority for recommended methods of disposal in your area.

STAKING AND TRELLISING

Many vegetable crops benefit from the addition of structural supports on which they are grown in the field. The benefits include: 1) better utilization of available space and light; 2) improved air flow for more rapid drying of foliage; 3) reduction in certain disease pathogens; 4) protection against plant breakage; 5) protection of developing fruits and other plant parts against rain, dew, and sun; 6) ease of harvest, and 7) possible higher net yields. The disadvantages include mainly cost of materials and installation, and disposal. Each grower must assess his/her broad situation on a case-by-case basis in deciding whether a structural support system is desirable.

Crops in which structural support systems have been used successfully include fresh market tomatoes, peppers, eggplants, legumes, cucumbers, and okra. The types of materials and how they are assembled differ for each crop. Specifics of the design and installation of structural support systems are included in Section F. If materials fail during the growing phase, the resulting damage can be catastrophic. It is advisable, therefore, to utilize high quality materials in the construction of all structural support systems, and to adhere to minimum size and spacing recommendations. Where wooden stakes are used, it is recommended that a clear hard wood source be used.

It is a common practice to re-use wooden stakes over many production seasons in the field. Since they are in contact with the environment and plant material while being used, there is a significant probability that surfaces will become infested with pathogens, especially bacteria. If left untreated, re-used infested stakes may re-introduce diseases into the field, although the extent of this problem has not been determined. Therefore, it is recommended that re-used stakes be thoroughly disinfested.

The preferred (and most expensive) method of stake disinfestation is heat treatment. Pathogens are completely eliminated from wooden stakes with exposure to $\geq 220^{\circ}\text{F}$ for ≥ 15 minutes. This can be accomplished in a large capacity autoclave, or seed dryer. It is unlikely that most growers will have access to such equipment. Alternatively, therefore, stakes may be exposed to disinfestants such as commercial bleach (sodium hypochlorite) or Oxidate® (hydrogen dioxide; see below). Research has shown that a 20-minute soak in a 5% solution of $\geq 5.25\%$ hypochlorite commercial bleach (equivalent to 0.026% hypochlorite) is effective in eliminating pathogens *only from the surface* of wooden stakes. It is crucial to maintain the pH of the bleach solution within the 6.0-6.5 range, as effectiveness decreases at lower and higher pH levels.

Studies on stakes treated with bleach solutions show that pathogens may still be present beneath the surface at depths $\geq 1/16^{\text{th}}$ inch. Pathogens embedded deep within the stake may be able to migrate back to the surface and re-infest fields, although this possibility has not yet been demonstrated. Adding a non-ionic surfactant to the disinfesting solution, increasing the soaking time to ≥ 1 hour, applying a vacuum during the stake soak, using a higher concentration or more potent source of hypochlorite (such as "heavy duty" or swimming pool grade chlorine), or using stakes comprised of non-absorbent stake materials

(such as plastic or metal) will help to ensure the elimination of pathogens from the potentially infested stake. Many growers have successfully used the commercial product Oxidate® to disinfest stakes, but there is no research to establish the efficacy of this disinfesting agent as compared to heat or commercial bleach.

HIGH TUNNELS

High tunnels are designed to improve growing conditions during the early spring and late fall growing seasons and to accommodate workers and equipment. High tunnels are either freestanding or connected at the gutters to cover larger areas. Freestanding tunnels are between 14 and 30 feet in width and 96 feet to 100 feet in length. High tunnels are typically tall enough so that a person can stand straight up in at least part of the structure. While high tunnels are not greenhouses (generally no heat or automatic ventilation), the greenhouse principle is the basis for the function and design of a high tunnel.

Taking the time to level the tunnel site prior to construction will make subsequent steps much easier. Spacing between high tunnels should be at least several feet to facilitate snow removal. The distance between tunnels should be large enough to allow for adequate (cross) ventilation in all of them. For freestanding high tunnels, metal bows approximately 1.75 to 2 inches in diameter are used as the support frame for a single layer of polyethylene covering (typically 6 mil greenhouse plastic that lasts 3-4 years). These bows are spaced 4 feet apart and are connected to metal posts, which are driven at least 2 feet into the ground. The end walls generally have removable framing (Penn State design) to allow the use of power tillage equipment within the tunnel (see high tunnel component list at the following website: <http://plasticulture.cas.psu.edu>).

Once the tunnel is covered, prepare the soil, apply and incorporate lime and preplant fertilizer as recommended for the crop (See section F). Make beds, if needed, and install drip irrigation to supply moisture. Using a small bedmaker/mulch layer, cover soil or beds with black or clear polyethylene to warm soil for spring crops. When transplanting crops into tunnels during July and August, use white or silver polyethylene mulch on the soil or beds rather than black polyethylene to reduce soil temperature and excessive heat build up in the tunnels.

For freestanding high tunnels, snow removal from the top of the tunnels may be necessary after heavy, wet snowfalls. In addition, it is recommended that heavy snowfall be removed from the sides of the tunnels as needed to reduce/eliminate outside water intrusion into the tunnel and collapse of the tunnel sidewalls. Gutter-connected high tunnels are constructed with much lighter posts and bows and cannot be used for crop production during the winter. During the winter season, the plastic on gutter-connected high tunnels must be bundled and moved to the gutters for storage. Hence, freestanding high tunnels allow for year-round production while gutter-connected tunnels do not.

The keys to successful production of vegetable and other horticultural crops in high tunnels are crop scheduling, ventilation and moisture control. When planting high tunnel crops in the spring, it is generally recommended to transplant

the vegetable crop about two to three weeks earlier compared to the earliest planting date in the field on bare ground. If unusually cold night temperatures are experienced several days to weeks after planting the vegetable crop in the high tunnel, floating row covers, low tunnels, thermal blankets and/or portable clean burning propane heaters (11,000 to 44,000 Btu per hour) can be placed in the high tunnel until more seasonal temperatures return to the location.

The most critical component of the system is ventilation. In freestanding high tunnels, ventilation is accomplished by rolling up the sides of the tunnel to the batten boards, approximately 5 to 6 feet above the ground on each side of the tunnel. In gutter-connected high tunnels, ventilation is accomplished by sliding the plastic covering aside creating ventilation openings in the roof bows, as well as by opening the end walls. Maintaining optimum growing conditions inside high tunnels without having extreme fluctuations in temperature and/or high humidity conditions will guarantee early, high yielding and high quality horticultural crops. Checking and adjusting high tunnel internal temperature and humidity conditions several times a day will help ensure increased crop yields and profitability.

Depending on the crop to be grown, there are several production systems that can be used in a high tunnel. Conventional tillage and establishment of the crop in soil may be efficient for cool season crops that can be direct seeded or transplanted, Swiss chard, spinach, collards or kale. For warm season crops especially cucurbits (cucumbers, squash, cantaloupe and watermelon) and solanaceous (potato, tomato, pepper and eggplant) crops, use of raised beds with plastic mulch and drip irrigation is required for optimum yield, maturity and quality. Warm season vegetable crops dramatically benefit from higher soil temperatures in early spring in high tunnels. In addition, multiple cropping is possible from the initial raised bed/plastic mulch – drip irrigation system established in the spring. Permanent raised beds with a width of 24 inches may also be constructed in the high tunnels wooden boards measuring 2 by 12 inches. Use of permanent raised beds may limit crops grown on them depending on the distance between raised beds (center to center) within the high tunnel. Some growers successfully use 30-36 quart potting soil bags that are drip irrigated to grow their high tunnel crops. These bags are placed end-to-end in rows and on a landscape fabric. Either one or two drip irrigation lines are inserted through each bag.

High tunnel culture is conducive to powdery mildew development on crops such as cucurbits and tomatoes. Plan and execute a prophylactic fungicide program according to crop recommendations in Section F. See also Rutgers Cooperative Extension Fact Sheet No. 358 titled: "Important diseases of tomatoes grown in high tunnels and greenhouses in NJ". This can be found at the website njaes.rutgers.edu/pubs/ and select All Fact Sheets and Bulletins.

POLLINATION

Honeybees and pollinating wild bees visit the flower of several flowering vegetables and strawberries. They may improve the yield and quality of fruit in beans, eggplants,

peas, and peppers and they are essential for commercial production of all vine crops and most strawberry varieties. Vine crops require bee pollination since two types of flowers are found on the vines and the pollen is dense and sticky. Cucumbers, squash, pumpkins, and watermelons have separate male and female flowers, while muskmelons 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. 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 usually related to the number of seed produced by pollination; each seed requires one or more pollen grains.

Even though bumblebees and some species of wild bees are excellent pollinators, populations of these native pollinators usually are not adequate for large acreages grown for commercial production. The best way to ensure adequate pollination is to own colonies or rent strong colonies of European honeybees from a reliable beekeeper. Commercial bee attractants, such as Bee Scent or Bee Here, have not proven to be effective in enhancing pollination in the Mid-Atlantic states. Growers are advised to increase numbers of rented bee colonies and not rely on such attractants.

The North American beekeeping industry is currently in crisis. European honeybees are afflicted with diseases and parasitic mites that have greatly reduced hive availability, and the pollinating effectiveness of existing stock. It may be wise to consider the use of alternative pollinators, such as bumblebees, mason bees, and leafcutter bees. Organizations have sprung up that specialize in the rearing and distribution of such alternative pollinators. A good resource to locate these organizations may be found on the web at www.pollinator.com/alt_pollvenders.htm

Movement of bees into the crop at the correct time will greatly enhance pollination. Individual cucurbit and strawberry 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, and watermelon flowers normally open around daybreak and close by noon, whereas, cucumbers, strawberries, and muskmelons generally remain open the entire day. Pollination must take place on the day the flowers open, since pollen viability, stigmatic receptivity, and attractiveness to bees last only that day.

Bee activity is determined, to a great extent, by weather and conditions within the hive. Honeybees rarely fly when the temperature is below 55°F (12.8°C). Flight seldom intensifies until the temperature reaches 70°F (21.1°C). Wind speed beyond 15 mph seriously impedes bee activity. Cool, cloudy weather and threatening storms greatly reduce bee flights. In poor weather, bees foraging at more distant locations will remain in their 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. A clean water supply should be available within a quarter mile of the hive.

The number of colonies needed for adequate pollination varies with location, attractiveness of crop, density of flowers, length of blooming period, colony strength, and

competitive plants in the area. In vine crops and strawberries, recommendations are one to two colonies per 1 acre, with the higher number on higher density plantings. Each hive or colony should contain at least 1,200 square inches of brood and enough adult bees to care for the brood, regardless of weather conditions. Multiple bee visits of eight or more visits per flower are required to produce marketable fruit. When hybrid cucumbers are grown at high plant populations for machine harvesting, flowers should receive 15 to 20 visits for maximum fruit set. Strawberries require multiple pollination for perfect fruit formation. Generally, as the number of visits increases, there will be an increase in fruit set, number of seed per fruit, fruit shape and fruit weight. Insecticides applied during bloom are a serious threat to bees visiting flowers. If insecticides must be applied to any of these crops, select one that will give effective control but pose the least danger to bees (see Table D-6). **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.

A written contract between the grower and beekeeper can prevent misunderstandings and, thus, ensure better pollination service. Such a contract should specify the number and strength of colonies, the rental fee, time of delivery, and distribution of bees in the field. Recommendations for pollinators on specific crops may be obtained from your local Extension agent or Beekeeper.

DIAGNOSING VEGETABLE CROP PROBLEMS

When visiting a vegetable field, follow the steps outlined below to help solve any potential problems.

1. Determine whether there is a pattern to the symptoms.
 - a. Does the pattern correlate with a certain area in the field, such as a low spot, poor-drainage area, or sheltered area? Does the pattern correlate with concurrent field operations, such as time of planting, method of fertilization, and rate of fertilization?
2. Try to trace the history of the problem.
 - a. On what date were the symptoms first noticed?
 - b. What fertilizer and liming practices have been used?
 - c. What pest-management practices have been used to suppress or control diseases and undesirable insects and weeds--what chemicals (if any), when applied, and what application rates?
 - d. What were the temperatures, moisture conditions, and level of sunlight?
3. Examine the plants affected to determine whether the problem is related to insects, diseases, or cultural practices.
 - a. Do the symptoms point to **insect** problems? (A hand lens is usually essential to determine this.)
 - (1) Look for the presence of insects on foliage, stems, and roots.
 - (2) Look for feeding signs such as chewing, sucking, or boring.
 - 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, and flowers.
 - (2) Look for discoloration of the vascular tissue (plant veins).
 - (3) Look for fungal or bacterial growth.
 - (4) Look for virus patterns; often these are similar to injury from 2,4-D or other hormones.
 - c. Do the symptoms point to **cultural** problems? Look for the following:
 - (1) Nutrient deficiencies.
 - Nitrogen--light green or yellow foliage. Nitrogen deficiencies are more acute on lower leaves.
 - Phosphorus--purple coloration of leaves; plants are stunted.
 - Potassium--brown leaf margins and leaf curling
 - Magnesium--interveinal chlorosis (yellowing between veins of 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) Nutrient toxicities.
 - Toxicity of minor elements--boron, zinc, manganese.
 - Soluble salt injury--wilting of the plant when wet; death, usually from excessive fertilizer application or salts in the irrigation water.
 - (3) Soil problems. (Take soil tests of good and poor areas.)
 - Poor drainage.
 - Poor soil structure, compaction, etc.
 - (4) Pesticide injury. (Usually uniform in the area or shows definite patterns.)
 - 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.
 - Physiological damage.
 - Air-pollution injury.

In summary, when trying to solve a vegetable crop problem, look for a pattern in the symptoms, trace the history of the problem, and examine the plants and soil closely. Publications and bulletins designed to help the grower identify vegetable problems are available from your county Extension Agent.

FOOD SAFETY CONCERNS

In recent years, the importance of fruits and vegetables in the diet has received a considerable amount of attention. Fresh or processed products supply vitamins, fiber, and phytochemicals that are known to decrease the risk of several chronic diseases, including heart disease and cancer. Consumers are purchasing more product than ever before and per capita consumption of fresh fruits and vegetables increased 26 percent between 1970 and 1997.

However, reports of foodborne illness attributed to consumption of these products have also increased. Unlike processed foods, fresh fruits and vegetables are not heat-treated to eliminate potentially harmful microorganisms. Larger and more centralized farming and improved storage methods have resulted in the distribution of product over vast geographic areas. Raw fruits and vegetables are also handled more frequently in the distribution chain. Cases of foodborne illness that once were limited to localized areas can now be spread over many states or countries. In addition, new minimal processing technologies have brought to the marketplace fruits and vegetables that have been washed, peeling, and cut into convenient ready-to-eat products. Because these products are subject to more handling and typically are not heat-processed to eliminate harmful bacteria, they are at a greater risk for becoming contaminated and causing foodborne illness. The vast majority of fresh fruits and vegetables are grown, harvested, and packed under safe and sanitary conditions. However, several highly published cases of foodborne illness have been associated with consumption of lettuce, salad mixes, green onions, tomatoes, sprouts, cantaloupe, cabbage, and carrots. Implicated in most of these outbreaks have been the human pathogens *Salmonella*, *E. coli* O157:H7, *Listeria*, and *Shigella* bacteria; *Cryptosporidium* and *Cyclospora* parasites; and Hepatitis A and Norwalk viruses.

In response to increasing concerns about the safety of fresh produce grown in the United States, the Food and Drug Administration published in 1998, *The Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables*. Many internet resources on Food safety are also available that feature updated information from this guide and other sources (e.g. www.foodsafety.gov). See resource section of this publication. The guide is intended to assist growers, packers, and shippers of unprocessed or minimally processed fresh fruits and vegetables by increasing awareness of potential food safety hazards and providing suggestions for practices to minimize these hazards.

In response to recent outbreaks of foodborne pathogens on fresh produce, an increasing number of distribution networks are mandating an approved plan of "Good Agricultural Practices" (GAP) from each participating grower. Third party audits are often imposed to ensure compliance with GAPs. Increased record-keeping and adherence to strict procedures of human hygiene are inevitable. Although this document provides only voluntary guidelines, many produce distributors, major retail grocery and food service chains, and other whole buyers of fresh produce are relying on the standards as the basis for

mandating sanitation specifications for growing and packing. The guide specifically addresses potential hazards and possible methods for their control in seven areas: 1. Water, 2. Manure and municipal biosolids, 3. Worker health and hygiene, 4. Field sanitation, 5. Packing facility sanitation, 6. Transportation, and 7. Product traceback. Each section is summarized below.

1. **Water.** Water is used for irrigation, pesticide application, cooling, transporting, washing, and processing. It also has the potential to be a source of microbial contamination. Growers and packers, therefore, should be aware of the source and quality of water that contacts fresh produce and consider practices that will protect water quality. Growers often irrigate field crops using water obtained from rivers, lakes, ponds, or irrigation ditches. However, surface water can become contaminated by upstream animal operations, sewage discharge, or runoff from fields. Drip, furrow, underground, or low volume spray irrigation techniques are ways to minimize contact with edible portions of the crop. Groundwater is less likely to become contaminated, although wells should be maintained in good working condition and be constructed and protected so that surface water or runoff from manure storage areas cannot enter the system.

In packing operations, periodic testing for microbial contamination, changing dump tank and flume water regularly, and cleaning and sanitizing water contact surfaces will help to prevent contamination. Antimicrobial chemicals such as chlorine may be added to water, but should be routinely monitored and recorded to ensure they are maintained at appropriate levels.

2. **Manure and Municipal Biosolids.** Manure may be contaminated with human pathogens and should be properly treated and stored before field application. Composting or aging will reduce the level of pathogens in manure but cannot guarantee that it is safe to use. Current recommendations are to maximize the time between application of manure to production areas and harvesting. In the spring, manure should be incorporated into the soil at least two weeks prior to planting. Harvesting should not take place within 120 days after manure application. Store manure or compost away from fresh produce fields or packinghouses to protect crop from seepage and runoff. Physical barriers such as ditches, mounds, grass/sod waterways, diversion berms, and vegetative buffer areas help to prevent runoff. Domestic animals are another source of contamination and should be excluded from fields during the growing and harvesting season. Wild animals, though more difficult to control, should be discouraged from entering where crops are destined for fresh produce markets.

Municipal biosolids (sewage sludge) approved for certain agricultural uses, but is not recommended for application to soils used for vegetable production. This is due to the potential for human health issues. Refer to www.epa.gov/owm/mtb/biosolids/index.htm for an explanation of risks. See "Sewage Sludge" in the Plant Nutrient Recommendations Section of this manual.

3. **Worker Health and Hygiene.** Human pathogens can be transferred to vegetables by workers who harvest or pack

fresh produce. Growers should provide sanitary facilities that are well equipped, accessible, clean, and train employees to use toilet facilities and wash their hands properly. Workers at distribution centers, farm stands, or farmers' markets who handle produce should also follow good hygiene practices. Any worker who shows signs of an infectious disease such as diarrhea, boils, sores, or infected wounds should not be allowed to handle produce.

4. **Field Sanitation.** Fresh produce can become contaminated through contact with soils, pests, equipment, and chemicals such as fertilizers and pesticides. Growers should clean harvest equipment and containers or bins prior to use and keep harvesting and packing equipment as clean as practical.
5. **Packing Facility Sanitation.** In packing facilities, clean pallets, containers, or bins before use and discard damaged containers. Keep packing equipment, packing areas, and storage areas clean and store empty containers in a covered location to prevent becoming contaminated. Use an antimicrobial product, such as a chlorine, to prevent contamination of produce during washing or transporting in water flumes and change the water when it becomes excessively soiled. Clean and sanitize food contact surfaces at the end of each day.
Establish a pest control program that prevents rodents, birds, and insects from entering packing and storage facilities, and safely exterminate or remove them once they have entered the facility.
6. **Transportation.** Fresh produce can become contaminated when loading, unloading, and during shipping. Inspect transportation vehicles for cleanliness, insects, other pests, odors, and obvious dirt or debris before loading. Make sure that fresh produce is not shipped in trucks that have previously been used to transport animals, fish, chemicals, or refuse. Refrigeration units in trucks should be turned on before loading to insure that proper temperatures are maintained during transit.
7. **Traceback.** The ability to trace the distribution history of food items from grower to consumer will not prevent a foodborne illness outbreak from occurring. However, being able to quickly trace a food back to its source can limit the public health and economic impacts of an outbreak. Growers should be able to trace each packing with the date of harvest, farm identification, and who handled the produce from grower to receiver.

Additional information to help vegetable growers practice GAPs on the farm and in the packinghouse can be obtained from county extension offices.

POSTHARVEST HANDLING

Vegetables that are fresh and have good flavor bring repeat sales and may bring higher prices. How you handle your produce directly affects freshness and, with some vegetables, how well they retain peak flavor.

For most vegetables, maintaining cool temperatures to slow deterioration and high humidity to prevent moisture loss are the most effective means of preserving quality. Different vegetable commodities, however, respond differently to temperature (Table A-6). Listed below are several things producers, handlers, and retailers can do to assure that vegetables going to the market or into storage are high quality.

Harvesting and handling.

1. Provide gentle harvesting and handling to avoid cuts, abrasions, and bruising damage that allow decay-causing microorganisms to enter the tissue.
2. Harvest produce when consumers will be provided with the peak of quality. This assures greatest value at the time the commodity begins a sales period or storage period for later sale. Since most vegetables begin to deteriorate at the time of harvest, the highest quality produce will have the greatest shelf life.
3. Harvest during the cool part of the day, if possible. Since temperature controls the rate at which produce deteriorates, harvesting when the vegetables are coolest (usually just after sunrise) will extend their quality as long as possible.
4. If storage facilities are not available, harvest only as much produce at one time as you can pack or sell while the quality is optimal. This will also allow you to replenish displays at roadside markets with freshly harvested produce throughout the day, which ensures highest quality available to your customers.
5. Make successive planting and use several varieties of varying maturity to spread the harvest season. This allows you to have freshly picked material available over an extended period.
6. Use a shade cover on field wagons, trucks, and market areas. Perform sorting and packing operations in a shaded location. Vegetables exposed to the sun will absorb solar energy and become warmer than those in the shade. This is especially true of dark-colored vegetables, such as zucchini squash, eggplants, peppers, watermelons, green beans, and tomatoes that are often harvested during the middle of summer when solar energy is at a maximum. Workers will be more comfortable and, thus, work more efficiently in a shaded area. Shade may be provided by an open shed, shade cloth over a simple framework, or even by a large tree.
7. Display only good quality vegetables for sale. Those of poor quality will never improve. Frequent sorting to remove poor quality material will present the best display possible to your customers. Shade the sales display from the sun.
8. Remind your customers to keep produce cool (see Table A-6) and prevent moisture loss during transportation and storage at home.
9. For commodities that lose quality rapidly and those to be shipped to market, special postharvest washing, handling, and cooling are required to maintain quality (see Table A-6).

Washing, and chlorination. Bacteria and fungi are present on the surface of freshly harvested vegetables. Where wash water is used, the temperature of the water should be warmer (ideally 10°F warmer) than the pulp temperature of the produce to prevent decay-causing micro-organisms from being drawn into the tissue. Addition of chlorine to the wash water is effective in destroying decay-causing microorganisms on the surface of vegetables and extending shelf life.

Chlorine can be added as a liquid concentrate in the form of sodium hypochlorite (commercial bleach) or as a dry powder in the form of calcium hypochlorite. The optimum concentration of available chlorine in the wash water depends on the kind of vegetable. Chlorination is most effective at pH 6.5 to 7.5. Buffers should be added to keep the pH in the desired range. Monitor dump/wash tanks and spray wash with commercially available test kits to verify that the correct pH and concentration of available chlorine are present. Consult label for information on adjusting chlorine levels. **Note: Acidity and alkalinity are best controlled using available machinery and not manually. Consult with a water treatment specialist about availability, installation, and operation of this type of equipment.**

Cooling. Two types of heat are present in vegetables. *Field heat* is the heat content of the vegetable that is due primarily to heat energy absorbed from the surrounding environment. *Heat of respiration* is the heat produced in the cells of the vegetable when sugars, fats, and proteins are oxidized to produce high-energy intermediate compounds, carbon dioxide, water, and **heat**. Quality is lost faster by vegetables with high respiration rates and heat production. High produce temperatures also increase evaporation and transpiration of moisture for fruits and vegetables which result in more rapid wilting and loss of quality. Cooling vegetables removes field heat, lowers the temperature of the vegetable, and thus slows respiration, metabolic rates, and heat production. Slowing respiration and metabolic rates of the vegetable slows the rate of development, senescence, ripening, and tissue breakdown. Lowering the temperature also slows the growth rate of microorganisms, thus, decreasing and delaying decay.

The length of time required to cool produce depends on method (air-, hydro-, or vacuum-cooled) and temperature of the medium used, initial temperature of the produce, final desired temperature, type of vegetable (i.e., fruit, leaf, or root), use and design of boxes or containers, and flow of cooling medium around the produce or containers. Thus, specific recommendations for cooling times for individual vegetables cannot be made. Growers can determine the cooling time required in their own operations by measuring the initial product temperature and the temperature during and after cooling. Temperatures of produce (head, cob, or pulp) must be measured because the temperature of air incartons or cooling/storage room does not accurately indicate product temperature.

The term *half-cooling time* is the time required to cool produce to one-half the difference between initial and final (or cooling medium) temperature. Half cooling time will vary according to the crop, temperatures, and cooling method used. For example, if muskmelons with a pulp temperature of 80°F (26.7°C) are to be cooled to 40°F

(4.4°C), the half-cooling time (*t* minutes) is the time required to cool the melons from 80°F (26.7°C) to 60°F (15.6°C). The time required to cool the melons from 60°F (15.6°C) to 50°F (10°C) is also equal to the half-cooling time of *t* minutes. This principal is illustrated in the Table A-5 and Figure A-1. Table

A-5 The Concept of Half Cooling Time

Produce Temperature, °F	Proportion of Cooling Completed	Relative Time to Cool to Indicated Temperature
80.0 (26.7°C)	--	--
60.0 (15.6°C)	1/2	<i>t</i> min
50.0 (10°C)	3/4	<i>t</i> min
45.0 (7.2°C)	7/8	<i>t</i> min
42.5 (5.8°C)	15/16	<u><i>t</i> min</u>
		4 <i>t</i> min

It can be seen that rate of cooling is most rapid during the early stages of cooling and declines as temperature of the vegetable approaches the desired temperature or the temperature of the cooling medium. Cooling for a time equal to 4 times the half-cooling time or 15/16 of the desired cooling is sufficient for short-term holding and transit and when additional cooling will take place in transit or storage. For example, if a grower wishes to use hydrocooling (chilled water) to reduce the temperature of carrots, from 80° to 34° F the time necessary to reach 57°F would be determined (e.g. 15 minutes), then the cooling would continue for at least 4 times longer (e.g. 60 minutes).

Some vegetative tissues and many fruits of vegetable crops are sensitive to chilling temperatures [between 35°F (1.7°C) and 55°F (12.8°C)]. Avoid holding chilling-sensitive crops at these temperatures. See Table A-6 for information on chilling sensitivity of vegetable crops. Monitor temperatures during transit and storage to determine if optimum temperatures are being maintained.

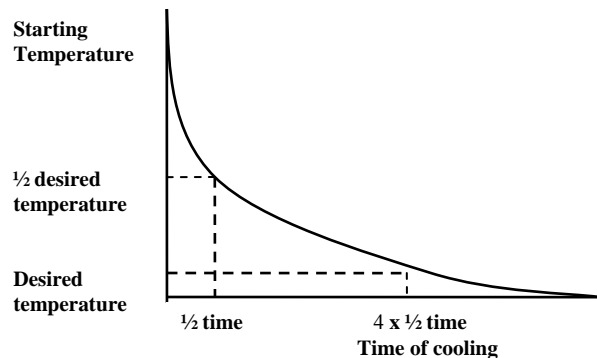


Figure A-1: Relationship of Half Cooling Time and Desired Temperature

Ethylene effects. Many vegetable crops lose quality, have reduced shelf life, and show specific symptoms of injury when exposed to ethylene at concentrations of 1 to 100 ppm after harvest. Some examples of ethylene effects include: russet spotting of lettuce along the mid-rib of the leaves, loss of green color in snap beans, increased toughness in turnips and asparagus spears, and development of

bitterness in carrots and parsnips. Ethylene also causes yellowing and abscission of leaves of broccoli, cabbage, Chinese cabbage, and cauliflower; more rapid softening and yellowing of cucumbers, acorn and summer squash; and softening and development of off-flavor in watermelons. Ethylene increases browning and discoloration in eggplant pulp and seed and discoloration and off-flavor development in sweet potatoes. Ethylene can also cause sprouting of softening and development of off-flavor in watermelons. Ethylene increases browning and discoloration in eggplant pulp and seed and discoloration and off-flavor development in sweet potatoes. Ethylene can also cause sprouting of potatoes and increase ripening and softening of mature green tomatoes.

To avoid the detrimental effects of ethylene on vegetable quality and shelf life:

1. Do not store or transport ethylene-sensitive crops indicated above with ripening fruits such as apples, pears, peaches, plums, melons, avocados, bananas, and tomatoes that produce ethylene naturally.
2. Use electric forklifts in storage and transport areas because internal combustion engines may emit ethylene.
3. Vent storage areas (one air exchange per hour) to reduce ethylene levels, or install ethylene absorbers in storage areas.

NOTES

Table A-6. Handling Produce for Higher Quality and Longer Market Life¹

Vegetable Crop	Recommended Cooling Methods ²				Important Handling Factors ³				
	Forced Air or Room Cooling	Hydrocooling	Package Ice or Liquid Icing	Vacuum Cooling	Transit Icing	Recommended Transit and Storage Temperature, °F	Recommended Transit and Storage Relative Humidity, %	Expected Marketable Life Under Best Conditions	Sensitivity to Chilling Injury
Asparagus		+		+	N	32-36	95	1-2 weeks	L
Basil	+				N	46-50	90-95	4-7 days	H
Beans, lima & pod	+	+			N	38-42	90-95	7-10 days	M
Beans, snap	+	+			N	40-45	90-95	7-10 days	M
Beets, bunched		+			R	32	95	1-2 weeks	I
Broccoli			+		E	32	90-95	1-2 weeks	I
Brussels sprouts	+	+	+	+	R	32	90-95	3-5 weeks	I
Cabbage	+				N	32	90-95	3-6 weeks	I
Cabbage, Chinese	+		+	+	R	32	90-95	4-8 weeks	I
Carrots, bunched	+		+		E	32	90-95	1 month	I
Cauliflower	+		+	+	R	32	90-95	2-4 weeks	I
Celery		+			R	32	90-95	2-3 weeks	I
Collards & kale		+	+		R	32	90-95	1-2 weeks	I
Cucumbers	+	+			N	50	90-95	1-2 weeks	H
Eggplant	+				N	50	90-95	1 week	H
Endive & escarole				+	R	32	90-95	2-3 weeks	I
Horseradish	+				N	30-32	90-95	1 year	I
Kohlrabi	+	+	+		R	32	90-95	2-4 weeks	I
Leeks		+	+	+	R	32	90-95	1-3 months	I
Lettuce, crisphead				+	N	32-36	95	2-3 weeks	I
Lettuce, leaf & bibb			+	+	R	32-36	95	1 week	I
Lettuce, romaine				+	R	32-36	95	1-2 weeks	I
Muskmelon, 3/4 slip	+		+		R	36-40	85-90	1-2 weeks	M
Muskmelon, full slip	+		+		R	32-36	85-90	4-7 days	M
Okra		+			N	45-50	95	1 week	VH
Onions, dry					N	32	65-70	1-8 weeks	I
Onions, green		+	+		N	32	90-95	7-10 days	I
Parsley		+	+		E	32	95	1-2 months	I
Parsnips	+				N	32	90-95	2-6 months	I
Peas		+	+		E	32	90-95	1-2 weeks	I
Peppers	+			+	N	45-50	90-95	2-3 weeks	M
Potatoes, early	+				N	40	90	2-4 months	L
Potatoes, late	+				N	40-45	90	5-8 months	L
Pumpkins					N	50-55	70-75	2-3 months	H
Radishes, bunched		+	+		E	32	95	1-2 weeks	I
Rhubarb		+	+		R	32	95	3-4 weeks	I
Rutabagas	+				N	32	95	2-4 months	I
Spinach		+	+	+	E	32	90-95	7-10 days	I
Squash, summer	+	+			N	50	90-95	4-7 days	H
Squash, winter	+				N	50-55	50-75	2-6 months	M
Strawberries	+				N	32	95	1 week	L
Sweet potatoes	+				N	55-60	85-90	3-5 months	VH
Sweet corn	+	+	+		E	32	90-95	5-7 days	I
Tomatoes, green	+				N	60-70	85-90	1-3 weeks	H
Tomatoes, pink	+				N	55-65	85-90	5-10 days	M
Tomatoes, ripe	+				N	55-60	85-90	4-7 days	M
Turnips	+				N	32	95	4-5 months	I
Turnip & mustard tops		+	+	+	E	32	90-95	1-2 weeks	I
Watermelons		+			N	45-50	85-90	3-4 weeks	M

¹ Information on optimum temperatures, relative humidity, and storage life was adopted from USDA Handbook 66 and modified by experience under eastern conditions.

² *Cooling Method*: + = cooling method is suitable for the crop.

³ *Transit Icing*: The importance of transit icing depends on time in transit, transit conditions, and outside temperature. N = not recommended, R = recommended, and E = essential.

Sensitivity to Chilling Injury: I = insensitive, L = low sensitivity, M = medium sensitivity, H = high sensitivity, and VH = very high sensitivity.

SOIL AND NUTRIENT MANAGEMENT

SOILS

The best soils for growing vegetables are well drained, fairly deep, and relatively high in organic matter. They have good structure and have been adequately limed and fertilized for the past few growing seasons. Soil textures, such as sandy loam or loamy sand are generally best suited for growing early market crops. Loam and silt loam soils are generally better suited for growing crops for later fresh-market use or for processing. Deep, well-drained muck soils are ideally suited for growing such crops as leafy vegetables and bulb and root crops that offer a high return per acre.

The better job you do as a grower in matching the crop to your soil, the greater chance you will have of producing a successful crop. For example, if you plant crops that require well-drained soils on poorly drained soils, you are doomed to failure regardless of your other skills as a grower.

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

Soil Tests

The most economical means of determining the lime and fertilizer needs of your vegetable soils is to have your soil tested. You can obtain soil sample kits or containers and instructions through your county Extension agents' office.

If you do not know the present fertility level of the soil in a field, your application rates of lime and fertilizer materials are likely to be too high or too low. Either situation is undesirable and expensive. For most efficient production, application rates of lime and fertilizer materials should be matched to the existing soil fertility level, past cropping and soil management practices, and the crop to be grown. A controlled soil fertility program of this nature also minimizes the potential for soil and water pollution.

Lime and fertilizer recommendations from a soil testing laboratory are based on the soil test results and past cropping, liming, and fertilization practices you supply with the soil sample questionnaire when submitting the sample. For this reason, it is very important that you supply accurate information about the history and future use to be made of the field along with the soil sample.

If you have a special problem, inform your county Extension Agent when you pick up the soil sampling kit or container, so that he/she can advise you if any special tests are needed. Also, he/she has a current list of charges made for soil testing services performed by the Soil Testing Laboratory.

LIMING SOILS

Most of the soils in the Mid-Atlantic Region are naturally acidic or become acidic under crop production systems. If soils become too acidic (pH less than 6.0), crop performance is hindered by many factors – including reduced availability of soil nutrients. A regular liming program is required to neutralize soil acidity and to supply crops with calcium and magnesium. The first step in a liming program is knowing the optimum or target value of the crop to be grown. Many crops will grow over a wide range of soil pH but most vegetable crops perform best when soils are limed to pH 6.0 to 6.5. There are several important exceptions. The target pH values and the low pH limits suitable for vegetable crop production are listed in Table B-1.

Table B-1. Target Soil pH Values for Vegetable Crop Production

Crop	Target pH	Lime when pH Falls Below
Asparagus	6.8	6.2
Beans, lima, snap	6.2	6.0
Beets	6.5	6.2
Broccoli	6.5	6.2
Brussels sprouts	6.5	6.2
Cabbage	6.5	6.2
Cauliflower	6.5	6.2
Collards	6.5	6.2
Cantaloupes	6.5	6.0
Celery	6.5	6.0
Cucumber	6.5	6.0
Eggplant	6.5	6.0
Endive, escarole	6.5	6.0
Horseradish	6.5	5.5
Kale	6.5	6.2
Kohlrabi	6.5	6.2
Leeks	6.5	6.0
Lettuce, leaf, Iceberg	6.5	6.0
Mixed vegetables	6.5	6.0
Muskmelons	6.5	6.0
Okra	6.5	6.0
Onions, green, bulb, scallions	6.5	6.0
Parsley	6.5	6.0
Parsnips	6.5	6.0
Peas	6.5	6.0
Peppers	6.5	6.0
Potatoes, sweet	5.2	5.0
Potatoes, white, scab susceptible	5.2	5.0
Potatoes, white, scab resistant	6.2	5.5
Pumpkins	6.5	6.0
Radish	6.5	6.2
Rhubarb	6.5	5.5
Rutabaga	6.5	6.2
Spinach	6.5	6.0
Squash, winter, summer	6.5	6.0
Sweet corn	6.5	6.0

(table continued next page)

Table B-1. Target Soil pH Values for Vegetable Crop Production (cont'd.)

Crop	Target pH	Lime when pH Falls Below
Strawberries	6.2	5.8
Tomatoes	6.5	6.0
Turnips	6.5	6.0
Watermelon	6.2	5.5

Soil pH alone cannot be used to determine the amount of liming material to apply to correct soil acidity. The second step in a liming program, therefore, is to have a soil fertility test performed. The soil test results provide the data needed to determine the lime requirement and the type of lime to use.

Lime Requirement

The lime requirement of a soil depends on total acidity that must be neutralized to raise pH to the desired level. It is important to understand that a soil pH measurement only indicates the concentration of active acidity in soil solution. Total acidity represents the active acidity in solution plus the amount of exchangeable acid cations held on clay and organic matter. For the purpose of lime recommendations, total acidity is estimated from soil texture plus soil pH or it is measured directly by titration (which is referred to as buffer pH or lime requirement index). Buffer pH or lime requirement index measurements that appear on soil test reports are a measurement used to determine lime requirement and should not be confused with soil pH. The interpretation of buffer pH is specific to the buffer method employed by the laboratory and the properties of the soils in the region.

Lime requirement is also commonly determined by soil pH measurement and soil texture. Soil texture classifications (i.e. loamy sand, sandy loam, loam, silt loam, or clay loam) may be considered a fixed property of a soil because it is not readily changed. Thus, once soil texture is known and soil pH is measured, the lime requirement of a soil can be determined by referring to the appropriate table for the crop to be grown without any reevaluation of soil texture. Once growers know the soil texture, they may find portable pH meters to be helpful in the evaluation of their liming program.

For the majority of crops which have target pHs in the range of 6.3 to 6.5, refer to Table B-2 for lime requirement. For scab susceptible potatoes which have a target pH of 5.2, refer to Table B-3 for lime requirement. For beans grown on sandy Coastal Plain soils, the target pH should not exceed 6.2 (Table B-4). An excessively high pH increases the possibility of manganese deficiency in sensitive crops. On soils with a high organic matter content (greater than 6 percent) many crops with a desired pH of 6.5 can be grown at a lower soil pH (typically pH 5.6) than on mineral soils.

The typical soil test will include a summary of pH, and relative availability of Magnesium (Mg) and Calcium (Ca). Soil pH is a measure of the acidity or alkalinity of soil. While most vegetable crops grow best in soils that are slightly acid (soil pH 6.0 to 6.9) some crops such as sweet potato and some white potato varieties are best grown at soil pH 5.2. The soil test report will usually report Mg and Ca levels as "above optimum", "optimum", or "below optimum" and go further to specify low/high and very low/very high.

Table B-2 Pounds of Calcium Carbonate Equivalent (CCE) Recommended Per Acre for Crops with a Target pH of 6.5

Initial Soil pH	Soil Texture				
	Loamy Sand	Sandy Loam	Loam	Silt Loam	Clay Loam
4.1-4.4	4,500	5,400	9,800	11,600	23,300
4.5-4.8	3,600	4,500	8,100	9,800	18,800
4.9-5.2	2,700	3,600	6,300	8,100	15,200
5.3-5.6	1,800	2,700	4,500	6,300	12,500
5.7-6.0	900	1,800	3,600	4,500	8,100
6.1-6.4	500	900	1,800	3,600	5,400
Above 6.5	0	0	0	0	2,700

Table B-3 Pounds of Calcium Carbonate Equivalent Recommended Per Acre for Potato Varieties with a Target pH of 5.2

Initial Soil pH	Soil Texture			
	Loamy Sand	Sandy Loam	Loam	Silt Loam
4.5	630	990	1,350	1,790
4.6	540	810	1,160	1,520
4.7	450	630	940	1,250
4.8	360	540	760	990
4.9	270	450	540	760
5.0	180	270	400	490
5.1	90	100	180	270
5.2	0	0	0	0

Table B-4. Pounds of Calcium Carbonate Equivalent (CCE) Recommended Per Acre for Crops with a Target pH of 6.2

Initial Soil pH	Soil Texture				
	Loamy Sand	Sandy Loam	Loam	Silt Loam	Clay Loam
4.1-4.4	4,000	4,500	8,000	8,900	20,600
4.5-4.8	3,100	3,600	6,300	7,100	16,100
4.9-5.2	2,200	2,700	4,500	5,400	12,500
5.3-5.6	1,300	1,800	2,700	3,600	9,800
5.7-6.0	500	900	1,200	1,800	5,400
Above	6,500	0	0	0	2,700

Calcium Carbonate Equivalent

Soil test recommendations for liming should be given in pounds of calcium carbonate equivalent per acre (lb CCE/A). Pure calcium carbonate (CaCO_3) has a CCE of 100 percent and is the standard against which all liming materials are measured. Since the CCE of liming materials may vary from 40 to 179 percent, the amount of liming material needed to supply a given quantity of CCE will vary considerably. By law, the CCE of a liming material must be stated on the product label.

To calculate the corresponding application rate of a given liming material: (*see next page*)

Table B-5 Conversion for Pounds of Calcium Carbonate Equivalent to Pounds of Actual Liming Material Applied

Pounds/Acre CCE Recommended by Soil Test	Percent Calcium Carbonate Equivalent (% CCE) of Liming Material							
	70	75	80	85	90	95	100	105
	-----Actual Limestone Recommendation (lb/acre) ^{1,2} -----							
1,000	1,400	1,300	1,200	1,200	1,100	1,100	1,000	1,000
2,000	2,900	2,700	2,500	2,400	2,200	2,100	2,000	1,900
3,000	4,300	4,000	3,700	3,500	3,300	3,200	3,000	2,900
4,000	5,700	5,300	5,000	4,700	4,400	4,200	4,000	3,800
5,000	7,100	6,700	6,200	5,900	5,600	5,300	5,000	4,800
6,000	8,600	8,000	7,500	7,100	6,700	6,300	6,000	5,700
7,000	10,000	9,300	8,700	8,200	7,800	7,400	7,000	6,700
8,000	11,400	10,700	10,000	9,400	8,900	8,400	8,000	7,600
9,000	12,000	12,000	11,200	10,600	10,000	9,500	9,000	8,600
10,000	14,300	13,300	12,500	11,800	11,100	10,500	10,000	9,500
11,000	15,700	14,700	13,700	12,900	12,200	11,600	11,000	10,500
12,000	17,100	16,000	15,000	14,100	13,300	12,600	12,000	11,400
13,000	18,600	17,300	16,200	15,300	14,400	13,200	13,000	12,400
14,000	20,000	18,700	17,500	16,500	15,600	14,700	14,000	13,300

¹ The amount of CCE recommended in the table are for increasing the pH of an 8-inch soil layer to the desired pH value. Multiply the numbers in the table by 1.25 to adjust a 10-inch plow layer to the desired pH.

² It is not advisable to apply more than the following pounds of CCE per acre as a topdressing: loamy sand 2,000, sandy loam 3,000, loam 4,000, and silt loam 5,000. When fields are to be plowed and the CCE recommendation exceeds 3,000 pounds per acre, plow under half the needed amount and apply the other half after plowing and then disk in as deeply as possible.

$$\frac{\text{Actual amount of liming material} = (\text{Soil test CCE recommendation})}{(\% \text{ CCE of liming material})} \times 100$$

Example: Soil test recommendation is to apply 2,000 lb CCE per acre

Liming material purchased as 80% CCE

Actual amount of liming material required:
 $(2,000 \div 80) \times 100 = 2,500 \text{ lb liming material per acre}$

Table B-5 may be used instead of the formula to convert soil test recommendations for pounds CCE per acre to pounds of the actual liming materials to be applied. To use Table B-5, find your soil test limestone recommendation in the left hand column, then read across the table on the line until you come to the column headed by the percent CCE nearest to that of your liming material. Application rates may be rounded off to the nearest 500 pounds per acre practical for spreading equipment. Although liming recommendations should now be given in pounds CCE per acre, recommendations that are given as total oxides can be converted to CCE by multiplying by 1.79. Suppose the recommendation calls for 2,000 pounds per acre of total oxides; then, to convert the recommendation to CCE:

$$2,000 \times 1.79 = 3,580 \text{ pounds CCE per acre}$$

Selection of Liming Material

Liming materials neutralize soil acidity and supply Ca and Mg. Selection of the appropriate liming material based on its Ca and Mg concentrations is a key to furnishing crops and soils with sufficient amounts of these nutrients. The goal of a liming program is to establish the desired soil pH and to maintain the soil fertility levels for Mg and Ca in the *optimum* range.

Fine-sized liming materials are recommended when rapid neutralization of soil acidity is desired. Medium and coarse-sized liming materials are best suited for maintenance of soil pH once the desired soil pH range has been attained through the use of fine-sized liming material.

When the soil pH is low, the soil test levels of Ca and Mg may be *below optimum*, it is important to choose a liming material that contains a significant concentration of Mg (such liming materials are commonly referred to as dolomitic type or dolomite.) If the soil Mg level is *below optimum—very low* or *low*, use a liming material that has a minimum concentration of 9% Mg. If the soil Mg level is *below optimum—medium*, use a liming material that has 3.6 to 9% Mg. If the soil Mg level is *optimum* or *above optimum*, use a liming material that has less than 3.6% Mg (such liming materials are commonly referred to as calcitic or calcite).

Occasionally soils test *below optimum* in Mg or Ca, but do not need lime for pH adjustment. For soils needing Mg, apply Epsom salt (9.9% Mg) or sulfate of potash magnesia (21.8% Mg). If soil pH is satisfactory for the crop, but the soil test Mg level is *below optimum—very low*, apply 30 pounds Mg per acre from a Mg fertilizer. If Mg is *below optimum—low*, apply 15 pounds per Mg acre.

If soil pH is satisfactory for the crop, but the Ca level is *below optimum—very low*, apply 350 pounds Ca per acre (=1500 pounds per acre of gypsum). If the pH is satisfactory, but Ca is *below optimum—low*, apply 175 pounds Ca per acre (=750 pounds per acre of gypsum)

Timing of Application

Lime is slow to react in soil. The desired soil pH increase may require several months. Thus, it is important to plan ahead and apply lime several months in advance of planting. Lime can be applied at any time of the year provided weather and soil conditions permit. Plan ahead and apply lime well in advance of planting crops that are sensitive to soil acidity. Fall applications have the advantage of allowing the lime to react in the soil prior to the start of the next growing season.

Careful attention to liming prior to planting perennial crops is important. Once the crop is established, it is difficult to correct a soil acidity problem using surface applications of lime. Lime should be applied at least six months to a year in advance of planting to insure that the target pH has been achieved.

Soils naturally become acidic over time. The frequency of lime application varies with soil characteristics, cropping system, and fertilizer practice. Heavy use of ammonium and urea nitrogen fertilizers speed soil acidification. Soil testing for pH measurement should be performed every one to three years. Relime soils before pH drops below the desired range to avoid development of excess acidity in the root zone.

Lime Placement

Lime applications are most effective at neutralizing acidity when they are spread uniformly and thoroughly mixed with the soil by plowing, disking, and harrowing. When applying large amounts of lime, it is best to use split applications. Apply half the lime and plow it under. Next apply the other half to the plowed surface and disk it into the soil.

Whenever tillage is not possible (e.g. perennial crops, no-tillage systems), surface applications are recommended but the rate of pH adjustment is much slower. Monitor soil pH change and the need for lime to avoid higher lime requirements. Surface lime application rates should not exceed 3,000 pounds CCE per acre.

Special Considerations

Potato scab is caused by a soil-inhabiting fungus (*Streptomyces scabies*). The disease is suppressed in acid soils (pH <5.2) but the addition of lime favors development of scab. When lime is needed, it is best to apply the lime after potato harvest and before the other crops grown in rotation. The optimum soil pH for growing scab susceptible potato varieties is about 5.0 to 5.2. Scab resistant varieties may be grown at pH 5.5 to 6.2.

Cabbage, broccoli, and leafy greens are subject to infection by the clubroot fungus. If clubroot is known to be present, cole crops should be grown at pH 6.5 to 7.0. The disease is suppressed at pH 7.2 to 7.4 but crop production and/or quality may be decreased.

Sweet potato production is optimum at pH 5.2. Use Table B-3 to adjust soil pH.

Spinach requires an initial pH of 6.5 to 6.7 for good growth and leaf quality. Calcium levels in the soil should be medium or optimum and in balance with magnesium. Plan ahead and adjust pH, calcium, and magnesium the season before planting spinach.

Lime and Fertilizer

Lime and fertilizer work together as a team to produce high yields and better crops. Lime is not a substitute for fertilizer, and fertilizer is not a substitute for lime. The proper use of the two together makes for profitable vegetable crop production. The rate and frequency of their use depend on the crop to be grown, type of soil, soil acidity, and past use of fertilizer materials.

PLANT NUTRIENTS

Many factors influence the nutrient requirements for optimum yield and quality of a given vegetable crop. The parent material of soils, textural classification, cation exchange capacity, organic matter content, and drainage are important soil properties that influence the rates of nutrients applied to vegetables. In addition, rainfall amounts and distribution, irrigation types and management, soil and air temperatures during the growing season can alter the retention, availability, and uptake of nutrients. Varieties within a vegetable species often differ significantly in their nutrient requirements. Growers are encouraged to test soils to determine the kinds and amounts of preplant fertilizer nutrients required for optimum production. During the growing season, sap and tissue testing should be used when they have been shown to be effective to adjust nutrient applications to current growing conditions and the nutrient status of the crop.

Pennsylvania growers will receive soil test results directly from the Agricultural and Analytical Services Laboratory, College of Agriculture, The Pennsylvania State University. Growers in Delaware, Maryland, New Jersey, and Virginia should use Tables B-7, and B-10 as described below.

See important notes and discussion in the following Plant Nutrient Recommendations section to adjust nutrient rates and timing based on soil type, cation exchange capacity cropping and manure history, and soil temperatures.

Soil Fertility Test Interpretation

A soil fertility test evaluates the nutrient-supplying power of a soil. The results of the test are used to predict if, or how much fertilizer is required for optimum plant growth. The relationship between soil nutrient level and plant response is shown in Figure B-1. Relative fertility levels, are classified into three main categories: *Below optimum*, *optimum* and *above optimum*. *Below optimum* is divided into subcategories: *very low*, *low*, and *medium*. These soil fertility categories gauge the probability of a plant showing a beneficial response to the addition of a given nutrient (assuming that other factors such as temperature, moisture, disease are not limiting growth). The critical level is the soil test level; below which a crop response to a nutrient application may be expected, and above which no crop response is expected. At very high soil test levels crop yield may decrease.

Soil Test Categories

The soil test categories as described in Table B-6 are the basis for how much phosphorus (P) and potassium (K) to apply to reach optimum growth levels. For limestone recommendations, these categories indicate the concentrations of calcium (Ca) and magnesium (Mg) most suitable for use as a liming material. Soil test categories, along with crop nutrient requirements, are the basis for nutrient recommendations.

For example, when the soil test category for K is *below optimum—low* the recommendation will indicate how much K to apply. The amount of K recommended however, varies amounts of nutrients. Generally, crops that produce large

yields of harvestable material will remove large amounts of nutrients from the soil and will have a higher nutrient recommendation. When the soil fertility category is *below optimum*, the nutrient recommendation for a particular crop is designed to achieve its full crop yield potential and to build depending on the crop. Various crops accumulate different the soil fertility level into the *optimum* range over time. If the soil fertility level is already in the *optimum* range, the nutrient recommendation is designed to replace the amount of nutrient removed by the crop so as to maintain *optimum* soil fertility. No nutrient application is generally recommended when the soil test category is *above optimum*. This allows “draw-down” of the nutrient level to the *optimum* range. These concepts are illustrated in Figure B-2 and summarized in Table B-6.

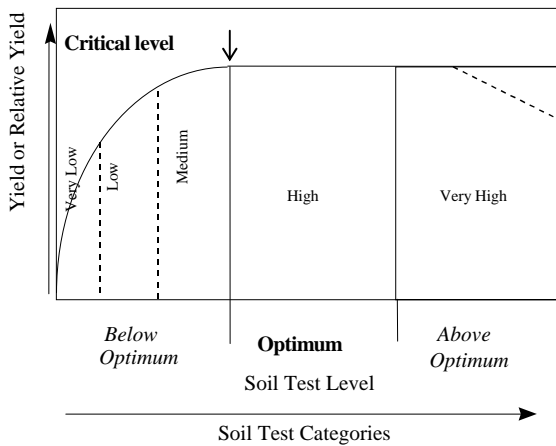


Figure B-1. The relationship between soil test levels and yields.

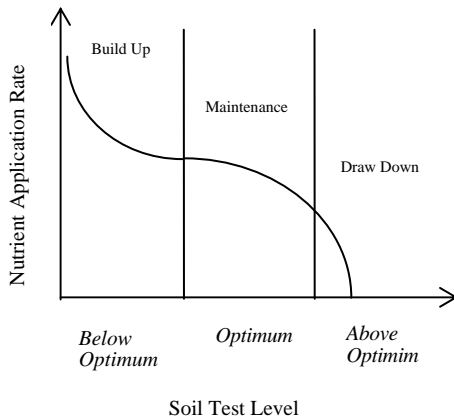


Figure B-2. Nutrient application rates vary in relation to soil test category.

Soil Test Method and Interpretation

A common misconception is that a soil fertility test is a direct measurement of the total nutrient content of a soil that is available to the plant. Soil test values have historically

been expressed in units of pounds per acre, but they have no meaning in terms of actual quantity of plant-available nutrients. A soil test only provides an index of soil nutrient availability that is correlated with plant response. This correlation is determined by soil test calibration research and is the foundation for soil test interpretation.

Many different types of soil test extraction methods are in use, but only a few are appropriate for our local soils. The Mehlich-3 soil test is most appropriate for soil types found in the Mid-Atlantic Region. Soil test results and interpretations are specific for the soils of a region and for the particular soil test method employed. The soil test values for the Mehlich-3 categories (Table B-7) were established based on research conducted on soils in the Mid-Atlantic Region. The categories were developed from crop yields that were observed during nutrient response studies conducted over a range of soil test levels.

Reading and understanding the soil report from any particular laboratory depends on knowing what soil test method is being used and what units are used to express the soil nutrient levels. If the soil test report does not state the method used, call the laboratory to find out. This information is needed before interpreting the soil test results based on the categories given in Table B-7.

Plant Nutrient Recommendations

To obtain the best results, always base plant nutrition decisions on a current soil test. When soil test results are not available, use recommended amounts of P₂O₅ and K₂O listed under medium phosphorus and medium potassium soil test levels for the crop to be grown. Although this is not necessarily accurate, the chances are good that beneficial results will be obtained.

Refer to Table B-7 to interpret the relative levels of phosphorus and potassium in the soil based on the soil test report from the laboratory.

When a current soil test is available, use recommendations for the specific commodity listed under Recommended Nutrients Based on Soil Tests located in Section F

The following adjustments to the nutrient recommendations in section F are recommended based on soil type and cation exchange capacity.

1. For most vegetables grown on light-textured soils, apply the total recommended P₂O₅ and K₂O together with 25 to 50 percent of the recommended nitrogen before planting. The remaining nitrogen can be sidedressed with a fertilizer containing nitrogen only. Sidedressing or topdressing potash (K₂O) is recommended only on extremely light sandy soils with very low cation exchange capacities.
2. It may be desirable to build up the phosphorus and potassium levels in very low-fertility loam and silt loam soils more rapidly than provided by these recommendations. In such instances, add an additional 40 to 50 pounds of P₂O₅ and K₂O, respectively, to the recommendations listed in the table for soils testing low in phosphorus and potassium. Apply the additional amounts in broadcast and plow down or broadcast and disk-in application.

3. **For Pennsylvania growers producing vegetables clay loam soils:** If you use the recommendations in the tables in section F, reduce the recommended nitrogen and potassium rates by 20 percent and increase the phosphorus rate by 25 percent of the rates indicated in the table.

Plant nutrient recommendations listed in tables in Section F under Recommended Nutrients Based on Soil Tests 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 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—low, medium, optimum, or excessive.

The cropping and manuring history of the field must be known before a fertilization program can be planned. This history is very important in planning a nitrogen fertilization program.

Plant nutrient recommendations listed in tables in Section F under Recommended Nutrients Based on Soil Tests were developed for fields where no manure is being applied and where no legume crop residue is being incorporated prior to the planting of a new crop. If manure and/or legume crops are being used, the plant nutrient recommendations in the specific commodity should be reduced by the amounts of nitrogen (N), phosphate (P_2O_5), and potash (K_2O) being contributed from these sources. See Table B-9 for value credits to be allowed for manure applications and legume crop residues.

When warm season crops, such as sweet corn, tomatoes, peppers, eggplants, and the vine crops are seeded or transplanted and soil temperatures are below 65°F (18.3°C), 20 pounds per acre of P_2O_5 may be applied to replace the phosphorus removed by the crop when soil test levels for phosphorus are above optimum.

Once the final fertilizer-plant nutrient needs are determined, it will then be necessary to 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), you would need a fertilizer with a 1:2:3 ratio, such as a 5-10-15, 6-12-18, 7-14-21, etc. Once you have selected the grade of fertilizer you need to use, 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 you choose a 5-10-15 fertilizer grade to supply the 50 pounds of N, 100 pounds of P_2O_5 , and 150 pounds of K_2O needed, you can 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 of fertilizer needed. When you use this system, it is possible for you to select your fertilizer needs based on the most economical fertilizer grades available to you. In cases where the preferred grade is not available, it is also possible to

change from one fertilizer grade to another, providing the plant nutrient ratio is the same. This flexibility may be necessary because of a shortage of some fertilizer materials.

NUTRIENT MANAGEMENT

Phosphorus Management

Crops are very likely to respond to P fertilization when the soil test indicates that P is *below optimum*—*very low* or *low*. A soil testing *below optimum*—*medium* will sometimes respond to P fertilization and will sometimes not. Soils testing *optimum* or *above optimum* 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 are *above optimum*, a small amount of banded P may benefit crop establishment. When the soil test level is *below optimum*, P should generally be applied as a combination of broadcast and banded methods. When the level is *above optimum*, only a small amount of P may be applied as a band. Many soils test *above optimum* 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 is *above optimum*, 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 *below optimum*—*very low* or *low*. A soil testing *below optimum*—*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 *above optimum* are unlikely to respond to K fertilizer, but K may be applied to maintain the fertility level in the *optimum* range.

In general, most of the K fertilizer should be broadcast. When the fertility level is *below optimum*, 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 *above optimum*.

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, more frequent applications of K are needed to maintain K at an optimum fertility level.

Secondary and Micronutrient Management

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. Magnesium may be applied as a foliar spray to supply magnesium to the crop in emergency situations. Contact your county Extension agent for recommendations.

Sulfur is an important nutrient for plants, those especially in the onion family and cole crops. Sulfur may become deficient on light, sandy 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. Sulfur levels where greater than 5 ppm will cause increased pungency in sweet Spanish onions. Sulfur can be supplied by application of sulfur-containing nitrogen fertilizers, gypsum, or epsom salts. See Table B-8.

Table B-6 Definition of Soil Fertility Test Categories

Category Names (Commonly used terms)	Category Definition	Recommendations
Below Optimum (Very Low, Low, Medium)	The nutrient is considered deficient and will probably limit crop yield. There is a high-to-moderate probability of an economic crop yield response to additions of the nutrient.	Recommendations are based on crop response. These recommendations will generally build the soil into the optimum range over time. Starter fertilizer is recommended as appropriate.
Optimum (High)	The nutrient is considered adequate and will probably not limit crop growth. There is a low probability of economic crop yield response to additions of nutrient.	If soils are tested annually, no nutrient additions are needed for the current crop. For other than annual testing, recommendations are generally for maintenance applications to maintain the soil in the optimum range. Starter fertilizer is recommended as appropriate
Above Optimum (Very High)	The nutrient is considered more than adequate and will not limit crop yield. There is a very low probability of an economic crop yield response to additions of the nutrient. At very high levels there is a possibility of a negative impact on the crop if nutrients are added.	No nutrient additions are recommended. Starter fertilizer may be recommended as appropriate. At very high levels, remedial action may be required.

Adapted from *Recommended Soil Testing Procedures for The Northeastern United States*, Northeastern Regional Publication No. 493.

Table B-7 Soil Test Categories for Nutrients Extracted by Mehlich 3 and Mehlich 1

	Soil Test Category	Mehlich – 3 Soil Test Value (lbs/acre) ^{2,3}			
		Phosphorus (P)	Potassium (K)	Magnesium (Mg)	Calcium (Ca) ¹
Mehlich 3	Below Optimum (very low)	0-24	0-40	0-45	0-615
	Below Optimum (low)	25-45	41-81	46-83	616-1007
	Below Optimum (medium)	46-71	82-145	84-143	1008-1400
	Optimum (high)	72-137	146-277	144-295	1401-1790
	Above Optimum (very high)	138+	278+	296+	1791+
Mehlich 1		Mehlich – 1 Soil Test Value (lbs/acre) ²			
	Below Optimum (very low)	0-13	0-29	0-35	0-400
	Below Optimum (low)	14-27	30-70	36-70	401-800
	Below Optimum (medium)	28-45	71-134	71-125	801-1200
	Optimum (high)	46-89	135-267	126-265	1201-1600
	Above Optimum (very high)	90+	268+	266+	1601+

¹ Calcium values are for sandy loam soils. Multiply the calcium values in the table above by 0.625 to use for loamy sand soils; by 1.25 for loam soils; by 1.5 for silt loam soils, and by 1.75 for clay loam soils.

² Values are reported in elemental forms.

³ Soil tests that based on Bray-1 extractable P and neutral, 1N ammonium acetate extractable, K, Ca, and Mg are very similar to the Mehlich-3 extractable amounts of these nutrients.

⁴ Soil fertility levels for Ca, Mg, and K in the optimum range should typically have about 65 to 70% Ca to 10 to 20% Mg, and 3 to 5% K saturation of the soil cation exchange capacity.

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. See Table B-10 for boron recommendations for various crops based on soil test results. Use of excessive amounts of boron can be very toxic to plant growth. Do NOT exceed recommendations listed in Table B-10 and in specific commodity recommendations section for Plant Nutrient Recommendations Based on Soil Tests for Vegetable Crop Production.

Manganese deficiency often occurs in plants growing on soils that have been overlimed. A broadcast application of 20 to 30 pounds or a band application of 4 to 8 pounds of manganese per acre will usually correct the deficiency. When manganese is applied as manganese sulfate, foliar application of 0.5 to 1 pound of manganese in 20 gallons of water per acre in one to three applications usually will help relieve the deficiency. Use a sulfate or chelate of manganese. 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 in cauliflower (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 to the acre will usually correct this deficiency. 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 this area are rare; and when present, are usually caused by overliming or other poor soil management practices. Contact your county Extension agent if you suspect a deficiency of zinc, iron, copper, or chlorine in your crops. Sources of fertilizers for the essential plant nutrients may be found in Table B-8.

Sustainable Nutrient Management

A major objective of nutrient management is to bring the soil fertility level into the optimum range and to sustain that fertility level for the long term. Once the soil fertility has been built up to the *optimum* level, the nutrient application rate should be only large enough to maintain the *optimum* level. This can be accomplished by applying nutrients at a rate that closely matches the rate of nutrient removal in the harvested crop. The rate may need to be slightly higher to account for other losses such as leaching.

Keeping records of soil test results enables growers to track changes over time and to adjust recommendations as needed to maintain soil fertility in the *optimum* range. Meaningful records require a consistent approach to soil testing in terms of sample collection, sampling depth, and laboratory submission. Soil test levels can vary somewhat from sample to sample, and having records helps to spot unusual soil test values that should be rechecked.

Although soil fertility levels naturally fluctuate from year to year due to crop rotation and manure application, the average trend over time should remain in the *optimum* range, as shown in Figure B-3. If soil fertility levels are observed to fall *below optimum*, under fertilization is indicated. The nutrient recommendation should be adjusted so that the nutrient application rate is large enough to meet the needs of the current crop and also gradually rebuild the nutrient supply

to the *optimum* level. If soil fertility levels are observed to climb well *above optimum*, good crop yields can be obtained without adding the nutrient. Over a period of time, nutrient removal by crops should allow the soil fertility level to fall back into the *optimum* range (see Fig. B-2).

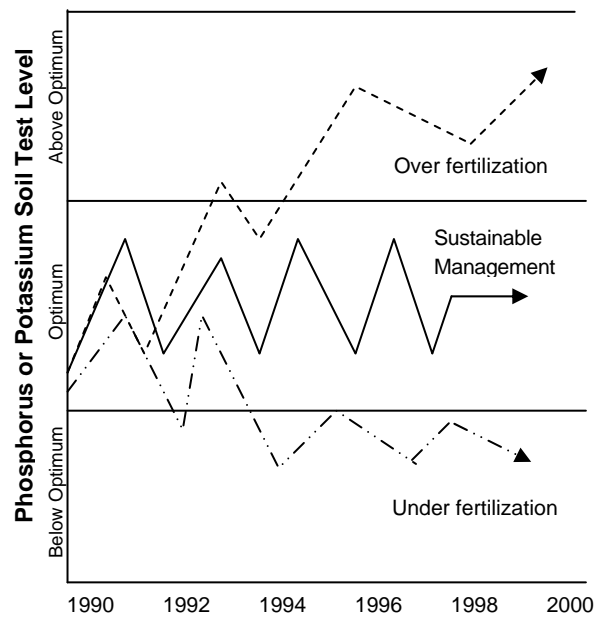


Figure B-3. Changes in soil test levels over time under different nutrient management scenarios.

Sewage Sludge

Sewage sludge is a by-product of the purification of waste-water. Sewage sludge has significant organic matter content and contains micro- and macronutrients essential for plant growth. Sewage sludge can also contain contaminants such as heavy metals, organic contaminants, and pathogens. Before it can be used for land application, sewage sludge must undergo additional treatment to stabilize and disinfect it. If the sewage sludge can be beneficially used, it is also called biosolids. After appropriate treatment, federal and some state regulations allow the use of sewage sludge on vegetables. However, Cooperative Extension guidelines are more conservative than current regulations due to disagreements related to research, public perception, and liability issues. **Cooperative Extension does not recommend the application of sewage sludge to soils used for vegetable production.**

If the grower elects to use biosolids despite this warning, the material should not be applied to steeply sloping land, soils with bedrock near the surface, highly leachable soils, soils having a pH less than 6.0, soils with high water tables, or fields near surface water. When considering the land application of biosolids, carefully review the regulations and consult your county Extension Agent.

Foliar Fertilization

It is known that plants can absorb a limited amount of some nutrients through aerial organs such as leaves in addition to the root system. Properly managed soils are usually able to supply the essential mineral nutrients the crop will need during

its development. If one or more soil-supplied nutrients become deficient or unavailable during the development of the crop, foliar nutrient applications may then be beneficial.

Very high soil nutrient levels can be as detrimental as low or deficient levels. High soil nutrient levels may not only result in an economic loss but they may also cause problems to animals or the environment. Very high P levels (above about 370 lbs P₂O₅/acre or 160 lbs P/acre) in the soil may lead to nutrient deficiencies, especially of iron and zinc. High K levels (above about 205 lbs K₂O/acre or 170 lbs K/acre) can induce magnesium or calcium deficiency through competition for plant uptake and vice versa. Use best management practices to avoid increasing soil nutrient levels that are already high.

Organic Nutrient Sources

Cover Crops

Seeding spring oats at 60 to 100 pounds per acre during August or early September provides a good cover crop that will winter-kill in the colder areas but may overwinter in warmer areas. Rye or wheat can be seeded at 80 to 110 pounds per acre after early September. These crops can also provide strips for wind protection during the early part of the next growing season. A mixture of annual and perennial ryegrass (domestic) seeded at 15 pounds per acre before September is also a good cover crop.

Proper management of living cover crops can reduce nutrient loss during the winter and early spring. Living cover crops should be disked or plowed to return nutrients to the soil and before they seriously deplete soil moisture.

Summer cover crops such as sudangrass or sudex, seeded at 20 to 40 pounds per acre are good green manure crops. They can be planted as early as field corn is planted and as late as August 15 in Maryland and Virginia, and July 25 to August 1 in cooler areas of New Jersey and Pennsylvania. 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 in wheat or rye in September or allowed to winter-kill and tilled in the spring.

Many soils that are not very productive due to poor physical properties can be restored and made to produce good crops through the use of a good resting-crop program. This practice also helps to counteract the buildup of many diseases and insects that attack vegetable crops. Small grains, sudangrass, sudex, timothy, orchardgrass, and ryegrass are good soil-resting crops. Consult your state field crop or agronomy recommendations for details on seeding rates and management practices.

Intensive cropping, working the soil when it was too wet, and excessive traffic from using heavy-tillage equipment have severely damaged many soils. These practices cause the soils to become very hard and compact, resulting in poor seed germination, loss of transplants, and shallow root formation of surviving plants. Also, such soils crust easily and compact severely, making them very difficult to irrigate properly and results in poor plant stands, poor crop growth, low yields, and loss of income. Subsoil Tilling in the row may help improve aeration and drainage

of soils damaged by several years of excessive traffic from heavy-tillage equipment.

Alfalfa can aid in breaking up deep soil compaction. It is useful as a soil-resting crop and in crop rotations. However, it should not be used in rotation with soybeans; peas; snap, dry, and lima beans; especially where soil-borne diseases have been a problem.

Compost and Manure

Application and incorporation of compost to soils will increase soil organic matter and certain soil nutrient levels. Since compost ingredients can include animal manures, scrap table foods, food wastes, leaves, grass, and sawdust both microbial and nutrient content (phosphorus) of the compost become extremely important considerations in field applications. Microbial populations (*E. coli* 0157:47, *Listeria*, *Salmonella*, etc.), heavy metals such as nickel, lead, or cadmium and excessive nutrient levels such as nitrogen may be present in the compost so that it should not be used for edible food production. Also, the ingredients, which make up specific compost may be highly alkaline, resulting in a high compost pH of 7.5 to 8.5. Therefore, application rates of compost must be determined by considerations of nutrient content, microbial content, crop use, and pH before field applications are made. Applications should be made at low rates (1 to 3 tons per acre) since high rates of compost (10+ tons per acre) can result in soil pH problems, nutrient imbalance in the soil, or microbial contamination of edible crops.

Organic Production

Nutrient sources used for certified organic production must be approved by the Organic Materials Review Institute. See Publication Resources in Section R of this publication, or visit the website at www.omri.org for detailed information.

Table B-8. Percentage Equivalents and Conversion Factors for Major, Secondary, and Micronutrient Fertilizer Sources

Fertilizer Source Material	Plant Food Contents, %	Lb of Material Required to Supply 10 Lb of the Initially Listed Plant Nutrient
<i>Nitrogen Materials</i>		
Monoammonium phosphate*	11 (N) and 48 (P ₂ O ₅)	91
Nitrate of potash*	13 (N) and 44 (K ₂ O)	77
Nitrate of soda-potash*	15 (N) and 14 (K ₂ O)	67
Calcium nitrate*	15 (N) and 19 (Ca)	67
Nitrate of soda	16 (N)	63
Diammonium phosphate*	18 (N) and 46 (P ₂ O ₅)	56
Nitrogen solution	20 (N)	50
Ammonium sulfate*	20.5 (N) and 23 (S)	49
Ammonium sulfate nitrate*	26 (N) and 14 (S)	38
Nitrogen solution	30 (N)	33
Nitrogen solution	32 (N)	31
Ammonium nitrate	33.5-34.0 (N)	30
Nitrogen solution	40 (N)	25
Urea	45-46 (N)	22
Anhydrous ammonia	82 (N)	12

(table continued next page)

Table B-8. Percentage Equivalents and Conversion Factors for Major, Secondary, and Micronutrient Fertilizer Sources

Fertilizer Source Material	Plant Food Contents, %	Lb of Material Required to Supply 10 Lb of the Initially Listed Plant Nutrient
Phosphorus Materials		
Normal superphosphate*	20 (P ₂ O ₅) and 11 (S)	50
Triple superphosphate*	44-46 (P ₂ O ₅)	22
Monoammonium phosphate*	11 (N) and 48 (P ₂ O ₅)	21
Diammonium phosphate*	18 (N) and 46 (P ₂ O ₅)	22
Potassium Materials		
Nitrate of soda-potash*	13 (N) and 14 (K ₂ O)	71
Sulfate of potash-magnesia*	21.8 (K ₂ O) and 11.1 (Mg)	46
Nitrate of potash*	13 (N) and 44 (K ₂ O)	23
Sulfate of potash*	50 (K ₂ O) and 17 (S)	20
Muriate of potash*	60 (K ₂ O)	17
Magnesium Materials		
Epsom salts*	10 (Mg) and 13 (S)	96
Sulfate of potash-magnesia*	21.8 (K ₂ O) and 11.1 (Mg)	90
Kieserite*	18.1 (Mg)	55
Brucite	39 (Mg)	26
Sulfur Materials		
Granulated sulfur	90-92 (S)	11
Ammonium sulfate*	23 (S) and 20.5 (N)	43
Gypsum*	15-18 (S) and 19-23 (Ca)	61
Ammonium sulfate nitrate	14 (S) and 26 (N)	71
Epsom salts*	13 (S) and 10 (Mg)	77
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
*Best for fertilizer blends		
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

Table B-9. Plant Nutrient Value Credits to Be Allowed for Manure Applications and Crop Residues

	N	P ₂ O ₅	K ₂ O
----- Pounds per Ton -----			
Cattle manure	5-10 ¹	3	3
Poultry manure	25-50 ¹	40-80	30-60
Pig manure	5-10 ¹	2	2
Horse manure	6-12 ¹	3	6
Liquid poultry manure (5-15% solids)	7-15 ¹	5-10	5-10
----- Pounds per Acre -----			
Alfalfa sod	50-100 ²	0	0
Hairy vetch	50-100	0	0
Ladino clover sod	60	0	0
Crimson clover sod	50	0	0
Red clover sod	40	0	0
Birdsfoot trefoil	40	0	0
Lespedeza	20	0	0
Soybeans			
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.

* Best for fertilizer blends

Table B-10. Boron Recommendations Based on Soil Tests for Vegetable Crops

Interpretation of Boron Soil Tests			Crops that Often Need Additional Boron ¹	Boron (B)
Parts per Million	Pounds per Acre	Relative Level		Recommendations Pounds per Acre ²
0.0-0.35	0.0-0.70	Low	Beets, broccoli, brussels sprouts, cabbage, cauliflower, celery, rutabaga, and turnips	3
			Asparagus, carrots, eggplant, horseradish, leeks, muskmelons, okra, onions, parsnips, radishes, squash strawberries, sweet corn, and tomatoes	2
			Peppers and sweet potatoes	1
0.36-0.70	0.71-1.40	Medium	Beets, broccoli, brussels sprouts, cabbage, cauliflower, celery, rutabaga, and turnips	1½
			Asparagus, carrots, eggplant, horseradish, leeks, muskmelons, okra, onions, parsnips, radishes, squash, strawberries, sweet corn, and tomatoes	1
>0.70	>1.40	High	All crops	0

¹ If boron deficiency is suspected in vegetable crops not listed above, a soil and/or plant tissue test should be made and used as a basis for treatment recommendations.

² Approximate conversion factors to convert elemental boron (B) to different boron sources: Boron (B) x 9 = borax (11.36% B); boron (B) x 7 = fertilizer borate granular (14.3% B); boron (B) x 6.7 = fertilizer borate-48 (14.91% B); boron (B) x 5 = fertilizer borate-65 (20.2% B) or Solubor (20.5% B); boron (B) x 4.7 = fertilizer borate-68 (21.1% B).

Note. The most practical way to apply boron as a soil application is as an additive in mixed fertilizer bought specifically for the crop or field where it is needed. Do not use fertilizer containing more than 0.5 pound of boron (B) per ton of fertilizer for crops not listed above, unless specifically recommended. To avoid possible boron toxicity damage to crops, apply boron in broadcast fertilizer rather than in bands or as a sidedressing. Boron may be broadcast preplant as a soluble spray alone or with other compatible soluble chemicals.

IRRIGATION MANAGEMENT

BASIC PRINCIPLES

Moisture management throughout the growing season is a critical factor for production of high quality vegetables. Even relatively short periods of inadequate soil moisture can adversely affect many crops. Thus, supplemental 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, as well as yields or even result in irreversible damage. Over-irrigating, especially late in the season, can reduce quality and postharvest life of the crop. Table C-1 shows the periods of crop growth when an adequate supply of water is critical for high quality vegetable production.

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 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 the plant, is the major factor. Other important factors include air temperature, wind speed, and humidity level. Different crops also have different rates of transpiration.

Table C-1. Critical Periods of Water Need by Crops

Crop	Critical Period
Asparagus	Brush
Beans: lima	Pollination and pod development
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	Seed enlargement and flowering
Peppers	Flowering and fruit development
Potatoes: white	Tuber set and tuber enlargement
sweet	Root enlargement
Radishes	Root enlargement
Strawberries	Establishment, runner development, fruit enlargement
Squash: summer	Bud development and flowering
Tomatoes	Early flowering, fruit set, and enlargement
Turnips	Root enlargement

Plant factors that affect the crop irrigation requirement are crop species; canopy size and shape; leaf size, shape, and orientation; plant population; rooting depth; and stage of growth and development of the crop. The plant canopy size

and shape influences transpiration, light absorption, reflection, and the rate at which water evaporates from the soil. Crops which completely shade the soil surface (mature corn, potatoes, snap beans) use more water than crops which do not have a complete canopy (immature plants, recently transplanted crops, certain species grown on mulched beds). Leaf architecture affects the transpiration rate from individual leaves. Rooting depths vary with crop species and may be affected by compaction or hard pans which may exist. Rooting depth determines the volume of soil from which the crop can draw water and is important when determining to what depth the soil must be wetted when irrigating.

Plant growth stage also influences the susceptibility of crops to moisture stress. Irrigation is especially useful when establishing newly seeded or transplanted crops. During seedling or transplant growth, especially the first 1-2 weeks, the root system is not yet established in surrounding soil. Irrigation after transplanting can significantly increase plant survival, especially when soil moisture is marginal and ET is high. Irrigation can also increase the uniformity of emergence and final stand of seeded crops. For seeded crops, reduce the rate of application and the total amount of water applied to avoid crusting. If crusting is present, apply low rates and amounts of irrigation water to soften the crust while seedlings are emerging.

Cultural practices also influence ET. Cultivation, mulching, weed growth, and method of irrigation are factors to consider. Cultivation generally increases soil evaporation but if crop roots are pruned by cultivating too close, water uptake and, thus, transpiration may be reduced. Shallow cultivation may help eliminate soil crusts and, therefore, improve water infiltration from rainfall or irrigation. The effects of mulching are discussed in the next section. Weeds compete with the crop for water and increase the amount lost through transpiration. Sprinkler irrigation wets the entire crop area and, thus, has a greater evaporation loss than does trickle irrigation which wets only the area in the region of the crop.

Soil factors must also be considered. Soils having high levels of silt, clay, and organic matter have greater available water-holding capacities than do sandy soils or soils that are compacted (Table C-2). Available water refers to the amount of water that a plant is able to withdraw from the soil. Soils with high available water-holding capacities require less frequent irrigation than soils with low available water-holding capacities. However, when irrigated less frequently, a greater amount of water must be applied per application.

Table C-2. Available Water Holding Capacity Based on Soil Texture

Soil Texture	Available Water Holding Capacity (inch of water/inch of soil)
Coarse sand/compacted sands	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/compacted loams	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

Another soil factor which influences 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. Excessive water conditions may lead to erosion from runoff and elevated disease incidence. Table C-3 lists the typical infiltration rates of several soils.

Table C-3. 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

There is no simple method to accurately schedule irrigations since all the above factors interact to determine actual ET. Research is currently under way to develop methods for growers to use in scheduling irrigations for example canopy leaf temperature or water content. In the absence of proven methods to estimate ET, the following factors should be kept in mind when deciding when and how much to irrigate.

1. Soils vary greatly in water-holding capacity and infiltration rate. Silt and clay soils and those high in organic matter can hold much more water than sandy soils low in organic matter.
2. Water loss from plants and the soil surface is much greater on clear, hot, windy days than on cool, overcast, humid days. During periods of hot, dry weather, ET rates may reach 0.25 inch/day or higher. ET can be estimated by the use of a standard evaporation pan (check with your county extension office for information on using pans).
3. Results from research show that maintaining soil moisture levels in a narrow range, just slightly below field capacity (75 to 90 percent soil moisture), maximizes crop response. 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 percent soil moisture) and then applying a heavy irrigation.
4. Mulches reduce evaporation from the soil but also reduce the amount of water that can reach the root zone from rains. Thus, much of the natural precipitation should be ignored when scheduling irrigations for crops grown under plastic mulch.
5. In general, apply 0.25 inch or more of water in any one irrigation, except during early season when establishing crops. This will ensure that water reaches active areas of the root zone.

TRICKLE/DRIP IRRIGATION

Trickle (or drip) irrigation is a method of slowly applying small amounts of water directly to the plant root zone. Water is applied frequently, often daily, to maintain favorable soil moisture conditions. The primary advantage of trickle irrigation systems is that less water is used than with sprinkler or surface irrigation systems. In many cases, one-half or less of the water applied with sprinkler or surface systems is required with trickle systems. In addition, fertilizers applied through the trickle irrigation system are conserved along with water. Trickle irrigation is used on a wide range of fruit and

vegetable crops (e.g. muskmelons, watermelons, squash, peppers, eggplants, and tomatoes). It is especially effective when used with mulches and on sandy soils. Trickle irrigation systems also have several other advantages over sprinkler and surface irrigation systems. Low flow rates and operating pressures are typical of trickle systems. These characteristics lead to lower energy and equipment costs. Once in place, trickle systems require little labor to operate, can be automatically controlled, and can be managed to apply precisely the amount of water needed by the crop. These factors also reduce operating costs.

With most trickle systems, disease and insect damage is reduced because leaves are not wetted. The areas between rows also remain dry, thus reducing weed growth between rows and reducing the amount of water lost to weeds. Consequently, fewer pests and pathogens are encouraged in these areas of the field. In addition, field operations can continue during irrigation.

There are also several potential problems which are unique to trickle irrigation systems. Most of these require that a higher level of management be used with trickle systems than is used with other irrigation systems. Moisture distribution in the soil is limited with trickle 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. This requires that the trickle system be carefully managed.

The equipment used in trickle systems also presents potential problems and drawbacks. Trickle equipment can be damaged by insects, rodents, and laborers, and often has a higher initial investment cost than other system types. Pressure regulation and filtration require equipment not commonly found on sprinkler or surface systems. The trickle system, including pump, headers, filters, and connections must be checked and ready to operate before planting. Failure to have the system operational could result in costly delays, poor plant survival or irregular stands, and reduced yield. In addition, it is not practical to use trickle systems for frost control and the irrigation of solid-stand crops, such as forages and cereals.

Calculating the length of time required to apply a specific depth of water with a trickle irrigation system is more difficult than with sprinkler systems. Unlike sprinkler systems, trickle 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 and should be used to calculate system run-times. Table C-4 has been prepared to calculate the length of time required to apply one inch of water with a trickle irrigation system, based on the trickle tube flow rate and the mulched width. The use of this table requires that the trickle system be operating at the pressure listed in the manufacturers specifications.

On coarse-textured soils, applying an inch of water to the mulched width may not be affective. Because water is not absorbed by soil particles, it moves below the plant root zone, carrying nutrients and pesticides beyond the reach of the plant roots. Table C-5 has been prepared to calculate the maximum recommended irrigation period for trickle irrigation systems. The irrigation periods listed are based on the assumption that 50 percent of the available water in the plant root zone is depleted (see next section on the use of tensiometers for determining when this occurs). Soil texture directly influences the water-holding capacity of soils and,

therefore, the depth reached by irrigation water. The irrigation periods listed in Table C-5 will result in a water infiltration depth of 12-18 inches.

Table C-4. Hours Required to Apply 1 Inch Water to Mulched Area

Trickle Tube Flow Rate		Mulched Width (ft)				
(gph/100 ft)	(gpm/100 ft)	2.0	2.5	3.0	3.5	4.0
8	0.13	15.5	19.5	23.5	27.0	31.0
10	0.17	12.5	16.5	18.5	22.0	25.0
12	0.20	10.5	13.0	15.5	18.0	21.0
16	0.27	8.0	10.0	11.5	13.5	15.5
18	0.30	7.0	8.5	10.5	12.0	14.0
20	0.33	6.0	8.0	9.5	11.0	12.5
24	0.40	5.0	6.5	8.0	9.0	10.5
30	0.50	4.0	5.0	6.0	7.0	8.5
36	0.60	3.5	4.5	5.0	6.0	7.0
40	0.67	3.0	4.0	4.5	5.5	6.0
42	0.70	3.0	4.0	4.5	5.0	6.0
48	0.80	2.5	3.0	4.0	4.5	5.0
50	0.83	2.5	3.0	4.0	4.5	5.0
54	0.90	2.5	3.0	3.5	4.0	4.5
60	1.00	2.0	2.5	3.0	3.5	4.0

Table C-5. Maximum Irrigation Periods (Hours) for Trickle Irrigation Systems

Trickle Tube Flow Rate		Soil Texture				
(gph/100 ft)	(gpm/100 ft)	Sand	Loamy Sand	Sandy Loam	Clay Loam	Silt Loam
12	0.2	5.0	8.0	11.5	15.5	17.5
18	0.3	3.5	5.0	7.5	10.5	11.5
24	0.4	2.5	4.0	5.5	8.0	8.5
30	0.5	2.0	3.0	4.5	6.5	7.0
36	0.6	1.5	2.5	4.0	5.0	6.0
42	0.7	1.5	2.0	3.0	4.5	5.0
48	0.8	1.5	2.0	3.0	4.0	4.5

Scheduling Irrigation

Irrigation scheduling is a management practice used to determine how often to irrigate and how much water to apply with each irrigation. Irrigation duration was discussed in the previous section, and should be based on soil available water-holding capacity, soil moisture depletion level, and trickle tube flow rate. Tensiometers are excellent tools for determining irrigation frequency because they measure water available in the crop root zone.

Tensiometers directly measure soil tension. This is also often referred to as soil suction or vacuum. Soil tension is a measure of how tightly water is held in the soil, and is measured in pressure units of centibars (cb) or kilopascals (kPa). These are different units of measurement of the same condition-soil vacuum. To convert cb to PSI, multiply by 0.15; to convert PSI to cb, multiply by 6.67.

Soil tension increases as moisture in the soil is depleted. This force also draws water out of the tensiometer through its porous tip, creating a vacuum inside the tensiometer. This negative pressure, or tension, is registered on the tensiometer vacuum gauge. The soil tension measured with tensiometers is an indirect indication of soil moisture content and can be used as an indicator of irrigation need.

Table C-6 contains guidelines for using soil tension data to schedule irrigation events. Field capacity is the moisture content at which a soil is holding the maximum amount of water it can against the force of gravity. This moisture

content is reached 24 to 72 hours after a saturating rain or irrigation. Field capacity corresponds to soil tension levels ranging from 5 to 10 cb in coarse-textured soils and as high as 40 cb in fine-textured soils.

Table C-6. Irrigation Guidelines When Using Tensiometers

Soil Texture	Soil Tension (cb)	Soil Moisture Status and Irrigation Requirement
Sand, loamy sand	5 - 10	
Sandy loam, loam, silt loam	10 - 20	Soil at field capacity; no irrigation required
Clay loam, clay	20 - 40	
Sand, loamy sand	20 - 40	
Sandy loam, loam, silt loam	40 - 60	50% of available water depleted; irrigation required
Clay loam, clay	50 - 100	

The soil tension range corresponding to the time when irrigation should begin is also influenced by soil texture. In coarse-textured soils, irrigation should begin at soil tensions of 20 to 40 cb. In extremely coarse-textured soils, irrigation may be necessary at even lower tensions. Medium- and fine-textured soils do not need to be irrigated until soil tensions reach higher values, as shown in Table C-6. In all soils, irrigate when 50 percent of available water has been depleted.

The utility of tensiometers in fine-textured soils is limited because of the upper limit of tension that can be measured with tensiometers. When soil dries beyond the 80 cb tension level, the column of water in the tensiometer "breaks," allowing air to enter the device. After breaking tension, the device ceases to operate correctly until it is serviced. Thus, tensiometers are more practical in coarse-textured soils where appropriate soil tension levels are well below the point of breaking tension.

Ideally, four tensiometers per management zone should be used to account for variability in soil texture. Install at least one in the most droughty area of the zone that will likely require water sooner than other areas of the field.

Tensiometer placement influences measured soil tension levels. Tensiometers should be placed where plant roots are actively growing. Therefore, it is appropriate to monitor soil tension 6-12 inches below the soil surface and within 6-12 inches from the plant base. If using trickle irrigation, place the tensiometer close to the trickle tape or hose. This will insure that tensiometer readings decrease when an irrigation occurs. Placement near the trickle tape is even more important when growing in coarse-textured soils and on raised, mulched beds. In these situations, the bed shoulders often remain very dry. Placing tensiometers in the bed shoulders will not give an accurate measure of soil tension in the active crop root zone.

Tensiometers can also be used in other ways. Placing tensiometers at various soil depths at the same location is useful for determining whether or not an irrigation or rainfall has reached a certain depth. Placing tensiometers at various depths is also useful for determining the depth from which plants draw the most water.

Maintaining Trickle Systems

In trickle systems, water is carried through plastic tubing and distributed along the tubing through devices called emitters. The emitters dissipate the pressure from the

system by forcing the water exiting from an emitter through orifices, tortuous flow paths, or long flow paths, thus allowing a limited flow of water to be discharged. The pressure-reducing flow path also allows the emitter to remain relatively large, allowing particles that could clog an emitter to be discharged.

Insect damage to thin-walled polyethylene drip tubing or tape is a major problem. Ants, wireworms, earwigs, mole crickets, field crickets, grubs and other insects typically damage drip tape by chewing holes through the side walls. This damage destroys the integrity of the tape, resulting in small to massive leaks which may result in severe economic losses to growers.

Other types of drip tape damage may be mistaken for insects. For example, rats, mice, gophers and birds can chew, gnaw or pick holes in thin walled polyethylene tapes. Damaged tape should be viewed with a microscope or magnifying glass to provide clues to the source prior to taking action to remediate. Consult with your local extension professional for assistance.

To protect drip tape from insect damage, either chemical control agents or thicker walled tapes are typically used. Growers should consult with their Extension Agents or other crop protection professionals to select a suitable chemical agent for such control. When chemical control is not an option, growers should select a tape with sufficiently thick walls to withstand the damage without leaking. Ant damage to drip tape is most severe in tubing having wall thicknesses of less than 15 mils (0.015 inches). In some cases, 8-10 mil products are sufficient to minimize damage.

Although modern emitter design reduces the potential for trapping small particles, emitter clogging remains the most serious problem with trickle irrigation systems. Clogging can be attributed to physical, chemical, or biological contaminants. Filtration and occasional water treatment may both be necessary to keep trickle systems from clogging.

Bacteria can grow inside trickle irrigation tubes and form 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 trickle system. Periodic treatment **before** clogging develops can keep the system functioning efficiently. The frequency of treatment depends on the quality of the water source. Generally two or three treatments per season should be adequate.

Irrigation water containing high concentrations of iron (greater than 1 ppm) can also result in clogging problems due to a type of bacteria that "feed" on dissolved (ferrous) iron. The bacteria secrete a slime called ochre that may combine with other solid particles in the trickle tubing and plug emitters. The precipitated (ferric) form of iron, known commonly as rust, can also physically clog emitters. Treating water containing iron with chlorine will oxidize the dissolved iron, 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. Take care when adding chlorine to trickle irrigation systems, however, since concentration at or above 30 ppm can be toxic to growing plants.

Chlorine is available in either gas, liquid, or solid forms. Chlorine gas is extremely dangerous and not recommended for agricultural purposes. Solid chlorine is available as granules or tablets containing 65 to 70 percent calcium

hypochlorite. Liquid chlorine is available in many forms, including laundry bleach and postharvest wash materials. Liquid forms typically contain between 5 and 15 percent sodium hypochlorite. **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 rate of chlorine injection required 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 50 to 100 feet upstream from filters. An elbow between the injector and the filter will also insure 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 it must measure free chlorine and not total chlorine.

If you are without a chlorine test kit, 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.
- Inject 50 ppm during the last 30 minutes of irrigation cycles one to two times each month.
- 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.

Chlorine can be injected using many types of fertilizer/pesticide injectors, including positive displacement injection pumps. These types of pumps are powered by gasoline or electric motors and include piston, diaphragm, gear or lobe, and roller (or peristaltic) types. The injection rate for positive displacement injection pumps can be calculated from the following equation:

$$\text{Injection rate of chlorine solution in gallons/hour} = \frac{(0.006) \times (\text{desired chlorine concentration in ppm}) \times (\text{gpm of irrigation})}{\% \text{ chlorine in bleach or concentrate}}$$

As an example, assume household bleach (5.25% sodium hypochlorite) is being used as a chlorine solution, that a treatment level of 5 ppm of chlorine is desired, and that the trickle system has a 200-gallon-per-minute flow rate.

$$\text{Injection Rate} = \frac{0.006 \times 5 \times 200}{5.25} = 1.14 \text{ gal chlorine bleach/hour}$$

Proportional injectors are also commonly used to inject chlorine. Proportional injectors are powered by the water pressure of the irrigation system and inject materials at a rate which is proportional to the irrigation system flow rate or system pressure. Injection rates are often adjustable and are usually specified as ratios, percentages, or ppm. Table C-7 lists equivalent values of these injection rate units.

For proportional injectors, the following equation can be used to calculate the required chlorine solution injection rate:

$$\text{Injection rate of chlorine solution in ppm} = \frac{(100) \times (\text{desired chlorine concentration in ppm})}{\% \text{ chlorine in bleach or concentrate}}$$

As an example, assume postharvest wash material (12.5% sodium hypochlorite) is being used as a chlorine solution and that a treatment level of 10 ppm of chlorine is desired.

$$\text{Injection rate} = \frac{100 \times 10}{12.5} = 80 \text{ ppm}$$

It is important to note that both liquid and solid forms of chlorine will cause water pH to rise. This is critical because chlorine is most effective in acidic water. If water pH is above 7.5, it must be acidified for chlorine injection to be effective as a disinfectant.

Table C-7. Equivalent Injection Proportions

Ratio	ppm	Percent
1:10,000	100	0.01
1:5,000	200	0.02
1:2,000	500	0.05
1:1,000	1,000	0.1
1:500	2,000	0.2
1:200	5,000	0.5
1:100	10,000	1
1:50	20,000	2
1:20	50,000	5
1:10	100,000	10

Important Notes.

- Approved backflow control valves and interlocks must be used in the injection system to prevent contamination of the water source.**
- Chlorine concentrations above 30 ppm may cause phytotoxicity.**

Fertilization.

Before considering a fertilization program for mulched-trickle irrigated crops, the grower should 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 (see Table B-1).

When using trickle irrigation in combination with mulch, apply the recommended amount of preplant fertilizer and incorporate 5-6 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 row crop is through a trickle irrigation system which is usually installed during the mulching operation (see Chemigation Section below). Due to the very small holes or orifices in the trickle tubing, a completely soluble fertilizer must be used through the irrigation system. Best results have been achieved by using a 1-1-1 (N-P₂O₅-K₂O) ratio of completely soluble fertilizer, such as a 20-20-20. Including the essential micronutrients with the completely soluble N-P₂O₅-K₂O fertilizer has resulted in positive yield responses. Including boron with the completely soluble N-P₂O₅-K₂O fertilizer on sandy loam Coastal Plain soils testing low to low-medium in boron has produced superior results.

Fertilized-mulched acre:

All rates of soluble fertilizers applied through the trickle irrigation system are determined on a 3-foot soil surface area under the plastic mulch (fertilized-mulched acre), even though the crops are grown on 5-foot rows.

A fertilized-mulched acre is an acre (43,560 square feet) of fertilized-mulched soil. A fertilized-mulched acre is the surface area of soil covered by the mulch. For example, when 4-foot-wide plastic is laid on 5-foot row centers with 6 inches of each edge buried, 2 feet of the 5-foot row is uncovered and 3 feet is covered with mulch. This means that 3/5, or 60 percent, of the field acre is mulched and fertilized with trickle. All recommendations for fertilization through trickle are based on a fertilized-mulched acre.

Calculating fertilizer rates for trickle under mulch:

- First, determine the number of fertilized-mulched acres in the field using the following formula:

$$\frac{\text{width of soil surface covered by mulch (ft)}}{\text{row center width (ft)}} \times \text{field acres} = \text{fertilized-mulched acres}$$

Example: $\frac{3 \text{ feet}}{5 \text{ feet}} \times 10 \text{ field acres} = 6 \text{ fertilized-mulched acres}$

Using the same mulch and bed width example:

$$1\text{-}2\text{/}3 \text{ field acres or } 14,520 \text{ lin ft of mulched row} = 1 \text{ fertilized-mulched acre}$$

- Second, calculate the fertilizer requirements for a fertilized-mulched acre.

a. *Example for a soluble dry fertilizer to be dissolved and distributed through trickle.*

If 40 pounds of nitrogen (N), 40 pounds of phosphate (P₂O₅), and 40 pounds of potash (K₂O) per fertilized-mulched acre per application are recommended, select a dry, completely soluble fertilizer with a 1-1-1 ratio, such as a 20-20-20. To determine the amount of 20-20-20 needed per fertilized-mulched acre, divide the percent N, P₂O₅, or K₂O contained in the fertilizer into the quantity of the respective plant nutrient needed per acre and multiply the answer by 100.

$$\frac{40 \text{ lb N/A needed}}{20\% \text{ N in fertilizer}} = 2 \times 100 = \frac{200 \text{ lb of 20-20-20}}{\text{needed per fertilized-mulched acre}}$$

b. **Example for a liquid fertilizer distributed through trickle.**

Assume the same 40 lb N-P₂O₅-K₂O is needed and a 1 10-10-10 liquid is used. If a gallon of this fertilizer weighs 10 pounds, 40 gallons of 10-10-10 liquid fertilizer per fertilized-mulched acre per application is required.

$$\begin{array}{l} 1 \text{ gal (10 lb) of 10-10-10 contains:} \\ 10 \text{ lb} \times .10 \text{ (10\% N)} = 1 \text{ lb N in each gallon} \\ \frac{40 \text{ lb N/A needed}}{1 \text{ lb N/gal of 10-10-10}} = \frac{40 \text{ gal of 10-10-10}}{\text{needed per fertilized-mulched acre}} \end{array}$$

3. Conversion of fertilizer rates from mulched acre to linear foot equivalent.

When mulched beds are on 4.5- to 5.5-foot centers with 3 feet of the soil surface covered by mulch, the pounds of nutrients or fertilizer per mulched acre can be converted to pounds per linear feet of mulched row. A mulched acre on 5-foot centers has 14,520 linear feet of mulched row. See example in 1. above.

Example: If 40 pounds of nitrogen (N), phosphate (P₂O₅) and potash (K₂O) are to be applied (equal to 200 pounds of 20-20-20 per fertilized-mulched acre in example 2a. above) then apply 200 pounds 20-20-20 per 14,520 linear feet or 13.8 pounds of 20-20-20 per 1,000 linear feet of mulched row.

See table C-8 for convenient conversion of fertilizer rates from pounds of nutrient per mulched acre to pounds of nutrient per linear foot of mulched row. This conversion can be used when mulch is laid on 4.5 to 5.5 row centers.

Table C-8. Equivalent Pounds of Nutrients

Mulched Acre	1,000 Linear Feet
0.5	0.034
1	0.069
2	0.138
5	0.344
10	0.69
15	1.03
20	1.38
25	1.72
30	2.07
35	2.41
40	2.75
45	3.10
50	3.44

CHEMIGATION

Chemigation is the application of any pesticide or fertilizer through any irrigation system and includes furrow, border, overhead and trickle irrigation systems. Posting of areas to be chemigated is required when (1) any treated area

is within 300 feet of sensitive areas such as residential areas, labor housing, businesses, hospitals, or any public areas such as schools, parks, playgrounds, etc., or (2) when the chemigated area is open to the public such as golf courses or retail greenhouses.

Rates of water penetration and percolation vary with method of irrigation, soil type, texture, organic matter, pH, slope and grade. Irrigate to first wet the root zone, then introduce the pesticide uniformly over the crop being irrigated. After chemigation, flush the irrigation system with fresh water. Do not overwater to avoid removing the pesticide or fertilizer from the root zone.

The pesticide label must allow the use of chemigation before any pesticide can be applied in the irrigation system. Consult label for all rates and restrictions before use.

Chemigation systems connected to public water systems

These systems must contain a functional, reduced-pressure zone, backflow preventer or the functional equivalent in the water supply line upstream from the point of pesticide introduction. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent flow of fluid back toward the injection pump. The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the system is either automatically or manually shut down. A functional interlocking control to automatically shut off the pesticide injection pump when the water pump motor stops is also required, or if there is no water pump, when the water pressure decreases to the point where pesticide distribution is adversely affected.

Chemigation systems must use a metering pump, such as a positive displacement pump capable of being fitted with a system interlock.

Trickle and overhead systems

These systems must contain a functional check valve, vacuum relief valve and low pressure drain on the irrigation pipeline to prevent water source contamination from backflow. The pesticide pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back to the injection pump.

The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the system is either automatically or manually shut down.

The system must also contain a functional interlocking control to automatically shut off the pesticide injection pump when the water pump motor stops.

The water pump must also include a functional pressure switch which will stop the water pump when the water pressure decreases to the point where pesticide distribution is adversely affected.

PESTICIDE SAFETY

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 these chemicals. For restricted-use pesticides, an applicator is required to be certified or to work under the direct supervision of a certified individual.

Certification-Pesticide Applicators

The Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (FIFRA) required each state to set up a program to certify users of pesticides. 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, his fellowman, 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, pesticides 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. Private applicators who purchase and apply restricted-use pesticides must be certified and registered. In New Jersey, private applicators must be certified and registered to apply **any** pesticide.

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 job with any governmental agency. Examples of commercial applicators are: exterminators; landscapers; tree services; crop dusters; weed control firms; and owners of apartments, motels, nursing homes, restaurants, etc., who do their own pest control work. Commercial applicators must be certified and registered to use **any** pesticide in New Jersey.

For detailed information on certification of pesticide applicators, call your state agency or Extension agent. See the back cover of this publication for phone numbers of pesticide certification agencies.

Pesticide Operator Registration (*for New Jersey*)

Anyone applying pesticides under direct supervision of a commercial certified pesticide applicator must be registered as a pesticide *operator* unless the certified applicator is *always* physically present when the uncertified individual is handling pesticides. Contact the Pesticide Control Program for more information on pesticide operator training and registration (see back cover).

HANDLING PESTICIDES

Before opening a pesticide container, all applicators should read the label carefully, and accurately follow all directions and precautions specified by the labeling. In order to handle and apply pesticides safely, it is essential to use the proper safety equipment and protective clothing. For the custom or professional applicator, which includes both private and commercial applicators, safety equipment should at least consist of unlined neoprene or rubber boots and gloves, waterproof hat, coat, and coveralls, an approved respirator, and proper measuring equipment.

Your physician should be advised of the types of pesticides you use in your work. Before the start of the spray season, each applicator should have a blood cholinesterase level determined. Every 4 to 6 weeks during the spray season, the level should be redetermined.

When applying pesticides, be sure to have 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 as long as 15 minutes.

Only an experienced applicator wearing the protective clothing and safety equipment prescribed by the manufacturer should handle highly toxic pesticides, such as Guthion and Lannate.

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 your clothing; always begin the day with clean clothing.

Always have someone with you or close by if you are using highly toxic pesticides (those with the signal word **DANGER** plus skull and crossbones).

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. Always keep a record of all pesticides used.

Pesticide Transport

When pesticides are transported in a service vehicle to an application site outside the farm boundaries, the transport vehicle must be clearly marked as a pest control service vehicle in New Jersey and for Category 7 operators in Delaware. 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 Pesticide Control Program office or the Cooperative Extension pesticide office in your state.

Pesticide Storage

Pesticides should always be stored in their original containers and kept tightly closed. For the protection of others, and especially in case of fire, 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. Special precautions may be needed in case of a fire in these storage areas.

Any restricted pesticide or container contaminated by restricted pesticides **must** be stored in a secure, locked enclosure while unattended. That enclosure **must** bear a warning that pesticides are stored there. If any pesticide has to be stored in other than its original container, that container must be labeled with the name and concentration of the active ingredient and the signal word and warning statements for the pesticide. Keep an inventory of all pesticides held in storage and locate the inventory list in an accessible place away from the storage site, so 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. A fire with smoke from burning pesticides may also 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.

Winter Storage of Pesticides

Plan pesticide purchases so that supplies are used by the end of the growing season. When pesticides are stored for the winter, keep them at temperatures above freezing, under dry conditions, and out of direct sunlight.

The following points should be followed:

1. Read the label. Special storage recommendations or restrictions will be printed on the label.
2. Write the purchase or delivery date of the product on the label with indelible ink. Products may lose their effectiveness over several years.
3. Ventilation is important for storage of most pesticides.
4. Store herbicides separately from other pesticides to avoid contamination.
5. Signs of quality deterioration are shown in Table D-1.

Table D-1 Deterioration of Pesticides

Formulation	General Signs of Deterioration
EC	Evidence of separation of components, such as sludge or sediment. Milky appearance does not occur when water is added.
Oils	Milky appearance does not occur when water is added.
WP, SP, WDG	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 [10°-26.7°C]) 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 product. If in doubt, call the manufacturer.

For a listing of winter storage of pesticides, see Table D-2. Additional information can be obtained from manufacturers' websites.

Disposal of Pesticides

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** procedure or the **pressure-rinse** procedure is the recommended method to prepare pesticide containers for safe disposal. This method can save you 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.

Organic Phosphate Pesticides

The handling and disposal of waste organic phosphates is a specialized job. Many organophosphorous compounds break down by hydrolysis; most of these chemicals decompose much faster in alkaline situations.

Carbamate Pesticides

Usually these chemicals decompose rapidly in soil; many break down much faster in an alkaline situation. Examples of such carbamate chemicals are carbaryl and carbofuran.

Table D-2. Winter Storage of Chemicals

Chemical	Heated storage required	Heated storage not required	Quality questionable After freezing	Usable after freezing if Put in warm storage	Usable after freezing if put In warm storage and shaken	Quality damaged by high temperatures
acephate						x
Alanap-L					x	
Atrazine 4L		x		x		
<i>Bacillus thuringiensis</i>		x				x
Banvel		x		x		
Basagran	x				x	
Benlate		x				
captan WP		x				
chlorothalonil					x	
Cythion 5E					x	x
Dacthal WP		x				
diazinon		x		x		
dimethoate	x		x			
Di-Syston 6LC		x		x		
Dual Magnum		x		x		
Eptam 7E			x		x	
Furadan 4F	x		x			
Fusilade DX		x		x		
Goal 2XL	x					
Gramoxone	x				x	
Imidan WP		x				
Lannate	x				x	
Lexone 4L	x		x			
Lorox 4L	x		x			
Lorsban 4E		x			x	
malathion EC		x			x	x
Metasystox-R		x			x	
Micro-Tech	x				x	
Monitor 4E		x		x		
Partner	x				x	
Penncap-M		x			x	
Poast 1.5EC	x				x	
Pounce		x			x	
Prefar 4E	x		x			
Prowl EC	x		x			
Pursuit	x			x		
Roundup Ultra						
Max	x		x			
Sencor 4F		x			x	
Sevin 4F		x			x	
Solicam 80DF		x				
Surflan AS		x			x	
Treflan EC	x		x			
2,4-D amine	x		x			
Vydate L	x					

Source: Adapted from "Vegetable Newsletter," by Chris Doll, Illinois County Extension agent; the Cornbelt Chemical Company, McCook, Nebraska; and the "American Cemetery" magazine.

Disposal of Containers

Triple Rinse-and-Drain Method

To empty a pesticide container for disposal, drain the container into the spray tank by holding container in a vertical position for 30 seconds. Add a solvent, capable of removing the pesticide, to the pesticide container, so that it is approximately one-fourth full. Agitate the container thoroughly, and then drain the liquid (rinsate) into the spray tank by holding in a vertical position for 30 seconds. Repeat two more times.

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 the container is rendered unusable. In Pennsylvania, this permits the containers to be disposed of as solid waste (not hazardous waste) in an ordinary landfill.

FARM WORKER SAFETY

Identifying Treated Areas

New federal farm worker safety regulations are in effect that impact how workers must be informed about the pesticides with which they may come in contact. The following is a brief overview of some of these regulations.

1. Farm workers who enter treated fields within 30 days of an application of a pesticide must be trained as specified under the Worker Protection Standard (WPS) requirements.
2. No worker can enter a treated field before the end of the label specified restricted-entry interval (REI), unless step 3 below is followed. All agricultural pesticides now have reentry times that range from 4 to 48 hours or longer. Check your pesticide's label for the reentry time in effect.
3. Workers who enter treated fields before the end of the label specified reentry time must have been properly trained under the WPS regulations, must be provided with the protective equipment specified on the pesticide's label, cannot perform hand labor tasks such as thinning or harvesting, and can only spend up to 1 hour per day in the treated field. The protective equipment necessary may include socks, shoes, long pants, long-sleeve shirt, and a hat. Additional safety equipment may also be required by the label.
4. Farm workers must be orally informed, in their native language, of all reentry times (*this is mandatory in New Jersey*). If workers are not orally notified or the label requires it, the treated field must be posted with the prescribed WPS warning sign during the reentry period.

5. For all pesticides, workers must be warned by posting a bulletin board at a point(s) where workers might assemble. This bulletin board should have a listing of the following information:

- a. Location and name of crop treated,
- b. Brand name and common chemical of pesticide applied,
- c. Date of application, and
- d. Date of safe reentry into treated area.

For New Jersey. The bulletin board should also include a map of the farm which designates the different areas of the farm which might be treated. The required information must also be listed using column headings as defined by New Jersey Department of Environmental Protection (See "Spray Record" in the back of this publication for an example) and must be in the native language of workers, in addition to English, if they do not read English. This information must be posted either before workers enter treated fields or prior to workers entering fields at the beginning of the next workday, whichever occurs first. Once posted, this information must remain posted for 30 days following the date for safe reentry.

6. Every farm must post the WPS safety poster in a central area at the farm where farm workers are able to view it.
7. Agricultural employers must also provide a decontamination site that includes water, soap, and single use towels for all farm workers who enter treated areas of the farm.

These requirements are being implemented in different ways in each state. For additional information on these and other state farm worker regulations, contact your state Department of Agriculture, Department of Environmental Protection, or local county Cooperative Extension office.

Respiratory Protective Devices for Pesticides

You may be subject to exposure to toxic gases, vapors, and/or particulates when using pesticides. Although our respiratory (breathing) system tolerates exposure to a limited degree, some chemicals can impair or destroy portions of the system. For many pesticides, the respiratory system is the quickest and most direct route into the circulatory system, allowing rapid transport throughout the body. Thus, it is important to follow the pesticide label and employ directions for control of exposure, especially when respiratory protection is specified.

A respirator is a safety device covering at least the mouth and nose that protects the wearer. Respiratory protection varies in design, use, and protective capacity. There are two major classes of respirators:

1. Air-purifying respirators that remove contaminants from the air
2. Atmosphere-supplying respirators that provide clean, breathable air from an uncontaminated source

Air-purifying respirators may be powered or non-powered. A powered air-purifying respirator uses a blower to pass contaminated air through purifying elements. Non-powered air-purifying respirators may be designed for single use or with replaceable filters, canisters, or cartridges. Air-purifying respirators **do not** supply oxygen and should **never** be used

when oxygen may be limited (<19.5 percent oxygen by volume) or when an environment is immediately dangerous to life or health (IDLH).

Purifying elements for air-purifying respirators contain a filter, sorbent, or catalyst (or a combination of these items) to remove specific contaminants from the air passing through the container. When pesticides are used, particulates may be present as solids and/or liquids. When this is the case, a particulate respirator (or filter) is prescribed for use. Pesticide products may be present as gases or vapors. When this is the case, a contaminant-specific chemical cartridge or canister is prescribed. Be sure that the respirator assembly (with component purifying element) is approved for protection against the pesticide you intend to use (see "Selection" below). Respirators approved only for use against particulates must not be used for gases and vapors.

Air-supplying respirators include supplied-air respirators and self-contained breathing apparatus. These respirators should be used when oxygen is limited. However, the only type of atmosphere-supplying respirators that may be used in an IDLH environment is a **pressure-demand**, self-contained breathing apparatus. The breathing air supply for these respirators should meet or exceed the specification for Grade D breathing air as described in the most current *Compressed Gas Association Specification G-7.1*.

Certification of Respirators

Standards, testing, and certification assure the commercial availability of safe, personal protective devices. The National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA) jointly certify respirators for the contaminant or situation of exposure. Approvals for these respirators bear both NIOSH and MSHA emblems and certification numbers under 30 CFR part 11.

When purchasing a new respirator, the certification numbers per respirator type, according to **current** 'part 84' NIOSH approved criteria, is as follows:

- TC-13F-XXXX: self-contained breathing apparatus
- TC-14G-XXXX: gas masks with canisters
- TC-19C-XXXX: supplied air respirators
- TC-21C-XXXX: **powered** particulate respirators **only** (with HE filter only)
- TC-23C-XXXX: chemical cartridge respirators
- TC-84A-XXXX: **non-powered** particulate respirators (with N, P, and R series filters)

The new 'TC-84' certification creates a total of nine classes of particulate filters based upon filter efficiency and oil degradation resistance. The nine new classes and prescribed use of each are as follows:

- N95: Not oil-resistant; moderate filtering efficiency
- R95: Oil-resistant; moderate filtering efficiency
- P95: Oil-proof; moderate filtering efficiency
- N99: Not oil-resistant; high filtering efficiency
- R99: Oil-resistant; high filtering efficiency
- P99: Oil-proof; high filtering efficiency
- N100: Not oil-resistant; highest filtering efficiency (99.97%)
- R100: Oil-resistant; highest filtering efficiency (99.97%)
- P100: Oil-proof; highest filtering efficiency (99.97%)

Although there are three efficiencies for filters, most manufacturers are marketing only the 95% and 99.97% efficiency filters as listed above. If you previously used a high efficiency particulate air filter (HEPA), a filtering unit with 99.97% filtering efficiency would be comparable. The appropriate N-, R-, or P-series for the filter will still need to be chosen. The class of the filter will be clearly marked on the filter, filter package, or respirator box. In the case of chemical cartridges that include these filter elements, similar markings will be present.

Selection of Respirator Type

Manufacturers now provide recommendations for appropriate respiratory protection on the pesticide label. These label recommendations are product and task specific. For example, manufacturers may specify organic vapor cartridges or canisters in formulations where the solvent carrier for the pesticide active ingredient is petroleum based. **It is extremely important** to read and follow the product label for respirator requirements since pesticides may have different formulations and use directions.

EPA provides pesticide manufacturers' specific **pesticide label statements for respiratory protection** for five categories of pesticide formulation and application activity. EPA label statements allow for use of either the old 'part 11' respirators with MSHA/NIOSH certifications, as well as the new 'part 84' respirators with NIOSH certification. It is surmised that EPA provides for the use of the now obsolete respirators so that the stock may be used until depleted.) If the pesticide label specifies N-, R-, or P-series filtering elements, do not to use the N-series when oil is present.

Service Life of Filters

The **service life of all filters** is limited and all soiled filters should be replaced whenever they are damaged or cause noticeably increased breathing resistance.

The effective service life of a chemical cartridge respirator depends on the conditions of use. Conditions include the type and concentration of contaminant(s), user's breathing rate, and humidity. Thus, cartridges should remain sealed until ready to use. Make sure to use cartridges within the manufacturer's prescribed cartridge shelf life.

Chemical cartridge respirators, when selected appropriately, are essentially 100 percent efficient until the gas or vapor "breaks through." The service life for chemical cartridges can be identified by: warning properties (smell, taste, irritation); chemical specific end-of-service-life-indicators (ESLI); and predetermined conservative change-out schedules. Reliance on warning properties is problematic due to a wide variation in odor threshold in the general population. The availability of ESLI is limited. Consult pesticide and respirator manufacturers, as well as NIOSH, OSHA, and EPA guidance when establishing a cartridge change-out schedule. Cartridges should be changed immediately whenever breakthrough is detected in the mask. Always dispose of chemical cartridges at the end of a workday. Never reuse a chemical cartridge.

Use and Care of Respirators

With the exception of hooded-powered, air-purifying respirators, no one respirator will fit everyone. The protection provided to a respirator wearer is a function of how well the facepiece (mask) fits. No matter how efficient the purifying

element or how clean the supplied air, little protection is provided when there is a leaky face-to-facepiece seal.

The most commonly used facepiece configurations for pesticide use are either half-masks or full-face masks. Half-face masks are typically available as single-use or with cartridges that are replaceable with each use. Full-face masks provide eye protection and a better seal; most full-face masks are sized small, medium, and large affording enhanced fit to the face. Full-facepieces, half-masks, quarter-masks, and even the different brands of the same type respirator have different fit characteristics. A qualitative or quantitative fit test of a given mask type on a user's face should be performed in order to select the best fitting respirator. Kits for qualitative testing are now marketed and easy to use.

Prior to using a respirator, read and understand the manufacturer's instructions that are supplied with the respirator and its component parts. 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 that can deteriorate. Replacement component parts are available from most manufacturers.

Wearers should perform both positive and negative seal checks every time respirator masks are put on. This will ensure that the respirator is properly sealed on the face and that all inhalation and exhalation ports are functioning properly. Facial hair (i.e., beards and mustaches) prevents the formation of a good seal and may negate any benefit gained by wearing a respirator.

- To perform a positive pressure seal check, cover the exhalation port with the palm of your hand and exhale into the mask. You will feel air escaping at any gaps in your seal. Readjust the mask until there is no leakage.
- To perform a negative pressure seal check, cover or seal off the surface or hose where air is inspired and suck in. A properly sealed mask should collapse on your face with no signs of leakage in the facepiece or hoses. Readjust the mask until there is no leakage.

After using the respirator, remove and properly dispose of any expendable components such as filters, cartridges, or canisters. Wash the facepiece in a cleaning/sanitizing solution as recommended by the respirator manufacturer. Take care to clean under and around gaskets and valves. Allow to air dry. Store cleaned respirators, as well as replacement purifying elements, in a clean dry place that is not exposed to sunlight or extreme temperatures. Do not store any protective equipment, including respirators, with or near chemicals such as pesticides.

Pesticide Poisoning

If you have any of the following symptoms during or shortly after using pesticides: headache, blurred vision, pinpoint pupils, weakness, nausea, cramps, diarrhea, and discomfort in the chest, call a physician and the Poison Control Center or agency 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 Poison Control Center or agency in your state. See back cover for emergency telephone numbers.
- Be prepared to give the active ingredient name (common generic name)

PROTECT THE ENVIRONMENT

General Guidelines

- 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 your sprayer to make sure of the output.
- Adjust equipment to keep spray on target. Chemicals off-target pollute and can do harm to fish, wildlife, honeybees, 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.
- 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.

Notification of Beekeepers *(for New Jersey only)*

Beekeepers registered with the Department of Environmental Protection (DEP) must be notified before certain pesticides are applied. Growers using pesticides on vine crops (June through August), strawberries (April 15 to May 15), or sweet corn (during flowering stage), or in fields where flowering weeds are present that have information on the label indicating the pesticide is toxic to bees must notify beekeepers within three miles of the target site at least 24 hours prior to application. Notification must include approximate date and time of application; location, brand name, and active ingredient of the pesticide to be used; and the name and registration number of the certified pesticide applicator(s). Notification can be made by phone, regular or certified mail as long as it is received 24 hours before the application. A list of registered beekeepers can be obtained by writing to Pesticide Control Program, CN 411, Trenton, NJ 08625. For more detailed information and regulations, contact the Pesticide Control Program or the Rutgers Cooperative

Extension Pesticide Office. See inside back cover for telephone numbers.

Protecting Your Groundwater

Groundwater is the water contained below our soils. This water is used by 90 percent of the rural population in the United States as their sole source of drinking water. Contamination of our 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 which 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.

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 which persist for a long time may be more likely to cause contamination than materials which breakdown quickly. Persistence is measured by the time it takes half of a given pesticide to degrade (half-life). Chemicals with an overall estimated half-life longer than 3 weeks pose a threat to groundwater.

How to Prevent Contamination of Your Ground Water

1. Examine the chemical properties of the pesticides that you use. If you are using materials which persist for long periods of time, are very water soluble, or are not tightly held by the soil then you may be contaminating your groundwater. You may wish to select another material that has a shorter persistence, lower water solubility or higher potential for soil adsorption. The following table will assist you with these decisions.

Table D-3 K_d , K_{oc} , Water Solubility and Persistence Values for Selected Pesticides

Pesticide	Adsorption to ¹		Water Solubility ² (ppm)	Half Life ³ (Days)
	Soil K_d	OM K_{oc}		
alachlor	4.35	190	242.0	14
atrazine	127.00	160	33.0	60
carbofuran	29.00	29	700.0	30
Dacthal	--	5,000	0.0	30
disulfoton	32.30	2,000	25.0	4
fenamiphos	4.41	171	700.0	20
methomyl	0.03	28	57,900.0	8
metribuzin	0.11	41	1,200.0	30
oxamyl	0.16	1	280,000.0	7
S-metolachlor	--	200	530.0	20
terbacil	0.78	41	710.0	90

¹ OM = organic matter. Chemicals with a lower K_d or K_{oc} number have a greater chance for groundwater contamination.

² Chemicals with higher water solubility have a greater chance for groundwater contamination.

³ Chemicals with longer half-life have a greater chance for groundwater contamination.

- Determine your local soil and geologic circumstances. If you are in an area with a shallow water table or your soil is low in organic matter or sandy in nature you have a greater risk of contaminating your groundwater. In these cases, choose a pesticide that has a low water solubility and is not persistent.
- Evaluate your management practices. They may be the most important factor in determining your risk of contaminating your groundwater. If you use the same materials year after year, or many times a season, you can increase the potential for contamination due to the amount of pesticide in your soil. The timing of pesticide applications has an effect on groundwater contamination. If you make applications during periods of high rainfall or heavy irrigation, 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. Finally, the method of application may have an effect. Direct injection, incorporation, and chemigation all increase the chance of contamination. If you use these techniques, be sure to follow the procedures listed on the material's label.
- The location of your wells can be important. If your sprayer loading area or pesticide storage building is too close to your well, the risk of contamination may be greater. Wells used for drinking water or other purposes should be at least 50 feet away from pesticide storage buildings and loading areas. 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.

- Check the condition of any wells in the vicinity of sprayer loading areas, pesticide storage areas or field applications. If they have cracked casings you are inviting trouble. Cracks in a well casing provide a direct point of entry for pesticide-contaminated water in the soil around the well.
- Use some type of anti back-flow device in any system used for chemigation or to fill your 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 your well. In New Jersey these devices are now required for sprayers by state law. New Jersey law requires 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.
- Care and maintenance of your equipment is also an important consideration. If your equipment does not function properly, you may be applying more than is needed and increasing the chance of groundwater contamination. Prior to the beginning of the season, inspect all of the working parts of your sprayer or chemigation system. Check the pump to see if 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 in unwanted areas. Be sure to calibrate your equipment. Uncalibrated equipment can cause over delivery as well. You should calibrate your equipment at the beginning of the season, periodically during the remainder of the season and any time you make changes or adjustment to the equipment.
- Apply materials only when needed. The use of pesticides, when not needed, can increase the threat of contamination. Check your irrigation practices as well. Don't 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, you must protect your groundwater.

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.

Reporting of Pesticide Spills (for New Jersey only)

Any registered pesticide applicator, or any registered pesticide applicator business, shall inform the DEP of any reportable pesticide spill (1 pound active ingredient or 1 gallon of liquid) occurring under such person's direct supervision and/or direct observation and shall provide the following information:

1. the name of the pesticide applicator,
2. the name of the applicator business, if any,
3. the name of the property owner or operator,
4. the location of the incident,
5. the name and EPA registration number of the pesticide,
6. the estimated amount of pesticide involved, and
7. the corrective action taken.

The report shall be made to the DEP immediately and may be made by telephone to the Pesticide Control Program or the DEP hotline at 877-927-6337. Submit a written follow-up within 10 days to the Pesticide Control Program, PO Box 411, Trenton, NJ 08625.

TOXICITY OF CHEMICALS

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 LD₅₀ 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 LD₅₀ 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 LD₅₀ and the test animals used to obtain the dermal values are usually rabbits.

Table D-4. Categories of Toxicity¹

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	20,000

¹ EPA accepted categories. For examples of each category, see Table D-6 (Toxicity of Chemicals).

² No signal word required based on acute toxicity; however, products in this category usually display "Caution."

Read the labels and become familiar with the symptoms of pesticide poisoning. For help in a pesticide emergency, call the appropriate poison information number on the back cover of this book.

Toxicity and LD₅₀ 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
150	= 67.5
200	= 90

To figure 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 figure LD₅₀, 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 LD₅₀ by body weight in kg.

Note: LD₅₀ numbers are given by the manufacturer.

Example: LD₅₀ 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.

Table D-5. LD₅₀ figures converted to ounces for three commonly used products in the agricultural industry.

LD ₅₀	Body Weight in Pounds					
	30	60	100	150	200	
----- Ounces -----						
<i>Insecticide</i>						
Furadan	11	0.005	0.010	0.017	0.026	0.035
<i>Herbicide</i>						
Micro-Tech/ Partner	1,800	0.9	1.7	2.8	4.3	5.7
<i>Fungicide</i>						
chloro- thalonil	10,000	4.9	9.5	15.7	23.8	31.5

Pesticide Formulations

Several formulations of many pesticides are available commercially. Some are emulsifiable concentrates, flowables, wettable powders, dusts, and granules. After each pesticide recommendation in this publication, one of these formulations is suggested; however, unless stated to the contrary, equivalent rates of another formulation or concentration of that pesticide can be used.

In most cases, Cooperative Extension suggests that sprays rather than dusts be applied to control pests of vegetables. This is because sprays have produced better control and resulted in less drift.

Table D-6 lists type class, use category, mammalian toxicity, reentry times, toxicity to birds, fish, and bees for the pesticides recommended for use in this manual.

Table D-6. Toxicity of Chemicals¹

Name ²	Type Class ³	Use Category ⁴	LD ₅₀ Values Mg/Kg ⁵		Reentry ⁶ (Hours)	Toxicity ⁷		
			Oral	Dermal		Bird	Fish	Bee
abamectin, Agri-Mek, ABBA, Epi-Mek	I-FB	R	300	>1,800	12	N	M	H
ABBA, abamectin	I-FB	R	300	>1,800	12	N	M	H
Abound, azoxystrobin,	F	G	>2,000	>5,000	4	--	H	N
acephate, Orthene	I-OP	G	tech 980	>10,250	24	M	N	H
acetamiprid, Assail	I	G	1,064	>2,000	12	N	N	M
acibenzolar-S-methyl, Actigard, Blockade	B,F	G	--	--	12	N	M	N
Acramite, bifentate	A	G	>5,000	>5,000	12	N	H	N
Actara, thiamethoxam	I-NN	G	>5,000	>2,000	12	N	N	H
Actigard, acibenzolar-S-methyl	B,F	G	--	--	12	N	M	H
Admire, imidacloprid	I-NN	G	tech 450	>5,000	12	M	M	H
Admire Pro, imidacloprid	I-NN	G	tech 450	>5,000	12	M	M	H
Address, acephate	I-OP	G	tech 980	>10,250	24	M	N	H
Agree, <i>Bacillus thuringiensis aizawai</i> + <i>kurstaki</i>	I-BT	G	See Footnote 8		4	N	N	N
Agri-Fos , phosphite salts,	F	G			4	--	M	N
Agri-Mek, abamectin	I-FB	R	300	>1,800	12	--	M	H
Agri-Mycin-17, streptomycin	B	G	9,000	--	12	--	--	--
Agri-Strep, streptomycin	B	G	9,000	--	12	--	--	--
Agrox D-L Plus	F,I	G	--	--	12	H	H	H
Agrox 2-Way	F,I	G	--	--	12	H	H	H
Aim, carfentrazone	H	G	5,143	>5,000	12	N	M	N
alachlor, Micro-Tech, Partner	H	R-12	1,800	--	12	N	N	N
Alanap L, naptalam	H	G	8,200	--	24	N	N	N
Alcide, sodium chlorite	F	G	--	--	12	N	N	N
Aliette, fosetyl Al	F	G	tech 5,000	>2,000	12,24	N	N	N
Allegiance, metalaxyl	F	G	>2,900	>2,000	24	N	N	N
Ambush, permethrin	I-PY	R-12	tech 430-4,000	>4,000	24	N	H	H
Amistar, azoxystrobin,	F	G	>2,000	>5,000	4	--	H	N
Ammo, cypermethrin	I-PY	R	250	>2,000	12	N	H	H
Apron, mfenoxam, metalaxyl	F	G	tech 669	>3,100	12	N	N	N
Asana XL, esfenvalerate	I-PY	R-12	458	>2,000	12	N	H	H
Assail, acetamiprid	I	G	1,064	>2,000	12	N	N	M
Assure II, quizalofop-P-ethel	H	G	1,210	--	12	N	N	N
Atrazine, atrazine	H	G	tech 1,780	7,500	12	S	S	N
Avaunt, indoxacarb	I-CA	G	268	--	12	M	M	H
azadirachtin, Aza-Direct, Azatin, Ecozin, Neemix	IGR	G	>5,000	>2,000	12	--	H	N
Aza-Direct, azadirachtin	I	G	>5,000	>2,000	4	--	H	N
Azatin, azadirachtin	IGR	G	>5,000	>2,000	12	--	H	N
azinphos-methyl, Guthion	I-OP	R-1,2,3, 8,10,12	tech 5-20	220	48	M	H	H
azoxystrobin, Abound, Amistar, Dynasty, Quadris,	F	G	>2,000	>5,000	4	--	H	N
azoxystrobin + chlorothalonil, Quadris opti	F	G	>2,000	>5,000	4	N	H	N
Aztec, cyfluthrin + tebuipirimphos	I	--	--	--	12	--	H	N
<i>Bacillus pumilus</i> GB34, Yield Shield	F-BT	G		NA	NA	NA	NA	NA
<i>Bacillus subtilis</i> GB03, Kodiak	F-BT	G		NA	4	NA	NA	NA
<i>Bacillus thuringiensis, Biobit</i>	I-BT	G	See Footnote 8		4	N	N	N
Banvel, dicamba	H	G	2,629	>2,000	12,24	--	--	N
Basagran, bentazon	H	G	2,063	>6,050	12	S	N	N
Basicop, fixed copper ¹⁰	F	G	472	--	24	--	H	N
Baythroid XL, beta-cyfluthrin	I	R	647	>2,000	12	--	H	H
Beleaf, flonicamid	I	G	>2,000	>2,000	12	--	N	--
bensulide, Prefar	H	G	tech 271-1,470	--	12	--	H	H

Table D-6. Toxicity of Chemicals¹ (continued)

Name ²	Type Class ³	Use Category ⁴	LD ₅₀ Values Mg/Kg ⁵		Reentry ⁶ (Hours)	Toxicity ⁷		
			Oral	Dermal		Bird	Fish	Bee
bentazon, Basagran	H	G	2,063	>6,050	12	S	N	N
beta-cyfluthrin, Baythroid XL	I	R	647	>2,000	12	--	H	H
bifenthrin, Brigade, Capture, Discipline, Empower, Fanfare, Tundra	I-PY	R	262	>2,000	24	M	H	H
bifenzate, Acramite, Floramite	A	G	>5,000	>5,000	12	N	H	N
Biobit, <i>Bacillus thuringiensis kurstaki</i>	I-BT	G	See Footnote 8		4	N	N	N
Blockade, acibenzolar-S-methyl	B,F	G	--	--	12	N	M	N
boscalid, Endura	F	G	>2,000	>2,000	12	--	--	--
Botran, dicloran	F	G	tech >5,000	--	12	S	M	N
Bravo, chlorothalonil	F	G	>10,000	>10,000	12	--	H	N
*Bravo 720, chlorothalonil	F	G	>10,000	>10,000	12	--	H	N
Bravo Ultrex, chlorothalonil	F	G	>10,000	>10,000	12	--	H	N
Brigade, bifenthrin	I-PY	R	262	>2,000	24	M	H	H
Brominal, bromoxynil	H	G	tech 260	>2,000	12	H	H	H
bromoxynil, Brominal, Buctril	H	G	tech 260	>2,000	12	H	H	H
Bucril, bromoxynil	H	G	tech 260	>2,000	12	H	H	H
butylate, Sutan +	H	G	4,500	>4640	2	--	H	--
Cabrio, pyraclostrobin	F	G	>500	>4,000	12	--	H	N
Callisto, mesotrione	H	G	>5,000	>5,000	12	N	N	N
Captan 400, captan	F	G	9,000	--	96	S	H	N
*captan, Captan 400	F	G	9,000	--	96	S	H	N
Captevate, fenhexamid + captan	F	G	>2,000	>5,000	24	N	H	N
*carbaryl, Sevin	I-CA	G	500	850	12	S	N	H
carbofuran, Furadan	I,N-CA	R-3	8	>3,000	48	H	M	N
carfentrazone, Aim	H	G	5,143	>5,000	12	--	M	N
CDAA, Randox	H	G	750	--	12	--	--	--
Champ, fixed copper ¹⁰	F	G	1,000	--	12	--	H	N
Champion, fixed copper ¹⁰	F	G	2,000	--	12	--	H	N
Chateau/Valor, flumioxazin	H	G	>5,000	>2,000	12	N	N	N
chlorethoxyfos, Fortress	I-PY	R	tech 1.8-4.8	12.5-18.5	48	H	H	N
chlorine, Clorox (bleach)	F	G	--	--	12	N	N	N
Chloro IPC, chlorpropham	H	G	3,800	--	48	--	N	N
chloroneb	F	G	>5,000	>5,000	12	N	--	--
chloropicrin	F,N	R-3,10	250	--	72	--	H	N
*chlorothalonil, Bravo, Bravo 720, Bravo Ultrex, Echo, Equus, Ridomil Gold Bravo	F	G	>10,000	>10,000	12	--	H	H
chlorpropham, Chloro IPC, Sprout Nip	H	G	3,800	--	48	--	N	N
*chlorpyrifos, Lorsban	I-OP	R	92-276	2,000	12,24	M	H	H
clethodim, Select	H	G	3,610	>5,000	12,24	L	M	L
clomazone, Command	H	G	1,369	>2,000	12	--	--	--
clopyralid, Stinger	H	G	>5,000	>2,000	12	--	N	N
Clorox (bleach), chlorine	F	G	--	--	12	N	N	N
clothianidin, Poncho	I-NN	G	>5,000	>2,000	--	N	M	H
Command, clomazone	H	G	tech 2,077	>2,000	12	--	N	N
Concur, imidacloprid								
Confirm, tebufenozide	I	G	>5,000	>5,000	4	L	H	M
<i>Coniothyrium minitans</i> , Contans	F	G	--	--	4	--	N	N
Contans, <i>Coniothyrium minitans</i>	F	G	--	--	4	--	N	N
Copper-Count-N, fixed copper ¹⁰	F	G	--	--	12	--	H	N
copper, fixed ¹⁰	F	G	--	--	24	--	H	N

Table D-6. Toxicity of Chemicals¹ (continued)

Name ²	Type Class ³	Use Category ⁴	LD ₅₀ Values Mg/Kg ⁵		Reentry ⁶ (Hours)	Toxicity ⁷		
			Oral	Dermal		Bird	Fish	Bee
copper hydroxide, Ridomil Gold Copper, ManKocide	F	G	tech 669	>3,100	48	--	H	N
Counter, terbufos	I-OP	R-1,2	tech 4.5	1.1	48	--	H	N
Cruiser, thiamethoxam	I-NN	G	5523	>2,000	12	N	N	H
Crymax, <i>Bacillus thuringiensis kurstaki</i>	I-BT	G	See Footnote 8		4	N	N	N
cryolite, Kryocide, Prokil	I-IO	G	>5,000	--	12	N	N	N
Cuprofix Disperss, fixed copper	F	G	>2,000	>4,000	24	--	H	N
Curbit 3E, ethalfluralin	H	G	>10,000	>10,000	12	--	H	N
Curzate, cymoxanil	F	G	433	>5,000	12	N	H	N
*Curzate M-8, cymoxanil + mancozeb	F	G	See Footnote 11		12			
Cutlass, <i>Bacillus thuringiensis kurstaki</i>	I-BT	G	See Footnote 8		4	N	N	N
cyazofamid, Ranman	F	G	>5,000	>2,000	12	L	L	L
*cycloate, Ro-Neet	H	G	3,160-4,640	--	12	--	M	N
cyfluthrin, Renounce, Tombstone	I-PY	R	500	>5,000	12	M	H	H
cymoxanil, Curzate,	F	G	433	>5,000	12	N	H	N
cymoxanil, Curzate M-8, Manex C-8	F	G	1,100	>3,000	12	L	H	N
cymoxanil + macezeb, Manex C-8								
cypermethrin, Ammo	I-PY	R	250	2,000	12	N	H	H
cyprodinil + fludioxonil, Switch	F	G	>5,000	>2,000	12	--	H	N
cyromazine, Trigard	IGR	R,G	3,387	>3,100	12	S	H	H
Cythion, malathion	I-OP	G	tech 5,500	>2,000	12	M	H	H
*Dacthal, DCPA	H	G	>10,000	>2,000	24	S	--	N
*dalapon, Dowpon M	H	G	9,330	--	24	S	N	N
Danitol, fenproparthrin	I-PY	R	66	>2,000	24	H	H	H
DCP, dichloropropene	N	R(NJ),G	300	333	72	--	--	--
*DCPA, Dacthal	H	G	>10,000	>2,000	24	S	--	N
Deadline, metaldehyde	I-OT	G	630	--	12,24	H	N	N
Desiccate II, endothall	H	R	233	481	48	H	--	H
Devrinol, napropamide	H	G	>4,640	--	12	--	N	N
diazinon	I-OP	R-11	tech 300-400	3,600	12,24	H	H	H
dicamba, Banvel	H	G	2,629	>2,000	12,24	--	--	N
dichloropropene + chloropicrin, Telone II, Telone C-35	F,N	R-3,10	127	423	72	H	N	--
dicloran, Botran	F	G	tech >5,000	--	12	S	M	N
dicofol, Kelthane, Kelthane MF	A	G	820-960	1,000-1,230	12	M	H	N
dimethenamid, Frontier, Outlook	H	H	849	>2000	12	--	--	--
*dimethoate	I-OP	R(NJ),G	tech 235	>400	48	H	H	H
dimethomorph, Forum	F	G	3,900	>2,000	24	--	H	N
dinotefuran, Venom	I	G	>5,000	>5,000	12	--	--	H
DiPel, <i>Bacillus thuringiensis kurstaki</i>	I-BT	G	See Footnote 8		4	N	N	N
diquat	H	G	215-235	400	24	--	--	N
Discipline, bifentrin	I-PY	R	262	>2,000	24	M	H	H
Dithane, mancozeb	F	G	11,200	15,000	24	--	H	N
diuron, Karmex	H	G	tech >5,000	>5,000	12	--	--	N
dodine, Syllit	F	G	1,000	>6,000	48	--	H	H
Dowpon M, dalapon	H	G	9,330	--	24	S	N	N
Dual Magnum, S-metolachlor	H	G	tech 2,780	>10,000	12	S	M	N
Dynasty, azoxystrobin	F	G	>2,000	>5,000	4	--	H	N
EBDC, Potato Seed Treater	F	G	4,500	>5,000	24	N	H	N
Echo, chlorothalonil	F	G	>10,000	>10,000	12	--	H	N
Ecozin, azadirachtin	IGR	G	>5,000	>2,000	12	--	H	N

Table D-6. Toxicity of Chemicals¹ (continued)

Name ²	Type Class ³	Use Category ⁴	LD ₅₀ Values Mg/Kg ⁵ Reentry ⁶			Toxicity ⁷		
			Oral	Dermal	(Hours)	Bird	Fish	Bee
Elevate, fenhexamid	F	G	>5,000	>5,000	4	L	M	N
emamectin, Proclaim	I-FB	R	1,516	>2,000	48	N	H	H
Empower, bifenthrin	I-PY	R	262	>2,000	24	M	H	H
endosulfan, Thiodan, Phaser	I-CH	R(NJ),G	tech 160	>500	48	H	H	N
endothall, Desiccate II	H	R	233	481	48	H	--	H
Endura, boscalid	F	G	>2,000	>2,000	12	--	--	--
Entrust, spinosad	I-ML	G	>5,000	>2,000	4	H	--	--
Epi-Mek, abamectin	I-FB	R	300	>1,800	12	N	M	H
Eptam, EPTC	H	G	tech 1,630	--	12	--	H	H
EPTC, Eptam	H	G	tech 1,630	--	12	--	H	H
Equus, chlorothalonil	F	G	>10,000	>10,000	12	--	H	--
esfenvalerate, Asana XL	I-PY	R-12	458	>2,000	12	--	H	H
ethalfluralin, Curbit 3E	H	G	>10,000	>10,000	12	--	H	N
ethephon, Ethrel	PGR	G	4,229	--	48	--	--	N
ethoprop, Mocap	N	R-2	6.2	2.4	48	H	H	H
Ethrel, ethephon	PGR	G	4,229	--	48	--	--	N
etoxazole, Zeal	A	G	>5,000	>5,000	12	N	H	N
Evolve, thiophanate methyl + mancozeb + cymoxanil	F	G	>5,000	>2,000	24	N	H	N
famoxodone + cymoxanil, Tanos	F	G	960	>2,000	12	--	H	--
Fanfare, bifenthrin	I-PY	R	262	>2,000	24	M	H	H
fenamidone, Reason	F	G	>5,000	>5,000	12	--	--	--
fenamiphos, NemaCur	N	R-2	tech 3	200	48	H	H	N
fenbutatin-oxide, Vendex	A	R	2,631	>2,000	48	M	M	N
fenhexamid, Elevate	F	G	>5,000	>5,000	4	L	M	N
fenhexamid + captan, Captevate	F	G	>2,000	>5,000	24	N	H	N
fenproparthrin, Danitol	I-PY	R	66	>2,000	24	H	--	H
fipronil, Regent	I	R	275	841	0	M	H	M
fixed copper ¹⁰ , Cuprofix Disperss	F	G	--	--	12,24,48	--	H	N
Flint, trifloxystrobin	F	G	>5,000	>2,000	12	M	H	N
flonicamid, Beleaf	I	G	>2,000	>2,000	12	--	N	--
Floramite, bifentate	A	G	>5,000	>5,000	12	N	H	N
Flouronil, mfenoxam+chlorothalonil	F	G	See Footnote 11		48			
*fluazifop-P-butyl, Fusilade DX	H	G	3,328	--	12	--	M	N
fluazinam, Omega	F	G	>5,000	>2,000	48	--	H	N
fludioxonil, Maxim	F	G	>5,000	>2,000	12	L	H	L
fludioxonil + mancozeb, Maxim MZ	F	G	>5,000	>5,000	24	N	H	N
flumioxazin, Chateau/Valor	H	G	>5,000	>2,000	12	N	N	N
flutolanil + mancozeb, MonCoat MZ	F	G	>5,000	>5,000	24	M	M	N
flutolanil, Moncut	F	G	>5,000	>5,000	12	N	H	N
fomesafen, Reflex	H	G	6,950	>1,000	24	N	N	N
Force, tefluthrin	I-PY	R	1,213	>2,000	0	N	H	N
Formula 40, 2,4-D (acid)	H	R(NJ),G	375	--	48	M	N	H
Fortress, chlorethoxyfos	I-PY	R	tech 1.8-4.8	12.5-18.5	48	H	H	--
Forum, dimethomorph	F	G	3,900	>2,000	24	--	H	N
fosetyl AI, Aliette	F	G	5,000	>2,000	12,24	N	N	N
Frontier, dimethenamid	H	G	849	>2000	12	--	--	--
Fulfill, pymetrozine	I-OT	G	>5,000	>2,000	12	N	N	N
Furadan, carbofuran	I,N-CA	R-3	8	>3,000	48	H	M	N
Fury, zeta-cypermethrin	I-PY	R-10,12	--	--	12	--	H	H
Fusarex, TCNB	GR	G	--	--	--	--	--	--

Table D-6. Toxicity of Chemicals¹ (continued)

Name ²	Type Class ³	Use Category ⁴	LD ₅₀ Values Mg/Kg ⁵		Reentry ⁶ (Hours)	Toxicity ⁷		
			Oral	Dermal		Bird	Fish	Bee
*Fusilade DX, fluazifop-P-butyl	H	G	2,712	>2,420	12	--	M	N
gammacyhalothrin, Proaxis,	I-PY	R-12	>2,500	>5,000	24	N	H	H
Gaicho, imidacloprid	I-NN	G	tech 450	>5,000	12	M	M	H
Gavel, zoxamide + mancozeb	F	G	--	--	48	--	M	--
Gem, trifloxystrobin	F	G	5,050	>2,000	12	--	H	N
gibberellic acid, GibGro, ProGibb	PGR	G	1,000-25,000	--	4	--	N	N
GibGro, gibberellic acid	PGR	G	1,000-25,000	--	4	--	N	N
Glyphomax Plus, glyphosate	H	G	>5,000	>5,000	24	N	N	N
glyphosate, Glyphomax Plus, Roundup Touchdown	H	G	>5,000	>5,000	24	N	N	N
Goal, oxyfluorfen	H	G	tech >5,000	>10,000	24	--	H	N
Gramoxone Max, paraquat	H	R-1,8	150	--	12,48	M	N	N
Guthion, azinphos-methyl	I-OP	R-1,2,3, 8,10,12	tech 10	200	48	M	H	H
halosulfuron, Sandea	H	G	1,287	>5,000	12	--	N	N
harpin protein, Messenger	F	G	>5,000	>6,000	4	--	N	N
Headline, pyraclostrobin	F	G	>500	>4,000	12	--	H	N
hexythiazox, Savey	A	G	>5,000	>5,000	12	--	H	N
imazamox, Raptor	H	G	>5,000	>4,000	4	N	N	N
imazethapyr, Pursuit	H	G	>5,000	>2,000	12,24	--	N	N
Imidan, phosmet	I-OP	R(NJ),G	tech 147-316	>4,640	24	S	H	H
imidacloprid, Admire, Admire Pro, Concur, Gaicho, Lattitude, Provado	I-NN	G	tech 450	>5,000	12	M	M	H
Impact, topramezone	H	G	>2,000	>2,000	12	N	N	N
Incite, piperonyl butoxide	I-OT	G	>7,500	--	12	N	N	N
indoxacarb, Avaunt	I-CA	G	268	--	12	M	M	H
insecticidal soap, M-Pede	I-SO	G	16,900	--	12	N	N	N
Intrepid, methoxyfenozide	I	G	>5,000	>2,000	4	--	N	N
*iprodione, Rovral	F	G	>4,400	>2,000	12	--	S	N
Javelin, <i>Bacillus thuringiensis kurstaki</i>	I-BT	G	See Footnote 8		4	N	N	N
K-Pam, metam potassium	F	G	630	>1,000	48	H	H	N
Karmex, diuron	H	G	tech >5,000	>5,000	12	N	N	N
Kelthane, Kelthane MF, dicofol	A	G	570-595	>5,000	12	M	H	N
Kerb, pronamide	H	R-5	tech 8,350	>3,160	12	--	N	N
Ketch, <i>Bacillus thuringiensis aizawai</i>	I-BT	G	See Footnote 8		4	N	N	N
Kickstart, carboxin+diazinon+lindane	I	G	829	>2,000	12	H	H	N
Kickstart VP, carboxin+permethrin	I	G	>5,050	>5,050	--	H	H	N
Knack, pyriproxyfen	IGR	G	>5,000	>2,000	12	--	H	N
Kocide, fixed copper ¹⁰	F	G	1,000	--	12,48	M	H	N
Kodiak, <i>Bacillus subtilis</i> GB03	F-BT	G		NA	NA	NA	NA	NA
Kryocide, cryolite	I-IO	G	>5,000	--	12	N	N	N
lambdacyhalothrin, Warrior	I-PY	R	tech 79	632	24	M	H	H
Lannate, methomyl	I-CA	R-8,10	17	5,880	48	H	H	H
Larvin, thiodicarb	I-CA	G	66	>2,000	12	H	H	M
Lattitude, imidacloprid	I-NN	G	tech 450	>5,000	12	M	M	H
Lepinox, <i>Bacillus thuringiensis kurstaki</i>	I-BT	G	See Footnote 8		4	N	N	N
Lexone, metribuzin	H	R-14	tech 2,000	20,000	12	--	N	N
lindane	I-CH	R-5	88-125	1,000	12,24	M	M	N
Linex, linuron	H	G	tech 4,000	--	24	--	S	N

Table D-6. Toxicity of Chemicals¹ (continued)

Name ²	Type Class ³	Use Category ⁴	LD ₅₀ Values Mg/Kg ⁵		Reentry ⁶ (Hours)	Toxicity ⁷		
			Oral	Dermal		Bird	Fish	Bee
linuron, Linex, Lorox	H	G	tech 4,000	--	24	--	S	N
Lorox, linuron	H	G	tech 4,000	--	24	--	S	N
*Lorsban, chlorpyrifos	I-OP	R	92-276	2,000	12,24	M	H	H
malathion, Cythion	I-OP	G	tech 5,500	>2,000	12	M	H	H
*mancozeb, Acrobat MZ, Curzate M-8, Dithane, Manex II, Manex C-8 ManKocide, Penncozeb, Ridomil Gold MZ	F	G	11,200	15,000	24	--	H	N
mancozeb + copper hydroxide, ManKocide	F	G	See Footnote 11			N	H	N
maneb, Manex	F	G	tech 7,990	>5,000	24	--	H	N
Manex, maneb	F	G	tech 7,990	>5,000	24	--	H	N
Manex II, mancozeb	F	G	11,200	>15,000	24	--	H	N
Manex C-8, cymoxanil + mancozeb	F	G	See Footnote 11		24			
ManKocide, mancozeb + copper hydroxide	F	G	See Footnote 11		48			
Matrix, rimsulfuron	H	G	>5,000	>2,000	4	N	L	L
Matth, <i>Bacillus thuringiensis</i> encapsulated delta endotoxin	I-BT	G	See Footnote 8		4	N	N	N
Maxim, fludioxonil	F	G	>5,000	>2,000	12	L	H	L
Maxim MZ, fludioxonil + mancozeb	F	G	>5,000	>5,000	24	N	H	N
*MC-2, MC-33, methyl bromide	F,H,N	R-8	See Footnote 9		48	--	--	N
mefenoxam, Apron, Ridomil Gold, Ultra Flourish	F	G	--	--	--	--	H	N
mefenoxam + chlorothalonil, Ridomil Gold Bravo, Flouronil	F	G	See Footnote 11					
mefenoxam + copper hydroxide, Ridomil Gold Copper	F	G	See Footnote 11					
mefenoxam + mancozeb, Ridomil Gold MZ	F	G	>5,000	>2,000	48	N	H	N
mefenoxam + PCNB, Ridomil Gold PCNB	F	G	>5,050	>2,020	48	N	H	N
Mertect, thiabendazole	F	G	>5,000	>5,050	12	N	H	N
mesotrione, Callisto	H	G	>5,000	>5,000	12	N	N	N
Messenger, harpin protein	F	G	>5,000	>6,000	4	--	N	N
metalaxyl, Allegiance, Apron, MetaStar	F	G	tech 669	>3,100	12	N	N	N
metalddehyde, Deadline	I-OT		630	--		H	N	N
metam potassium, K-Pam	F	G	630	>1,000	48	H	H	N
metam-sodium, Vapam HL	N	G	1,891	>3,074	48	--	H	N
MetaStar, metalaxyl	F	G	tech 669	>3,100	12	N	N	N
*Metasystox-R, oxydementon methyl	I-OP	R	tech 50	150	48	--	H	H
methamidophos, Monitor	I-OP	R-2,11	tech 20	130	48	H	M	H
methomyl, Lannate	I-CA	R-8,10	17	5,880	48	H	H	H
methoxychlor	I-CH	G	6,000	--	12	S	N	M
methoxyfenozide, Intrepid	I	G	>5,000	>2,000	4	--	N	N
*methyl bromide, MC-2, MC-33, Terr-O-Gas 67	F,H,N	R-8	See Footnote 9		48	--	--	N
methyl iodide, Midas	F, H, I	--	--	--	--	--	--	--
*methyl parathion	I-OP	R-2,8,10,11	6	50	48	H	H	H
*methyl parathion (encapsulated), PennCap-M	I-OP	R-2,8,10,11	>600	>5,400	48	H	H	H
metribuzin, Sencor, Lexone	H	R-14	tech 1,100-2,300	>20,000	12	--	M	N

Table D-6. Toxicity of Chemicals¹ (continued)

Name ²	Type Class ³	Use Category ⁴	LD ₅₀ Values Mg/Kg ⁵		Reentry ⁶ (Hours)	Toxicity ⁷		
			Oral	Dermal		Bird	Fish	Bee
Micro-Tech, alachlor	H	R-12	930-1,350	--	12	S	M	N
Midas, methyl iodide	F, H, I	--	--	--	--	--	--	--
Mocap, ethoprop	N	R-2	61.5	2.4	48	H	H	H
MonCoat MZ, flutolanil+mancozeb	F	G	>5,000	>5,000	24	M	M	N
Monitor, methamidophos	I-OP	R-2,11	tech 20	130	48	H	M	H
M-Pede, insecticidal soap	I-SO	G	16,900	--	12	N	N	N
Mustang, zeta-cypermethrin	I-PY	R-10,11	--	--	12	--	H	H
myclobutanil, Nova	F	G	1,600	>5,000	24	--	N	N
napropamide, Devrinol	H	G	>4,640	--	12	--	N	N
naptalam, Alanap L	H	G	1,770	--	24	--	N	N
Neemix, azadirachtin	IGR	G	>5,000	>2,000	12	--	H	N
Nemacur, fenamiphos	N	R-2	tech 3	200	48	H	H	N
norflurazon, Solicam	H	G	>8,000	>20,000	12	N	M	N
Nova, myclobutanil	F	G	1,600	>5,000	24	--	N	N
Novodor, <i>Bacillus thuringiensis tenebrionis</i>	I-BT	G	See Footnote 8		4	N	N	N
novoluron, Rimon	I-IGR	G	3,914	>2,000	12	N	H	N
Noxfire, rotenone	I-BO	G	132-1,500	--	12,48,24	S	H	N
NutriPhyte, phosphite salts	F	G			4	--	M	N
Oberon, spiromesifen	IGR	G	>2,000	>4,000	12	--	H	--
Omega, fluazinam	F	G	>5,000	>2,000	48	--	H	N
Orthene, acephate	I-OP	G	tech 980	>10,250	24	M	N	H
oryzalin, Surflan	H	G	>10,000	--	12	--	H	N
Outlook, dimethenamid	H	G	849	>2000	12	--	--	--
oxamyl, Vydate L	I,N-CA	R	37	2,960	48	H	H	H
*oxydemeton-methyl, Metasystox-R	I-OP	R	tech 50	150	48	--	H	H
oxyfluorfen, Goal	H	G	tech >5,000	>10,000	24	--	H	N
paraquat, Gramoxone Max	H	R-1,8	150	--	12,48	M	N	N
Partner, alachlor	H	R-12	930-1,350	--	12	S	M	N
PBO (piperonyl butoxide)	I-OT	G	>7,500	--	12	N	N	N
PCNB, Terraclor	F	G	tech 1,700-5,000	2,000-4,000	12,24	S	H	H
pebulate, Tillam	H	G	tech 921-1,900	>4,640	12	--	M	S
pendimethalin, Prowl	H	G	1,250	>5,000	12,24	--	M	N
*Pennacap-M, methyl parathion (encapsulated)	I-OP	R-2,8,10,11	>600	>5,400	48	H	H	H
Penncozeb, mancozeb	F	G	11,200	>15,000	24	--	H	N
permethrin, Ambush, Pounce	I-PY	R-12	tech >4,000	>4,000	24	N	H	H
Phaser, endosulfan	I-CH	R(NJ),G	tech 160	>500	48	H	H	N
*phenmedipham, Spin-aid	H	G	>8,000	>4,000	24	--	M	N
*phorate, Thimet	I-OP	R-2,10,11	tech 2-4	20-30	48	H	H	H
phosmet, Imidan	I-OP	R(NJ),G	tech 147-316	>4,640	24	S	H	H
phosphite salts, Phostrol, ProPhyt, Agri-Fos, NutriPhyte	F	G	>5,000	>5,000	4	N	H	N
Phostrol, phosphite salts	F	G	>5,000	>5,000	4	N	H	N
Platinum, thiamethoxam	I-NN	G	>5,000	>2,000	12	--	M	N
Poast, sethoxydim	H	G	3,200-3,500	>5,000	12,24	S	M	S
Poncho, clothianidin	I-NN	G	>5,000	>2,000	--	N	M	H
Potato Seed Treater, EBDC	F	G	4,500	>5,000	24	N	H	N
Pounce, permethrin	I-PY	R-12	tech 430-4,000	>4,000	24	N	H	H
Prefar, bensulide	H	G	tech 271-1,470	--	12	--	H	H
Previcur Flex, propamocarb hydrochloride	F	G	2,900	>3,000	12	--	N	N
Pristine, pyraclostrobin + boscalid	F	G	>2,000	>2,000	12	--	H	--
Proaxis, gammacyhalothrin	I-PY	R-12	>2,500	>5,000	24	N	H	H

Table D-6. Toxicity of Chemicals¹ (continued)

Name ²	Type Class ³	Use Category ⁴	LD ₅₀ Values Mg/Kg ⁵		Reentry ⁶ (Hours)	Toxicity ⁷		
			Oral	Dermal		Bird	Fish	Bee
Proclaim, emamectin	I-FB	R	1,516	>2,000	48	N	H	H
Procure, triflumizole	F	G	2,230	>2,000	12	--	H	N
ProGibb, gibberellic acid	PGR	G	1,000-25,000	--	4	--	N	N
Pro-Gro, thiram + carboxin	F	G	>2,000	>2,000	--	N	H	N
Prokil, cryolite	I-IO	G	>5,000	--	12	N	N	N
Prolong, <i>Bacillus thuringiensis kurstaki</i>	I-BT	G	See Footnote 8		4	N	N	N
pronamide, Kerb	H	R-5	tech 8,350	5,620	12	--	N	N
propamocarb hydrochloride, Previcur Flex	F	G	2,900	>3,000	12	--	N	N
ProPhyt, phosphite salts	F	G	>5,000	>5,000	4	N	H	N
*propiconazole, Tilt	F	G	1,517	>4,000	24	--	H	N
Provado, imidacloprid	I-NN	G	tech 450	>5,000	12	M	M	H
Prowl, pendimethalin	H	G	3,956	2,200	12,24	--	M	N
Pursuit, imazethapyr	H	G	>5,000	>2,000	12,24	--	N	N
pymetrozine, Fulfill	I-OT	G	>5,000	>2,000	12	N	N	N
pyraclostrobin, Cabrio, Headline	F	G	>500	>4,000	12	--	H	N
pyraclostrobin + boscalid, Pristine	F	G	>2,000	>2,000	12	--	H	--
pyrethrum	I-BO	G	1,500	>1,800	12	N	H	M
pyriproxyfen, Knack	IGR	G	>5,000	>2,000	12	--	H	N
Quadris, azoxystrobin	F	G	>2,000	>5,000	4	--	H	N
Quadris opti, azoxystrobin + chlorothalonil	F	G	1,750	>5,000	12	N	H	N
Quintec, quinoxyfen	F	G	>2,000	>2,000	12	N	H	--
quinalofop-P-ethyl, Assure II	H	G	1,210	--	12	N	N	N
Radiant, spinetoram	I	G	>5,000	>5,000	4	N	N	N
Radox, CDAA	H	G	750	--	12	--	--	--
Ranman, cyazofamid	F	G	>5,000	>2,000	12	L	L	L
Raptor, imazamox	H	G	>5,000	>4,000	4	N	N	N
Raven, <i>Bacillus thuringiensis tenebrionis</i>	I-BT	G	See Footnote 8		4	N	N	N
Reflex, fomesafen	H	G	6,950	>1,000	24	N	N	N
Regent, fipronil	I	R	275	841	0	M	H	M
Renounce, cyfluthrin	I-PY	R	500	>5,000	12	M	H	H
Reason, fenamidone	F	G	>5,000	>5,000	12	--	--	--
Ridomil Gold, mefenoxam	F	G	1,172	2,020	48	N	N	N
Ridomil Gold Bravo, mefenoxam + chlorothalonil	F	G	See Footnote 11		12			
Ridomil Gold Copper, mefenoxam + copper hydroxide	F	G	See Footnote 11		48			
Ridomil Gold MZ, mefenoxam + mancozeb	F	G	>5,000	>2,000	48	N	H	N
Ridomil Gold PCNB, mefenoxam + PCNB	F	G	>5,050	>2,020	48	N	H	N
Ridomil, metalaxyl	F	G	tech 669	>3,100	12	N	N	N
Rimon, novoluron	I-IGR	G	3,914	>2,000	12	N	H	N
rimsulfuron, Shadeout	H	G	>5,000	>2,000	4	N	L	L
*Ro-Neet, cycloate	H	G	tech 2,000-4,100	--	12	--	M	N
Rotacide, rotenone	I-BO	G	132-1,500	--	24	S	H	N
*rotenone, Rotenox, Rotacide, Noxfire	I-BO	G	132-1,500	--	12,24,48	S	H	N
Rotenox, rotenone	I-BO	G	132-1,500	--	48	S	H	N
Roundup, glyphosate	H	G	>5000	>5,000	24	N	N	N
*Rovral, iprodione	F	G	>4,400	>2,000	12	--	S	N
Sandea, halosulfuron	H	G	1,287	>5,000	12	--	N	N
Savey, hexythiazox	A	G	>5,000	>5,000	12	--	H	N
Select, clethodim	H	G	3,610	>5,000	24	L	M	L
*Sencor, metribuzin	H	R-14	tech 2,000	>20,000	12	--	M	N
sethoxydim, Poast	H	G	2,676-3,125	>5,000	12,24	S	M	S

Table D-6. Toxicity of Chemicals¹ (continued)

Name ²	Type Class ³	Use Category ⁴	LD ₅₀ Values Mg/Kg ⁵		Reentry ⁶ (Hours)	Toxicity ⁷		
			Oral	Dermal		Bird	Fish	Bee
Sevin, carbaryl	I-CA	G	tech 283	>2,000	12	S	N	H
*Sinbar, terbacil	H	G	5,000-7,500	--	12	--	N	N
S-metolachlor, Dual Magnum	H	G	tech 2,780	10,000	12	S	M	N
sodium chlorite, Alcide	F	G	--	--	12	N	N	N
SoilGard, streptomycetes	F	G	--	--	12	N	N	N
Solicam, norflurazon	H	G	>8,000	>20,000	12	N	M	N
*Spin-aid, phenmedipham	H	G	>8,000	>4,000	24	--	M	N
spinetoram, Radiant	I	G	>5,000	>5,000	4	N	N	N
spinosad, SpinTor, Entrust	I-ML	G	>5,000	>2,000	4	H	--	--
SpinTor, spinosad	I-ML	G	>5,000	>2,000	4	H	--	--
spiromesifen, Oberon	IGR	G	>2000	>4,000	12	--	H	--
Sprout Nip, chlorpropham	H	G	3,800	--	48	--	N	N
Stinger, clopyralid	H	G	>5,000	>2,000	12	--	N	N
Strategy, ethalfluralin + clomazone	H	G	>5,050	>5,050	24	--	H	N
streptomycetes, SoilGard	F	G	--	--	12	N	N	N
streptomycin, Agri-Mycin-17, Agri-Strep	B	G	9,000	--	12	--	--	--
Sutan +, butylate	H	G	4,500	>4640	2	--	H	--
sulfur	A,F,I-IO	G	>5,000	>5,000	12,24,48	N	N	N
Super Cu, fixed copper ¹⁰	F	G	--	--	12	--	H	N
Surflan, oryzalin	H	G	>10,000	--	12	--	H	N
Switch, cyprodinil + fludioxonil	F	G	>5,000	>2,000	12	--	H	N
Syllit, dodine	F	G	1,000	>6,000	48	--	H	H
TCNB, Fusarex	GR	G	--	--	--	--	--	--
Tanos, famoxodone + cymoxanil	F	G	960	>2,000	12	--	H	--
tebufenozide, Confirm	I	G	>5,000	>5,000	4	L	H	M
Tedion, tetradifon	A	G	>10,000	>10,000	12	--	--	--
tefluthrin, Force	I-PY	R	1,213	>2,000	0	N	H	N
Telone II, dichloropropene + chloropicrin	F,N	R-3,10	127	423	72	H	N	--
Telone C-35, dichloropropene + chloropicrin	F,N	R-3,10	127	423	72	H	N	--
Tenn-Cop, fixed copper ¹⁰	F	G	--	--	24	--	H	N
*terbacil, Sinbar	H	G	5,000-7,500	--	12	--	N	N
terbufos, Counter	I-OP	R-1,2	tech 4.5	1.1	48	--	H	N
Terraclor, PCNB	F	G	tech 1,700-5,000	2,000-4,000	12,24	S	H	N
*Terr-O-Gas 67, methyl bromide	F,H,N	R-8	See Footnote 9		48	--	--	N
tetradifon, Tedion	A	G	>10,000	>10,000	12	--	--	--
*thiabendazole, Mertect	F	G	>5,000	>5,050	12	N	H	N
thiamethoxam, Actara, Cruiser, Platinum	I-NN	G	>5,000	>2,000	12	N	N	H
*Thimet, phorate	I-OP	R-2,10,11	tech 2-4	20-30	48	H	H	H
thiodicarb, Larvin	I-CA	G	66	>2,000	12	H	H	M
Thionex, endosulfan	I-CH	R(NJ),G	tech 160	>500	48	H	H	H
thiophanate-methyl, Topsin M	F	G	7,500	--	12	--	S	N
thiophanate-methyl + mancozeb, Tops MZ	F	G	>5,050	>2,020	24	N	H	N
thiophanate methyl + mancozeb + cmoxanil, Evolve	F	G	>5,000	>2,000	24	N	H	N
thiram, Thylate, 42-S Thiram	F	G	tech 1,000	>5,000	12	S	H	N
thiram + carboxin, Pro-Gro	F	G	>2,000	>2,000		N	H	N
Thylate, thiram	F	G	tech 1,000	>5,000	12	S	H	N
Tillam, pebulate	H	G	tech 921-1,900	>4,640	12	--	M	S
*Tilt, propiconazole	F	G	1,517	>4,000	24	--	H	N
Tombstone, cyfluthrin,	I-PY	R	500	>5,000	12	M	H	H
topramezone, Impact	H	G	>2,000	>2,000	12	N	N	N
Tops MZ, thiophanate-methyl + mancozeb	F	G	>5,050	>2,020	24	N	H	N

Table D-6. Toxicity of Chemicals¹ (continued)

Name ²	Type	Use	LD ₅₀ Values Mg/Kg ⁵		Reentry ⁶	Toxicity ⁷		
	Class ³	Category ⁴	Oral	Dermal	(Hours)	Bird	Fish	Bee
Topsin M, thiophanate-methyl	F	G	7,500	--	12	--	S	N
Touchdown, glyphosate	H	G	>5,000	>5,000	24	N	N	N
Treflan, trifluralin	H	G	>10,000	--	12,24	N	M	N
Tri-Basic Copper Sulfate, fixed copper ¹⁰	F	G	472	--	24	--	H	N
trifloxystrobin, Gem, Flint	F	G	>5,000	>2,000	12	--	H	N
trifloxystrobin + metalaxyl, Trilex AL	F	G	>5,000	>5,000	24	N	H	N
triflumizole, Procure	F	G	2,230	>2,000	12	--	H	N
trifluralin, Treflan, Trilin	H	G	>10,000	--	12,24	N	M	N
Trigard, cyromazine	IGR	R,G	3,387	3,100	12	S	H	H
Trilex AL, trifloxystrobin + metalaxyl	F	G	>5,000	>5,000	24	N	H	N
Trilin, trifluralin	H	G	>10,000	--	12,24	N	M	N
Tundra, bifenthrin	I-PY	R	262	>2,000	24	M	H	H
Ultra Flourish	F	G	--	--	--	--	--	--
Vapam HL, metam-sodium	N	G	1,891	>3,074	48	--	H	N
Vendex, fenbutatin-oxide	A	R	2,631	>2,000	48	M	M	N
Venom, dinotefuran	I	G	>5,000	>5,000	12	--	--	H
Vydate L, oxamyl	I,N-CA	R	37	2,960	48	H	H	H
Warrior, lambdacyhalothrin	I-PY	R	tech 79	632	24	M	H	H
XenTari, <i>Bacillus thuringiensis aizawai</i>	I-BT	G	See Footnote 8		4	N	N	N
Yield Shield, <i>Bacillus pumilus</i> GB34	F-BT	G			NA	NA	NA	NA
Zeal, etoxazole	A	G	>5,000	>5,000	12	N	H	N
zeta-cypermethrin, Fury, Mustang	I-PY	R-10,12	--	--	12	--	H	H
zoxamide, Gavel	F	G	--	--	48	--	H	H
2,4-D (acid)	H	R(NJ),G	375	--	12,24	M	N	H
42-S Thiram, thiram	F	G	2,950 (f)- 4,430 (m)	>4,000	24	N	H	N

-- = Data not available

* = Material covered under the Superfund Amendments and Reauthorization Act of 1986 (SARA) for storage notification.

¹ The Occupational Safety and Health Administration (OSHA) now requires growers to keep on file Material Safety Data (MSD) sheets for certain chemicals used during normal spray programs. These MSD sheets should be obtained from either your local pesticide dealer or directly from the chemical manufacturer. Some labels carry technical assistance phone numbers that you can call for further information. Call this number to request a MSD sheet from the manufacturer.

² Names: Trade names begin with capital letters; common names with small.

³ Type class: A = acaricide; B = bactericide; F = fungicide; H = herbicide; IGR = insect growth regulator; I = insecticide (followed by the following: BO = botanical, BT = bacterial, CA = carbamate, CH = chlorinated hydrocarbon, EI = insect growth regulator [ecdysone inhibitor], FB = fermentation by-product, IO = inorganic, ML = macrocyclic lactone, NN = neonicotinoid, OP = organic phosphate, OT = other, PY = pyrethroid, SO = soap); N = nematocid; and PGR = plant growth regulator.

⁴ Use category: R = restricted use and G = general use. Chemicals designated as general or restricted use as determined by state or federal agencies. Restricted use may not apply to all formulations or all uses of a formulation. Check the label to be sure. The designation (NJ) refers to a compound that is classified as restricted use in New Jersey. The number(s) after the R designation refer to the following reasons for being classified as a federal restricted use product:

- | | |
|--|--|
| 1. acute oral toxicity | 8. accident history |
| 2. acute dermal toxicity | 9. exposure hazard to workers |
| 3. acute inhalation toxicity | 10. potential effects on wildlife |
| 4. corrosive to eyes | 11. potential effects on birds |
| 5. potential to cause tumors | 12. potential effects on fish and/or other aquatic species |
| 6. potential to cause genetic mutations | 13. potential for groundwater contamination |
| 7. potential to cause adverse reproductive effects | 14. lack of data |

⁵ LD₅₀ = milligrams of substance per kilogram of body weight of the test animal. > = higher than the figure listed. Formulations: LD₅₀ values given are for formulated material as you would purchase it; for example, 50WP, 4E, etc., unless otherwise noted. Source: *2001 Farm Chemicals Handbook*; information is listed as supplied by manufacturer.

⁶ Reentry: The EPA Worker Protection Standard now requires minimum 12-hour reentry times for all Category III (CAUTION) pesticides, 24-hour minimum reentry times for all Category II (WARNING) pesticides, and 48-hour minimum reentry times for all Category I (DANGER) pesticides. In New Jersey, the NJDEP Pesticide Control Program has assigned 12- or 24-hour reentry times. Chemicals with multiple designations are based on product and/or formulation differences.

⁷ N=nontoxic; L=minimum impact on bees; M=moderately toxic; can be used if dosage, timing and method of application are correct but should **NOT** be applied directly to crop if bees are present; H=highly toxic, severe losses expected.

⁸ Toxicity of *Bacillus thuringiensis* is listed as harmless to humans, animals, and useful insects. *Bacillus thuringiensis* is listed under several commercially available trade names such as Agree, Biobit, Cutlass, Crymax, DiPel, Javelin, Ketch, Lepinox, Match, Novodor, Prolong, Raven, and XenTari. *Bacillus thuringiensis* materials are marketed as several different subspecies such as *aizawai*, *kurstaki*, and *tenebrionis*. Different *Bacillus thuringiensis* subspecies may have different insect control properties. Please check labels for pest insects controlled before use.

⁹ Acute vapor toxicity, 200 ppm, extremely hazardous by vapor inhalation. Liquid can cause eye and skin burns.

¹⁰ Fixed coppers are listed under several commercially available trade names. Examples are: Basicop, Champ, Champion, Copper-Count-N,Cuprofix Disperss, Kocide, Super Cu, Tenn-Cop, Top Cop with Sulfur, Top Cop Tri-Basic, and Tri-Basic Copper Sulfate.

¹¹ For toxicity information on fungicide combinations, see toxicity of each component listed by the common chemical name in Table D-6.

PEST MANAGEMENT

HOW TO IMPROVE PEST MANAGEMENT

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

1. Delaying applications until pests become too large or too numerous.
2. Making applications with insufficient gallonage or clogged or poorly arranged nozzles.
3. Selecting the wrong pesticide.

The following points are suggested for more effective pest control:

1. **Inspect field.** Keep abreast of the pest situation and buildup in your fields. Frequent examinations (at least twice per week) help determine the proper timing of the next application. Do not apply controls simply because your neighbor does.
2. **Integrated pest management (IPM).** Guidelines and information about current pest activity in vegetables are published in weekly IPM newsletters and reports. These publications furnish accurate information for the timing of pesticide applications and suggestions for more effective control. To receive these newsletters and reports, contact your state Extension IPM specialist or county agent.

Ongoing programs utilize biological, physical, cultural, and chemical methods in an integrated approach to pest control. Programs involve pest management field 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. Action thresholds for insect pests are generally expressed as a numerical count of a given life stage or as a damage level based on a recommended sampling procedure. They are intended to reflect the population size that will cause economic damage and, thus, warrant the cost of treatment. Specific thresholds are given in this publication for a number of pests of certain crops. Control decisions also are based on many factors such as:

- a. economic action threshold level (when the cost of control equals or exceeds potential crop losses attributed to real or potential damage)
- b. field history
- c. growth stage and vigor of crop
- d. life stage of the pest
- e. parasite and predator populations
- f. pest populations
- g. resistance to chemicals
- h. time of the year
- i. variety
- j. weather conditions

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 himself, the grower still practices:

- a. frequent and regular examination of fields to determine pest populations and buildup,
 - b. applying a control measure only when the economic action threshold level has been reached, and
 - c. where possible, using a pesticide that is least harmful to parasites and predators.
3. **Resistance management.** Resistance to pesticides develops because pest organisms change genetically and because intensive pesticide use kills the susceptible individuals in a population, leaving only resistant ones to reproduce. See the sections on Insect Resistance and Control, and Disease Management for more specific suggestions to reduce the development of pest resistance.
 4. **Pest control.** 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 numerical count of a given 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 the field history, crop development, variety, weather conditions, and other factors. Control recommendations for various pests are presented in this manual.
- a. Insect population sampling techniques include: shake cloth, sweep net, and visual observation.

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. Plants are pushed back to their original position and gently shaken 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. The net should be rotated 180 degrees after each sweep and swung through the foliage in the opposite direction. Each pass of the net is counted as one sweep. The number of sweeps per field will vary with the crop.

Visual observation. Direct counts of any insect stages (eggs, larvae, adults, etc.) are accomplished by examining plants or plant parts (leaves, stems, flowers, etc.). 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 being less mobile.

- b. Weed population sampling techniques include: weed identification, growth stage determination, and population.

Weed identification. This first step is too 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 a weed or not must be carried out before the crop is affected and before the weed is too large to be controlled easily.

Weed population. Weed competition for light, water, nutrients, and space 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.

- c. Disease monitoring involves determining the growth stage of the crop, observing symptoms on plants, or the daily collection of weather conditions in the field.

Disease control is primarily obtained by applying protective fungicides on a regular schedule. For many diseases, fungicide application must begin at a certain growth stage and 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. When the first disease symptoms are noticed, a fungicide should be applied and repeated every 7 to 10 days.

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 when an infection period has occurred.

Information and guidelines about current pest activity are provided in weekly pest management and newsletter reports. These reports furnish accurate information for the timing of pesticide applications, aiding in more effective control. To receive these reports, contact your local state Extension agent or pest management specialist.

5. **Weather conditions.** These are important to consider before applying a pesticide. Spray only when wind velocity is less than 10 miles per hour. Dust only when it is perfectly calm. 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 the biological insecticides (*B.t.*'s) and some herbicides, are ineffective in cool weather. Others do not perform well or may cause crop injury when hot or humid conditions occur. Optimum results can frequently be achieved when the temperature is in the 70's during application.

Sprinkler irrigation washes pesticide deposits from foliage. Wait at least 48 hours after insecticide or systemic fungicide application and allow contact fungicides to dry on the leaf surface before irrigating. More frequent fungicide applications may be needed during and after periods of heavy rainfall. Provide a minimum rain-free period of 8 to 12 hours after most post-emergence herbicide applications.

6. **Coverage of plants.** The principal reason aphids, mites, cabbage loopers, and diseases are serious pests is that they occur beneath leaves, where they are protected from spray deposit or dust particles. Improved control 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 step 10). 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 to get good coverage. Good coverage is essential for disease control. Sprays from high-volume-high-pressure rigs (airblast) should be applied at rates of 40 to 100 gallons per acre at approximately 400 pounds pressure per square inch. Sprays from low-volume-low-pressure rigs (boom type) should be applied at rates of 50 to 100 gallons per acre at approximately 100 to 300 pounds pressure per square inch. The addition of a spreader- sticker improves coverage and control when wettable powders are applied to smooth-leaved plants, such as crucifers and onions.

Note. High gallonage is important for thorough spray coverage. It is recommended to use a minimum of 40 gallons per acre for effective pest control on vegetable crops.

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 (30 to 45 psi). Never apply herbicides with a high-pressure sprayer suitable for insecticide or fungicide application because excessive drift can result in damage to crops and nontarget plants in adjacent fields and areas. On crops that are difficult to wet (asparagus, cole crops, onions, peppers, and spinach), disease control can be improved with the addition of a spray adjuvant. However, DO NOT add oil concentrates, surfactants, spreader-stickers, or any other additive unless specified on the label, or the risk of crop injury may be increased.

7. **Pesticide selection.** Know the pests to be controlled and choose the recommended pesticide and rate of application. When in doubt, consult your county Extension agent. The herbicide choice should be based on weed species or cropping systems. The herbicides are listed in alphabetical order under the various crops (see Table E-3).

For certain insects that are extremely difficult to control or are resistant, it may be important to alternate labeled insecticides, especially with different classes of insecticides; for example, alternate a pyrethroid insecticide with either a carbamate or an organophosphate insecticide. Be alert for a possible aphid or mite buildup following the application of certain insecticides such as Sevin. For more assistance, contact your county Extension agent.

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

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

8. **Pesticide compatibility.** To determine if two pesticides are compatible, use the following "jar test" before you tank-mix pesticides or pesticides and fluid fertilizers:

- a. 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.
- b. To a second clean quart jar, add 1 pint of water or fertilizer solution. Then add 1/2 teaspoon of an adjuvant (such as Compex, Sponto 168D, Uni-Mix, or Unite) 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.
- c. 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.

9. **Calibration of application equipment.** Periodic calibrations of sprayers, dusters, and granule distributors are necessary to ensure accurate delivery rates of pesticides per acre. Calibrations are made by measuring the total gallons of water applied per acre, in the case of sprayers, and the total pounds of dust or granules applied per acre, in the case of dust and granule distributors. Too little spray or dust applied results in inadequate

distribution of toxicant over plant surfaces. Control is usually poor, and additional applications are required. Too much per acre is hazardous for the applicator, is frequently injurious to plants (phytotoxic), and could lead to excessive residues if applied close to harvest.

10. **Selection of sprayer tips.** The selection of proper sprayer tips for use with various pesticides is very 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 (30-60 psi) to produce small- to medium-sized droplets that do not have excessive drift. Some flat fan tips (SP) are designed to operate at even lower pressures (15-40 psi) and are generally used for preemergence herbicide applications. 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 fertilizer, liquid N, etc., and sometimes for spraying herbicides onto the soil surface prior to incorporation. They are less suited 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 standard 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 satisfactory weed control in most cases.

Full and hollow-cone nozzles deliver circular spray patterns and are used for application of insecticides or fungicides to crops where thorough coverage of the leaf surfaces is extremely important and where spray drift will not cause a problem (see step 6). 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.

11. **pH 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. One possible

reason for these problems 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.

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.**

Many manufacturers provide information on the rate at which their products hydrolyze or break down in water solutions. This rate is expressed as "half-life," meaning the time it takes for 50 percent hydrolysis or breakdown to occur. Some commonly used pesticides that are sensitive to hydrolysis in alkaline water solutions include Counter, malathion, dimethoate, Di-Syston, Furadan, Guthion, Imidan, Lannate, Metasystox-R, Pennacap-M, Sevin, and Thimet.

Check the pH of the water. You can purchase a pH meter or ask your county agricultural agent to test a sample.

How can you correct the alkaline pH? Nutrient buffer sprays are one method; some brand names include: Buffer-X (Kalo Lab), LI-700 Buffer (Hopkins), Mix-Aid (Agway), Nutrient Buffer Sprays (Ortho), Sorba Spray (Leffingwell), Spray-Aide (Miller), and Unite (Hopkins).

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.

CALIBRATING FIELD SPRAYERS

Width of Boom. The width of boom must be expressed in feet. The boom coverage is equal to the number of nozzles multiplied by the space between two nozzles.

Ground Speed (mph). Careful control of ground speed is very important for accurate spray application. Select a gear and throttle setting to maintain constant speed. A speed of 2 to 3 miles per hour is desirable. From a "running start," mark off the beginning and ending of a 30-second run. The distance traveled in this 30-second period divided by 44 will equal the speed in miles per hour.

Table E-1 Ground Speed Conversion

Tractor Speed	Distance	Travel Time per 500 Feet	
		Min	Sec
1.0	88	5	41
1.5	132	3	47
2.0	176	2	50
2.5	220	2	16
3.0	264	1	53
3.5	308	1	37
4.0	352	1	25
4.5	396	1	16
5.0	440	1	8
6.0	528	0	56
7.0	616	0	49
8.0	704	0	43
9.0	792	0	38
10.0	880	0	34

Example: At a tractor speed of 1 mile per hour, you would travel 88 feet in 1 minute or 500 feet in 5 minutes and 41 seconds.

Sprayer Discharge (gpm). Run the sprayer at a certain pressure, and catch the discharge from each nozzle for a known length of time. Collect all the discharge and measure the total volume. Divide this volume by the time in minutes to determine discharge in gallons per minute. *Catching the discharge from each nozzle checks the performance of the individual nozzle.* When it is not convenient to catch the discharge from each nozzle, a trough may be used to catch the total discharge.

Before Calibrating

1. Thoroughly clean all nozzles, screens, etc., to ensure proper operation.
2. Check to be sure that all nozzles are the same, are made by one manufacturer, and have the same part number.
3. Check the spray patterns of all nozzles for uniformity. Check the volume of delivery by placing similar containers under each nozzle. All containers should fill at the same rate. Replace nozzles that do not have uniform pat-terns or do not fill containers at the same rate.
4. Select an operating speed. Note the tachometer reading or mark the throttle setting. When spraying, be sure to use the same speed as used for calibrating.
5. Select an operating pressure. Adjust pressure to desired psi while pump is operating at normal speed and water is actually flowing through the nozzles. This pressure should be the same during calibration and field spraying.

Calibration (Jar Method)

Either a special calibration jar or a homemade one can be used. If you buy one, carefully follow the manufacturers instructions.

Make accurate speed and pressure readings and jar measurements. Make several checks. Keep in mind that you are collecting less than a quart of liquid to measure an application rate of several gallons per acre for many acres.

Any 1-quart or larger container, such as a jar or measuring cup, if calibrated in fluid ounces, can easily be used in the following manner:

1. Measure a course on the same type of surface (sod, plowed, etc.) and same type of terrain (hilly, level, etc.) as that to be sprayed, according to nozzle spacing as follows:

Nozzle spacing (in)	16	20	24	28	32	36	40
Course length (ft)	255	204	170	146	127	113	102

2. Time the seconds it takes the sprayer to cover the measured distance at the desired speed. Average several runs.
3. With the sprayer standing still, operate at selected pressure and pump speed. Catch the water from several nozzles for the number of seconds measured in step 2.
4. Determine the average output per nozzle in ounces. The ounces per nozzle equal the gallons per acre applied by one nozzle per spacing.

Calibration (Boom or Airblast Sprayer)

1. Fill sprayer with water.
2. Spray a measured area (width of area covered x distance traveled) at constant speed and pressure selected from manufacturer's information.
3. Measure amount of water necessary to refill tank (gallons used).
4. Multiply gallons used by 43,560, and divide by the number of square feet in area sprayed. This gives gallons per acre.

$$\text{gal used} \times 43,560$$

5. Add correct amount of spray material to tank to give the recommended rate per acre.

EXAMPLE:

Assume:

10 gal of water used to spray an area 660 ft long and 20 ft wide

Tank size-100 gal

Spray material-2 lb (actual)/A

Calculation:

$$\frac{\text{gal used} \times 43,560}{\text{area sprayed}} = \frac{10 \times 43,560}{660 \times 20} = 33 \text{ gal/A}$$

$$\frac{\text{tank capacity}}{\text{gal/A}} = \frac{100 (\text{tank size})}{33} = 3.03 \text{ acres sprayed per tank}$$

$$3.03 \times 2 (\text{lb/A}) = 6.06 \text{ lb material per tank}$$

If 80% material is used:

$$\frac{6.06}{0.8} = 7.57 \text{ lb material needed per tank to give 2 lb/A rate}$$

CALIBRATING GRANULAR APPLICATORS

Sales of granular fertilizer, herbicides, insecticides, etc., for application through granular application equipment have been on the increase. Much of the application equipment was not designed as precision equipment; therefore, extra care must be taken to get the results desired. How well the material is applied is no accident. It will take a conscientious operator, effort, knowledge of equipment, and calibration.

The first step to good application is to be sure the equipment is prepared for operation. Be sure all controls are free and work properly. Check and lubricate moving parts as necessary, remove corrosion, and tighten loose nuts and bolts.

Application rates of granular application equipment are affected by several factors: gate openings or settings, ground speed of the applicator, shape and size of granular material, and roughness of the ground.

Calibration for Broadcast Applicators (Gravity-Drop or Spinner Applicators)

1. From the label, determine the application rate.
2. From the operators manual, set dial or feed gate to apply desired rate.
3. On a level surface, fill hopper to a given level and mark this level.
4. Measure test area-length of run will depend on size of equipment. It need not be one long run but can be multiple runs at shorter distances.
5. Apply material to measured area, operating at the speed applicator will travel during application.
6. Weigh amount of material required to refill hopper to the marked level.
7. Determine application rate:

$$\text{Area covered (acres)} = \frac{\text{number of runs} \times \text{length of run (ft)} \times \text{width of application (ft)}}{43,560}$$

$$\text{Application rate (lb/A)} = \frac{\text{amount applied (pounds to refill hopper)}}{\text{area covered (acres)}}$$

Note. Width of application is width of the spreader for drop or gravity spreaders. For spinner applicators, it is the working width (distance between runs). Check operator's manual for recommendations, generally one-half to three-fourths of overall width spread.

EXAMPLE:

Assume:

50 lb/A rate

Test run-200 ft

Four runs made

Application width-12 ft

11.5 lb to refill hopper

$$\text{Area covered} = \frac{4 \times 200 \times 12}{43,560} = 0.22A$$

$$\text{Application rate} = \frac{11.5}{0.22} = 52.27 \text{ lb/A}$$

- If application rate is not correct, adjust feed gate opening and recheck.

Calibration for Band Applicators

- From the label, determine application rate.
- From the operator's manual, determine applicator setting and adjust accordingly.
- Fill hopper half full.
- Operate applicator until all units are feeding.
- Stop applicator; remove feed tubes at hopper.
- Attach paper or plastic bag over hopper openings.
- Operate applicator over measured distance at the speed equipment will be operated.
- Weigh and record amount delivered from each hopper. (Be sure all hoppers and all tubes deliver the same amount.)
- Calculate application rate:
Area covered in bands (acres) =

$$\frac{\text{number of bands} \times \text{length of run (ft)} \times \text{band width (ft)}}{43,560}$$

Application rate: Rate applied in bands (lb/A) =

$$\frac{\text{total amount collected (lb)}}{\text{area covered in bands (acres)}}$$

- If not correct, readjust and recheck.

Calibration for Changing from Broadcast to Band Application

Band width <u>in inches</u>	x	broadcast rate per acre	=	amount needed per acre of field
row spacing in inches				

SOIL FUMIGATION

In fields that are infested with soilborne plant pathogens and/or plant parasitic nematodes, soil fumigation is one method of reducing pest populations sufficiently to produce high quality and high yielding vegetable crops. Soil fumigants must be applied properly, and an aeration period is necessary between soil fumigant application and planting of the crop; otherwise, plant injury will occur.

Fields to be treated with soil fumigation must be prepared sufficiently to seed a vegetable crop. The soil should contain little or no crop debris, be free of clods, and soil moisture must be adequate to support seed germination. If soil moisture levels are low, fields should be irrigated to bring the moisture to a satisfactory level. If fields are not properly prepared, soil fumigation will be not effective due to lack of penetration of all soil particles by the gaseous fumigant.

Soil temperature at the 6-inch depth should be in the range of 50° to 80°F (10° to 26.7°C). Fall months are ideal for fumigation. Fumigation in the spring is less desirable because some fumigants may linger in cool, wet soils and increase the likelihood of reducing seed germination or injuring young plants.

The following multipurpose soil fumigants should be used to provide disease and nematode control:

- chloropicrin**--50 gal/A, or
- dichloropropene + chloropicrin (Telone C-17)**--11-17 gal/A
- dichloropropene + chloropicrin (Telone C-35)**--13-20.5 gal/A
- metam-sodium (Vapam HL)**--37.5-75 gal/A, or
- metam-potassium (K-PAM HL)**--30-60 gal/A, or
- methyl bromide (Terr-O-Gas 67, MC-33)**--225-350 lb/A

For nematodes only use one of the following:
dichloropropene (Telone II)--9-12 gal/A,

A plastic film seal is needed when methyl bromide is used, and it will increase the efficacy of all the above treatments. Other soil fumigants are injected to a depth of 6 to 8 inches. Immediately after application, soil should be dragged, rolled, or cultipacked to delay loss of fumigant. Metam-sodium is water-soluble and can be injected and applied via irrigation systems (solid set sprinkler or drip/trickle). Metam-sodium must be injected for the entire time that the field is irrigated (apply an acre inch of water). Rinse the irrigation system with clean water only long enough to clear the system. Too much rinsing or a heavy rainfall within 24 hours of application will reduce the efficacy of the treatment.

At least 2 to 3 weeks should intervene between the application of most soil fumigants and the time a crop is planted. See manufacturer's label recommendations for specific crops and fumigants. Methyl bromide requires only 2 to 7 days of waiting after removal of the tarp.

One week after application, work soil to a depth of several inches so that gases may escape. Severe injury or killing of sensitive plants may occur if the fumigant has not sufficiently dissipated.

To determine if it is safe to plant into fumigated soil, collect a soil sample from the treated field (do not go below the treated depth). Place the sample in a glass jar with a screw top lid. Firmly press numerous seeds of a small seeded vegetable crop (lettuce, radish, etc.) on top of the soil and tighten the lid securely. Repeat the process in another jar with nonfumigated soil to serve as a check. Observe the jars within 1 to 2 days. If seeds have germinated, it is safe to plant in the field. If seeds have not germinated in the fumigated sample and have germinated in the nontreated sample, then the field is not safe to plant. Rework the field and repeat the process in a few days.

Since nitrifying bacteria are reduced by fumigants, at least 50 percent of the nitrogen in the initial fertilizer application should be in the nitrate form.

WEED CONTROL

Effective weed control requires a program that emphasizes prevention by combining crop rotation with mechanical and chemical control methods.

Postharvest Weed Control

Weed seed populations in the soil should be kept to a minimum by preventing weeds from producing seed in and around vegetable fields. Destroy all weeds immediately after a crop is harvested.

Consider control measures after harvest, but before the first frost, for the following weeds:

1. To suppress or control bitter nightshade, Canada thistle, field bindweed, hemp dogbane, horsenettle, or poke-weed, use a tank-mix of 1 quart Banvel plus 1 quart 2,4-D amine in 10 to 20 gallons of water per acre. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness (**Note.** Delay seeding of winter cover crop 3 weeks for each pint per acre of Banvel used). See herbicide labels for optimum treatment time for each weed.
2. To suppress brambles, horseradish (volunteer), horse-nettle, milkweed, poison ivy, or sow thistle, tank-mix 1.5 lb acid equivalent glyphosate, using one of many labeled glyphosate products, plus 1 pint Banvel (see note above) in 10 to 20 gallons of water per acre. Use 1 to 2 quarts surfactant (50 to 100 percent active) per 100 gallons of spray mixture. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness. See herbicide labels for optimum treatment time for each weed.

3. To control johnsongrass, or quackgrass, apply 0.75 to 1.1 lb acid equivalent glyphosate, using one of many labeled glyphosate products, in 5 to 10 gallons of water per acre. Delay tillage until 4 to 7 days after application. Apply in late summer or early fall to healthy weed foliage for maximum effectiveness.

To control Bermudagrass, apply the maximum labeled rate of Poast, Fusilade 2000, OR clethodim (Select, Select Max, or Arrow) in late spring after the weed has begun to grow. Work toward planning your crops and crop rotation to be able to treat monthly with one of the above listed products through late summer without conflicting with the PreHarvest Interval (PHI) of the crop(s) being grown.

To control yellow nutsedge foliage and suppress nutlet formation, spray with a labeled glyphosate product after flowers (seedheads) appear, but before foliage dies. Use 2.25 lb acid equivalent glyphosate in 10 to 20 gallons of water per acre. Expect only partial control of yellow nutsedge the first year after initiating the program. Plant a crop the following spring with registered herbicides recommended for yellow nutsedge control (see Table E-2). Effective yellow nutsedge control can be achieved by repeating the application for several consecutive years.

NOTES

Table E-2. Herbicide Effectiveness on Major Weeds in Vegetables

Herbicide	Barnyardgrass	Crabgrass, Large	Fall Panicum	Foxtail sp.	Goosegrass	Johnsongrass (Seedlings)	Yellow Nutsedge	Carpetweed	Cocklebur, Common	Cranesbill	Galinsoga, Hairy	Jimsonweed	Lambsquarters, Common	Morningglory sp.	Shepherdspurse	Pigweed sp.	Purslane, Common	Ragweed, Common	Smartweed, Pennsylvania	Nightshade, Eastern Black	Velvetleaf
Preplant or Preplant Incorporated																					
Devrinol	G	G	G	G	G	G	N/P	G	N	-	F/P	N	F/G	N	-	F/G	G	P/F	P	N	N
Eptam	G	G	G	G	G	G	G	G	P	G	N	P	F	F	-	G	G	P	P	F/G	F/G
Goal	P	P	P	P	P	P	N	F/G	-	-	F	-	F	-	G	G	G	F	-	-	-
Prefar	G	G	G	G	F/G	G	N	N	N	N	N	N	F/G	N	P/F	F	F	N	N	N	N
Ro-Neet	G	G	G	G	G	-	N/P	G	N	G	N	N	F	-	G	G	G	N	-	-	F
Tillam	G	F	F	G	F	-	F	-	N	-	N	N	P	-	-	G	P/F	N	-	F/G	-
Treflan	G	G	G	G	G	G	N	G	N	-	N	N	F/G	P/F	N	F	G	N	P/F	P	N
Preemergence or Preplant Incorporated																					
Alanap	P	P/F	P	F	P/F	-	N	F	P	N	F	F	F	F	N	F/G	F/G	F	P	P	F
Atrazine	F	P/F	P	F	-	P	P/F	G	F/G	-	G	G	G	G	G	G	G	G	G	G	F
Dual Magnum	G	G	G	G	G	G	F/G	F	N	-	G	N	P	N	-	G	F/G	N	P	G	P
Micro-Tech/Partner	G	F/G	G	G	G	G	F	G	N	-	G	P	P/F	N	G	G	G	N	P	G	P
Prowl	G	G	G	G	-	G	N	G	N	-	N	N	F/G	P	N	F/G	F/G	N	F	P	G
Pursuit	P/F	P/F	P/F	P/F	-	N	G	F	-	P	F	G	F	F	G	G	P	G	F	G	
Sencor/Lexone	F	F	F	F	F	-	N	G	F	-	G	F/G	G	F/P	-	F/G	F	G	G	P	G
Preemergence																					
Callisto	N	F	N	P	N	N	P	-	P/F	-	G	F	G	F	G	F/G	-	P	-	P	-
Chateau	P	P	P	P	P	P	P	G	F	-	G	-	G	F	G	G	G	F	G	G	-
Command	G	G	G	G	G	G	N	N	N/F	-	F	G	G	P	F	N/P	G	P/F	G	-	G
Curbit	F	G	G	-	G	-	N	G	N	-	N	N	P/F	P	-	F	F/G	N	P	P	P
Dacthal	F/G	G	F/G	G	F/G	-	N	P	N	P	N	P	G	N	P	F/G	G	N	N	N	N
Galigan	P	P	P	P	P	P	P	G	P	-	G	F	G	F	G	G	G	F	G	G	F
Goal	P	P	P	P	P	P	P	G	P	-	G	F	G	F	G	G	G	F	G	G	F
Karmex	G	F/G	G	G	F/G	N	N	G	-	-	G	G	G	G	G	G	G	G	G	G	G
Kerb	G	G	G	G	G	-	N	G	N	-	P	N	G	-	-	G	G	P	-	-	P
Lorox	F	P/F	P	F	P/F	-	N	G	P	-	G	P/F	G	P	F	G	G	F	G	G	P
Sandea	N	N	N	N	N	N	F	P	G	-	G	G	F	F	-	G	F	G	F	N	G
Sinbar	F	F	-	F	F	-	P	G	-	G	G	G	G	G	G	P	G	G	G	G	G
Solicam	G	G	G	G	-	F	F	-	-	-	-	F	F	P	-	G	G	G	-	-	F
Strategy ²	G	G	G	G	G	G	N	G	N/F	-	F	G	G	P	F	F	G	F	G	P	G

table continued on next page

Table E-2. Herbicide Effectiveness on Major Weeds in Vegetables (continued)

Herbicide	Barnyardgrass	Crabgrass, Large	Fall Panicum	Foxtail sp.	Goosegrass	Johnsongrass (Seedlings)	Yellow Nutsedge	Carpetweed	Cocklebur, Common	Cranesbill	Galinsoga, Hairy	Jimsonweed	Lambsquarters, Common	Morningglory sp.	Shepherdspurse	Pigweed sp.	Purslane, Common	Ragweed, Common	Smartweed, Pennsylvania	Nightshade, Eastern Black	Velvetleaf
Postemergence																					
Aim	N	N	N	N	N	N	N	G	P	-	-	P	G	F	-	G	-	F	-	G	G
Alanap	N	N	N	N	N	N	N	N	N	N	P	-	P	P/F	-	F	F	P	-	P	P
Assure II/Targa	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Atrazine	F	F	F	F	F	-	G	-	F	-	G	G	G	G	G	G	G	G	G	G	F/G
Banvel	N	N	N	N	N	N	P	G	G	G	G	G	G	G	G	G	G	G	G	G	G
Basagran	N	N	N	N	N	N	F	N	G	-	F	G	F	P	-	F	F/G	G	G	P	G
Buctril	P	P	P	P	P	P	P	G	G	-	G	G	G	G	G	G	F	F	G	G	F
Callisto	N	F	P	P	P	P	F	-	F/G	-	G	G	G	F	F/G	G	-	P	-	F/G	G
Fusilade DX	G	F/G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
glyphosate products	G	G	G	G	G	G	F	G	G	G	G	G	G	F	G	G	G	F	G	G	G
Gramoxone products ¹	F/G	F/G	F/G	G	F/G	-	G	G	G	-	G	G	F/G	F/G	-	G	F/G	G	P	-	-
Impact	G	F/G	P/F	G	F	P	-	-	F/G	-	-	G	G	F	-	G	-	G	G	G	G
Lorox	F	F	F	F	F	F	F	G	P/F	-	F/G	P/F	G	-	G	G	G	G	G	F/G	G
Matrix	G	P/F	F/G	G	P	-	F	-	F/G	-	-	F	F	F	G	G	F/G	P	P/F	P	F
Poast	G	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Pursuit	F/G	F/G	F/G	F/G	P	F/G	-	G	F	-	G	F	G	F	P/F	G	G	P/F	-	-	G
Raptor	P	P	P	P	P	P	P	-	F/G	-	G	-	F	F	G	G	P/F	P/F	G	G	G
Reflex	P	P	P	P	P	P	P	G	F	-	G	G	P	F/G	G	G	-	F	P	F	P
Sandea	N	N	N	N	N	N	G	P	G	-	G	G	N	F	-	G	P	G	F	N	G
Select	G	G	G	G	P	G	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Sencor/Lexone	F	F	F	F	F	-	-	G	-	-	G	G	G	P	G	G	G	G	F	P	P/F
Sinbar	F	F	-	F	F	-	P	G	G	-	G	G	G	G	G	P	G	G	G	G	G
Spin-aid	P	P	P	P	P	P	P	-	P	-	G	G	F	G	G	P/F	G	F/G	-	-	N
Stinger	N	N	N	N	N	N	N	N	G	P	G	P	P	N	N	N	N	G	P	P	P
Touchdown	G	G	G	G	G	G	F	G	G	G	G	G	G	F	G	G	G	F	G	G	G
2,4-D	N	N	N	N	N	N	P	G	F/G	G	P	F	F/G	G	G	G	G	G	F	G	G

¹ Nonselective² Jug-mix of Command and Curbit

G = good F = fair P = poor N = no control

- = insufficient data

Herbicide performance is affected by weather, soil type, herbicide rate, weed pressure and other factors. These ratings indicate ONLY relative effectiveness in tests conducted by the University of Delaware, University of Maryland System, The Pennsylvania State University, Rutgers, The State University of New Jersey, and Virginia Polytechnic Institute and State University. Actual performance may be better or worse than indicated in this chart.

Table E-3 Vegetable Herbicide Recommendations and Postemergence Preharvest Intervals

Herbicide	Asparagus-seeded	Asparagus-established	Beans: lima	Beans: snap	Beets	Broccoli, Cauliflower	Brussels Sprouts	Cabbage	Carrots	Celery	Cucumbers	Garlic	Greens: Collard, Kale, Turnip	Greens: Mustard	Horseradish	Leeks	Lettuce: Head	Lettuce: Leaf	
Preplant or Preplant Incorporated																			
Devrinol		R		R		R ³		R ³											
Eptam				R															
Prefar						R	R	R			R		R	R				R	R
Roneet					R														
Sutan +																			
Tillam																			
Treflan			R	R		R	R	R	R				R	R					
Preemergence or Preplant Incorporated																			
Alanap											R								
Atrazine																			
Dual Magnum	16R ³		R	R				50R ³	64R ³						64R ³				
Micro-Tech/Partner			R																
Prowl			R	L															
Pursuit			R																
Sencor/Lexone		R																	
Preplant or Preemergence																			
Gramoxone Products ²	R	R	R	R		R		R	R		R		R					R	R
Preemergence																			
Callisto																			
Chateau																			
Command																			
Curbit											R ³								
Dacthal				R		R	R	R					R	R	R				
Galigan						R ³		R ³							R				
Goal						R ⁴		R ⁴							R				
Karmex		R																	
Kerb																		R	R
Lorox										R									
Sandea		1R	30R	30R							R								
Sinbar		R																	
Solicam		14R																	
Strategy											R								

¹ Nonselective—Do not allow spray or spray drift to contact crop.

² Nonselective—Apply before crop emergence or before transplanting.

³ Labeled and recommended in certain states only (see description under crop).

⁴ Transplanted ONLY

R = Recommended, Blank = Not recommended, Number = Minimum preharvest interval in days (for postemergence herbicides only)

table continued on next page

Table E-3. Vegetable Herbicide Recommendations and Postemergence Preharvest Intervals (continued)

Herbicide	Muskmelons	Okra	Onions	Parsley	Parsnips	Peas	Peppers-transplanted	Pumpkins	Radishes, Rutabagas, Turnips	Spinach	Strawberries	Summer Squash	Sweet Corn	Sweet Potatoes	Tomatoes-transplanted	Watermelons	White Potatoes	Winter Squash
Preplant or Preplant Incorporated																		
Devrinol							R				R				R			
Eptam																	R	
Prefar	R		R	R			R	R				R				R		R
Roneet										R								
Sutan + Tillam													R					
Treflan		R					R								R			
Preemergence or Preplant Incorporated																		
Alanap	R															R		
Atrazine													R					
Dual Magnum							65R ³						R				R	
Micro-Tech/Partner													R					
Prowl						L	70R						L		70R		R	
Pursuit						R												
Sencor/Lexone															R		R	
Preplant or Preemergence																		
Gramoxone Products ²	R		R			R	R	R			R	R	R		R	R	R	R
Preemergence																		
Callisto													R					
Chateau											R							
Command						R	R	R								R		
Curbit		R ³															R ³	
Dacthal			R						R		R			R				
Galigan																		
Goal																		
Karmex																		
Kerb																		
Lorox				R	R												R	
Sandea	R							L								57R ³		L
Sinbar																70R		
Solicam																		
Strategy	R							R				R				R		R

¹ Nonselective—Do not allow spray or spray drift to contact crop.

² Nonselective—Apply before crop emergence or before transplanting.

³ Labeled and recommended in certain states only (see description under crop).

⁴ Transplanted ONLY

R = Recommended, Blank = Not recommended, Number = Minimum preharvest interval in days (for postemergence herbicides only)

table continued on next page

Table E-3. Vegetable Herbicide Recommendations and Postemergence Preharvest Intervals (continued)

Herbicide	Asparagus-seeded	Asparagus-established	Beans: lima	Beans: snap	Beets	Broccoli, Cauliflower Cabbage	Brussels Sprouts	Cabbage	Carrots	Celery	Cucumbers	Garlic	Greens: Collard, Kale, Turnip	Greens: Mustard	Horseradish	Leeks	Lettuce: Head	Lettuce: Leaf
Postemergence																		
Aim																		
Assure II/Targa			15R															
Atrazine																		
Banvel		1R ³																
Basagran			30R	30R														
Buctril												112R						
Callisto																		
Fusilade DX	365R	R ³																
glyphosate products	7R ¹	7R ¹	R ²	R ²														
Goal																		
Gramoxone products ¹	6R ²	6R									0R ^{1,3}							
Impact																		
Lorox									0R									
Matrix																		
Poast	1R	365R	15R	15R	60R	30R		30R		30R	14R		30R		60R		30R	15R
Pursuit																		
Raptor		R																
Reflex			30R															
Sandea		1R	30R	30R							30R							
Select Max	1R	1R	21R	21R	30R	30R	30R	30R	30R	30R	14R	45R	14R	14R	30R			14R
Sencor/Lexone																		
Sinbar																		
Spin-aid					60R													
Stinger ³		0.5R			30R	30R	30R	30R					30R	30R				
Touchdown products	7R ¹	7R ¹	R ²	R ²														
2,4-D		0R																
Postharvest																		
Gramoxone products ³			R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³

¹ Nonselective—Do not allow spray or spray drift to contact crop.

² Nonselective—Apply before crop emergence or before transplanting.

³ Labeled and recommended in certain states only (see description under crop).

⁴ Transplanted ONLY

R = Recommended, Blank = Not recommended, Number = Minimum preharvest interval in days (for postemergence herbicides only)

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Table E-3. Vegetable Herbicide Recommendations and Postemergence Preharvest Intervals (continued)

Herbicide	Muskmelons	Okra	Onions	Parsley	Parsnips	Peas	Peppers-transplanted	Pumpkins	Radishes, Rutabagas, Turnips	Spinach	Strawberries	Summer Squash	Sweet Corn	Sweet Potatoes	Tomatoes-transplanted	Watermelons	White Potatoes	Winter Squash
Postemergence																		
Aim								OR				OR	R					OR
Assure II/Targa						30R												
Atrazine													21R					
Banvel																		
Basagran						OR							OR					
Buctril			R															
Callisto													45R					
Fusilade DX			45R											55R				
glyphosate products																		
Goal			60R															
gramoxone products ¹		R ^{1,2,3}					OR ¹	OR ^{1,3}			21R ¹	OR ^{1,3}	OR ¹		OR ¹	R ²		
Impact													45R					
Lorox																		
Matrix															45R		60R	
Poast	14R		30R	15R		R	20R	14R		15R	7R	14R		30R	20R	14R	30R	14R
Pursuit						OR												
Raptor																		
Reflex																		
Sandea	57R							30R							30R			30R
Select Max	14R		45R	14R	30R	21R	20R	14R	15R	14R	4R	14R		30R	20R	14R	30R	14R
Sencor/Lexone															7R		60R	
Sinbar											120R							
Spin-aid										40R								
Stinger ³																		
Touchdown products									30R	21R	30R		30R					
2,4-D											R		OR					
Postharvest																		
Gramoxone products ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³	R ³

¹ Nonselective—Do not allow spray or spray drift to contact crop.

² Nonselective—Apply before crop emergence or before transplanting.

³ Labeled and recommended in certain states only (see description under crop).

⁴ Transplanted ONLY

R = Recommended, Blank = Not recommended, Number = Minimum preharvest interval in days (for postemergence herbicides only)

Table E-4. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop¹

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Alfalfa	Barley, winter	Bean, lima	Bean, snap	Cabbage	Corn, field	Corn, sweet	Cucum- ber	Musk- melon	Onion	Pea
Accent	12	4	1 ²	10 ²	10 ²	NR	10	10 ⁵	10	10 ⁵	10 ²
Aim	1	12	1	1	1	NR	1	1	1	1	1
Alanap	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Assure II/Targa	4	4	4	NR	4	4	4	4	4	4	NR
Atrazine	SY	SY	SY	SY	SY	NR	NR	SY	SY	SY	SY
Authority MTZ	12	4	18	18	18	10	18	18	18	18	18
Axial	4	0	4	4	1	4	4	4	4	1	4
Axiom	NY	NY	NY	NY	NY	NR	NY	NY	NY	NY	NY
Backdraft	18	11	11	11	18	9.5	18	18	18	18	18
Balance	10	6	18	18	18	NR	6	18	18	18	18
Banvel	AH	1 ³	AH	AH	AH	NR	AH	AH	AH	AH	AH
Basagran	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Basis	10	8	18	8	18	NR	10	18	18	18	8
Basis Gold	18	10	18	18	18	NR	10	18	18	18	18
Beacon	8	3	18	8	18	0.5d	8	18	18	18	8
Boundary	4.5	4.5	12	12	12	8	12	12	12	18	12
Buctril	1	1	1	1	1	1	1	1	1	1	1
Callisto	NY	4	NY	NY	NY	NR	NY	NY	NY	NY	NY
Canopy	10	4	30	12	18	10	18	18	30	30	12
Canopy EX	12	4	12	12	18	10	18	18	30	18	12
Celebrity Plus	12	4	10 ⁵	10	10 ⁵	NR	10 ⁵	10 ⁵	10 ⁵	10 ⁵	10
Chateau	12	4	12	4	12	1	4	12	12	12	4
Cimarron Plus	B	10	B	B	B	B	B	B	B	B	B
Clarity	3	AH	AH	AH	AH	NR	AH	AH	AH	AH	AH
Classic ⁵	12	3	30	9	18	9	18	18	30	30	9
Cobra	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Command ⁵	16	12	16	9	12	9	9	9	9	16	NR
Curbit	NR	NR	AH	NR	NR	NR	NR	NR	NR	AH	NR
Dacthal	8	8	8	AH	NR	8	8	8	8	NR	8
Define	12	12	12	12	4	NR	12	12	12	18	12
Degree/Degree Extra	SY	SY	SY	SY	SY	NR	NY	SY	SY	SY	SY
Devrinol	12	12	12	12	NR	12	12	12	12	12	12
Distinct	1	1	1	1	1	1	1	1	1	1	1
Dual Magnum	4	4.5	NR	NR	NY	NR	NR	12	12	12	NR
Eptam	0	AH	AH	NR	AH	AH	AH	AH	AH	AH	AH
Eradicane/Eradicane Extra	AH	AH	AH	AH	AH	NR	NR	AH	AH	AH	AH
Evik	NY	AH	NY	NY	NY	NY	NY	NY	NY	NY	NY
Exceed	18	3	18	10	18 ⁵	1 ⁵	3	18	18	18	10
Extreme	4	9.5	NR	40	40	8.5	18	40	40	40	40
Field Master	SY	NY	SY	SY	SY	NR	NY	SY	SY	SY	SY
Finesse Grass & Broadleaf	B	B	B	B	B	B	B	B	B	B	B

¹AH = AFTER HARVEST, B = BIOASSAY OF SOIL RECOMMENDED BEFORE PLANTING, D = DAYS, NI = NO INFORMATION, NR = NO RESTRICTIONS, NY = NEXT YEAR, SY = SECOND YEAR FOLLOWING APPLICATION

² 18 Months with a soil pH \geq 6.5

³ 20 Days per pint

⁴ 30 Days per pint

⁵ Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.

⁶ Transplanted

⁷ Corn hybrids, which are classified as tolerant (IT) or resistant (IR) to Sceptor and/or other imidazoline herbicides (example Pursuit), may be planted in the spring of the following year following Sceptor or Pursuit application

⁸ See current 2,4-D label

table continued on next page

Table E-4. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop¹ (cont'd)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Potato,			Rye,	Sorghum,			Water-	Wheat,	
	Pepper	white	Pumpkin	winter	Soybean	grain	Squash	melon	winter	
Accent	10 ²	10 ²	10 ²	4	0.5	10	10	10 ²	10	4
Aim	1	1	1	12	1	1	1	1	1	1
Alanap	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Assure II/Targa	4	4	4	4	NR	4	4	4	4	4
Atrazine	SY	SY	SY	12	SY	NR	SY	SY	SY	SY
Authority MTZ	18	12	18	18	4	18	18	18	18	4
Axial	4	4	4	4	4	4	4	4	4	0
Axiom	NY	1	NY	NY	NR	NY	NY	NY	NY	NY
Backdraft	18	18	18	18	NR	11	18	18	18	4
Balance	18	6	18	18	6	6	18	18	18	4
Banvel	AH	AH	AH	1 ³	1 ⁴	NR	AH	AH	AH	1 ³
Basagran	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Basis	18	4	18	18	0.5	18	10	18	18	4
Basis Gold	18	18	18	18	10	10	18	18	18	10
Beacon	18	18	18	3	8	8	18	18	18	3
Boundary	12	8	12	12	NR	12	12	12	12	4.5
Buctril	1	1	1	1	1	1	1	1	1	1
Callisto	NY	NY	NY	4	NY	NY	NY	NY	NY	4
Canopy	30	30	18	4	NR	12	30	10	18	4
Canopy EX	30	18	18	4	NR	12	30	10	18	4
Celebrity Plus	10 ⁵	10 ⁵	10 ⁵	4	1	10 ⁵	10 ⁵	10 ⁵	10 ⁵	4
Chateau	12	12	12	4	NR	1	12	12	12	2
Cimarron Plus	B	B	B	B	B	B	B	B	B	1
Clarity	AH	AH	AH	1 ³	1 ⁴	NR	AH	AH	AH	AH
Classic ⁵	30	30	18	3	NR	9	30	9	18	3
Cobra	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Command ⁵	NR	9	NR	12	NR	9	NR	9 ⁶	9	12
Curbit	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Dacthal	8	8	8	8	8	8	8	8	8	8
Define	4	18	12	12	NR	12	12	12	12	12
Degree/Degree Extra	SY	SY	SY	SY	NY	NY	SY	SY	SY	AH
Devrinol	NR	12	12	12	12	12	12	NR	12	12
Distinct	1	1	1	1	1	1	1	1	1	1
Dual Magnum	12	NR	12	4.5	NR	NR	12	6	12	4.5
Eptam	AH	NR	AH	AH	AH	AH	AH	AH	AH	AH
Eradicane/Eradicane Extra	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Evik	NY	NY	NY	AH	NY	NY	NY	NY	NY	AH
Exceed	18	10	18	3	18 ⁵	10	18	18 ⁵	18 ⁵	3
Extreme	40	26	40	4	NR	18	40	40	40	4
Field Master	SY	SY	SY	NY	NY	NR	SY	SY	SY	NY
Finesse Grass & Broadleaf	B	B	B	B	B	B	B	B	B	4

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²18 Months with a soil pH \geq 6.5

³20 Days per pint

⁴30 Days per pint

⁵Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.

⁶Transplanted

⁷Corn hybrids, which are classified as tolerant (IT) or resistant (IR) to Sceptor and/or other imidazoline herbicides (example Pursuit), may be planted in the spring of the following year following Sceptor or Pursuit application

⁸See current 2,4-D label

table continued on next page

Table E-4. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop¹ (cont'd)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Alfalfa	Barley, winter	Bean, lima	Bean, snap	Cabbage	Corn, field	Corn, sweet	Cucum- ber	Musk- melon	Onion	Pea
First Rate	9	30B	30B	30B	30B	9	9	30B	30B	30B	30B
Flexstar	18	4	10	10	18	10	10	18	18	18	10
Forefront	12B	12B	12B	12B	12B	12B	12B	12B	12B	12B	12B
Fusilade DX/Fusion	2	2	NR	NR	NR	2	2	NR	NR	NR	NR
Galigan	2	10	2	2	2(NR ⁶)	10	10	2	2	2	2
glyphosate products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Goal	2	10	2	2	2(NR ⁶)	10	10	2	2	2	2
Gramoxone products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Guardman Max	SY	SY	SY	SY	SY	NR	SY	SY	SY	SY	SY
Halex	10	4	18	18	18	NR	NR	18	18	18	18
Harmony Extra	2	NR	2	2	2	2	2	2	2	2	2
Harmony GT	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Harness	SY	SY	SY	SY	SY	NR	NY	SY	SY	SY	SY
Harness Xtra	SY	SY	SY	SY	SY	NR	SY	SY	SY	SY	SY
Hornet	10.5	4	26B	26B	26B	NR	18	26B	26B	26B	18
Impact	9	3	18	18	18	0	0	18	18	18	9
Karmex	24	24	24	24	24	NY	24	24	24	24	24
Kerb ⁵	0	12	5	5	7	5	5	7	7	7	12
Liberty	4	2.5	4	4	4	NR	4	4	4	4	4
Liberty ATZ	SY	SY	SY	SY	SY	NR	NR	SY	SY	SY	SY
Lightning	9.5	9.5	40B	9.5	40B	8.5 ⁵	18	40B	40B	40B	9.5
Lorox	4	4	4	4	4	NR	4	4	4	4	4
Marksman	SY	10	SY	SY	SY	NR	NR	SY	SY	SY	SY
Matrix	12	12	10	10	12	NR	10	12	12	12	12
Micro-Tech/Partner	AH	AH	NR	NY	NY	NR	NR	NY	NY	NY	NY
Milestone	12B	12B	12B	12B	12B	12B	12B	12B	12B	12B	12B
NorthStar	8	3	18	8	18	0.5	8	18	18	18	18
Outlook/Frontier	NY	4	NY	NY	NY	NR	NY	NY	NY	NY	NY
Paramount	24B	10	24B	24B	24B	10	10	24B	24B	24B	24B
Paraquat products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Permit	9	2	9	9	15	1	3	9	9	18	9
Poast	NR	NR	NR	NR	NR	AH	NR	NR	NR	NR	NR
Poast Plus	NR	NR	NR	NR	NR	AH	NR	NR	NR	NR	NR
Prefar	4	4	4	4	NR	4	4	NR	NR	NR	4
Prefix	18	4.5	18	0	18	10	18	18	18	18	10
Princep	SY	SY	SY	SY	SY	NR	NR	SY	SY	SY	SY
Prism	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Prowl	NY	4	NR	NR	NY	NY	NY	NY	NY	NY	NY
Pursuit ⁵	4	9.5	NR	4	40B	8.5 ⁷	18	40B	40B	40B	4
Python	4	4	26B	26B	26B	NR	18	26B	26B	26B	4
Raptor	9	4	9	9	9	9	9	9	9	9	9

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² 18 Months with a soil pH \geq 6.5

³ 20 Days per pint

⁴ 30 Days per pint

⁵ Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.

⁶ Transplanted

⁷ Corn hybrids, which are classified as tolerant (IT) or resistant (IR) to Sceptor and/or other imidazoline herbicides (example Pursuit), may be planted in the spring of the following year following Sceptor or Pursuit application

⁸ See current 2,4-D label

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Table E-4. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop¹ (cont'd.)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Potato,		Rye,		Sorghum,		Squash	Tomato	Water- melon	Wheat, winter
	Pepper	white	Pumpkin	winter	Soybean	grain				
First Rate	30B	30B	30B	30B	NR	9	30B	30B	30B	3
Flexstar	18	18	18	4	10	18	18	18	18	4
Forefront	12B	12B	12B	12B	12B	12B	12B	12B	12B	12B
Fusilade DX/Fusion	NR	NR	NR	2	NR	2	NR	NR	NR	2
Galigan	2	2	2	10	NR	10	2	2	2	10
glyphosate products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Goal	2	2	2	10	NR	10	2	2	2	10
Gramoxone products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Guardsman Max	SY	SY	SY	SY	NY	NY	SY	SY	SY	SY
Halex	18	10	18	18	10	18	18	18	18	4
Harmony Extra	2	2	2	2	2	2	2	2	2	NR
Harmony GT	1.5	1.5	1.5	1.5	NR	1.5	1.5	1.5	1.5	1.5
Harness	SY	SY	SY	SY	NY	SY	SY	SY	SY	AH
Harness Xtra	SY	SY	SY	SY	NY	NY	SY	SY	SY	SY
Hornet	26B	18	26B	4	10.5	12	26B	26B	26B	4
Impact	18	9	18	3	9	9	18	18	18	3
Karmex	24	24	24	24	24	NY	24	24	24	12
Kerb ⁵	12	12	7	12	5	5	7	7	7	12
Liberty	4	4	4	2.5	NR	2.5	4	4	4	2.5
Liberty ATZ	SY	SY	SY	12	SY	NR	SY	SY	SY	SY
Lightning	40B	26	40B	4	9	18	40B	40B	40B	4
Lorox	4	NR	4	4	NR	4	4	4	4	4
Marksman	SY	SY	SY	10	SY	NR	SY	SY	SY	10
Matrix	12	NR	12	12	10	12	12	1	12	4
Micro-Tech/Partner	NY	NY	NY	AH	NR	NR	NY	NY	NY	AH
Milestone	12B	12B	12B	12B	12B	12B	12B	12B	12B	12B
NorthStar	18	8	18	3	8	8	18	18	18	3
Outlook/Frontier	NY	NY	NY	4	NR	NY	NY	NY	NY	4
Paramount	24B	24B	24B	10	24B	0	24B	24B	24B	0
Paraquat products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Permit	10	9	9	2	9	2	9	8	9	2
Poast	NR	NR	NR	NR	NR	AH	NR	NR	NR	NR
Poast Plus	NR	NR	NR	NR	NR	AH	NR	NR	NR	NR
Prefar	NR	4	NR	4	4	4	NR	NR	NR	4
Prefix	18	18	18	4.5	0	18	18	18	18	4.5
Princep	SY	SY	SY	SY	SY	SY	SY	SY	SY	SY
Prism	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Prowl	NY	NR	NY	NY	NR	NY	NY	NY	NY	4
Pursuit ⁵	40B	26	40B	4	NR	18	40B	40B	40B	4
Python	26B	12	26B	4	NR	12	26B	26B	26B	4
Raptor	9	9	9	4	9	9	9	9	9	3

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²18 Months with a soil pH \geq 6.5

³20 Days per pint

⁴30 Days per pint

⁵Read the label for additional restrictions due to special state restrictions, varieties, rate, rainfall, soil, pH, application rate, etc.

⁶Transplanted

⁷Corn hybrids, which are classified as tolerant (IT) or resistant (IR) to Sceptor and/or other imidazoline herbicides (example Pursuit), may be planted in the spring of the following year following Sceptor or Pursuit application

⁸See current 2,4-D label

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Table E-4. Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop¹ (cont'd.)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Alfalfa	Barley, winter	Bean, lima	Bean, snap	Cabbage	Corn, field	Corn, sweet	Cucum- ber	Musk- melon	Onion	Pea
Ready Master ATZ	SY	SY	SY	SY	SY	NY	NY	SY	SY	SY	SY
Reflex	18	4	10	10	18	10	18	18	18	18	10
Resolve	18	9	18	10	18	NR	10	10	18	18	18
Resource	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ro-Neet	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Sandea	9	2	NR	NR	15	1	3	NR	NR	18	9
Scepter ⁵	18	11	11	11	18	9.5 ^{5,7}	18	18	18	18	18
Select	NR	1	1	1	1	1	1	1	1	NR	1
Sempra	9	2	9	9	15	1	3	9	-	18	9
Sencor	4	4	12	12	12	4	12	12	12	18	8
Sequence	4	4.5	NR	NR	NY	NR	NR	NY	NY	NY	NR
Sinbar	24	24	24	24	24	24	24	24	24	24	24
Solicam	B	B	B	B	B	B	B	B	B	B	B
Sonalan	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Sonic/Authority First	12	12	30B	30B	30B	10	18	30B	30B	30B	12
Spin-aid	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Spirit	18	3	18	10	10	1 ⁷	8	18	18	18	10
Starane	4	NR	4	4	4	NR	NR	4	4	4	4
Status	1	1	4	4	4	0.25	0.25	4	4	4	4
Steadfast	12	4	10	10	18	NR	10	18	18	18	18
Steel	18	11	11	11	40	9.5	18 ⁵	40	40	40	18
Stellar	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Stinger	10.5	NR	18	18	NR	NR	NR	18	18	10.5	18
Stout	10	4	18	10	18	NR	10	18	18	18	10
Sure Start	NY	NY	26	26	26	0	18	26	26	26	NY
Synchrony STS ⁵	12 ⁵	3	30	9 ⁵	18	9 ⁵	18	18	30	30	9
Synchrony XP ⁵	12	3	9	9	18	9	18	18	30	30	9
Tillam	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Touchdown products	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Treflan	NR	NR	NR	NR	NR	5	5	NR	5	5	NR
Ultra Blazer	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH	AH
Valor	12	4	12	12	12	2	4	12	12	12	12
Valor XLT	18	4	30	30	30	10	30	30	30	30	30
Yukon	9	2	NI	9	15	1	3	9	NI	18	9
2,4-D	3	3	3	3	3	NR	NR	3	3	3	3

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Table E-4 . Crop Rotation Planting Restrictions—Months After Herbicide Application Until Planting New Crop¹ (cont'd.)

Table E-4 summarizes the crop rotation constrictions after certain herbicide applications have been made. Example: Devrinol was applied to tomatoes this year. You must delay planting sweet corn in the field for 12 months after application of Devrinol. Consult the label for a different time interval if two or more of these materials are applied in the same season. This table is not a substitute for the label!

Herbicide	Potato,		Rye,		Sorghum,		Tomato	Water-melon	Wheat, winter
	Pepper	white	Pumpkin	winter	Soybean	grain			
Ready Master ATZ	SY	SY	SY	SY	NY	NY	SY	SY	SY
Reflex	18	18	18	4	10	18	18	18	4
Resolve	18	NR	18	18	10	18	18	1	3
Resource	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ro-Neet	AH	AH	AH	AH	AH	AH	AH	AH	AH
Sandea	10	9	NR	2	9	2	NR	NR	2
Scepter ⁵	18	18	18	18	NR	11	18	18	3
Select	1	1	1	1	1	1	1	NR	1
Sempra	10	9	9	2	9	2	9	8 ⁶	2
Sencor	12	4	12	12	NR	12	12	4	4
Sequence	NY	NY	NY	4.5	NR	NR	NY	6	4.5
Sinbar	24	24	24	24	24	24	24	24	24
Solicam	B	B	B	B	B	B	B	B	B
Sonalan	AH	AH	AH	AH	AH	AH	AH	AH	AH
Sonic/Authority First	30B	18	30B	12	NR	12	30B	30B	4
Spin-aid	NR	NR	NR	NR	NR	NR	NR	NR	NR
Spirit	18	10	18	3	10	10	18	10	3
Starane	4	4	4	NR	4	NR	4	4	NR
Status	4	4	4	1	1	1	4	4	1
Steadfast	18	18	18	4	0.5	18	18	18	4
Steel	40	26	40	40	NR	18	40	40	4
Stellar	NR	NR	NR	NR	NR	NR	NR	NR	NR
Stinger	18	18	18	NR	10.5	10.5	18	18	NR
Stout	18	10	18	4	0.5	10	18	18	4
Sure Start	26	18	26	NY	NY	12	26	26	4
Synchrony STS ⁵	30	30	18	3	NR	9	30	9	3
Synchrony XP ⁵	30	30	18	3	NR	9	30	9	3
Tillam	AH	AH	AH	AH	AH	AH	AH	AH	AH
Touchdown products	NR	NR	NR	NR	NR	NR	NR	NR	NR
Treflan	NR ⁶	NR	5	NR	NR	5	5	NR ⁶	NR
Ultra Blazer	AH	18	AH	AH	AH	AH	AH	AH	AH
Valor	12	12	12	4	NR	2	12	12	2
Valor XLT	30	30	30	4	NR	18	30	18	4
Yukon	10	9	9	2	9	2	9	8	2
2,4-D	3	3	3	3	.25-1 ⁸	3	3	3	3

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Table E-5. Rain Free Requirement After Application of Postemergence Herbicides

Herbicide	Time (hrs)	Herbicide	Time (hrs)
Aim	1	Pursuit	1
Assure II/Targa	1	Roundup products	1-6
Atrazine	4	Sandea	4
Banvel	2	Select Max	1
Basagran	8	Sencor	--
Buctril	1	Spin-Aid	6
Fusilade DX	1	Touchdown	4
Gramoxone & Paraquat products	0	2,4-D	6-8
Lorox	--		
Poast	1		

NOTES

INSECT MANAGEMENT

Soil Pests-Detection and Control

Wireworms

Wireworms injure vegetable crops by killing seeds or seed-lings 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.

Since wireworm infestations are often localized within a field, it will be necessary to place the bait stations randomly throughout the field. One bait station per acre is desirable. Place two bait stations at the highest elevation in a field, two on a slope, and two in the lowest area.

Follow this procedure for baiting:

1. Mix 1 cup of untreated wheat and 1 cup of untreated shelled corn 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 (7.22° and 29.4°C) 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. Sample sites should be near plant crowns.
3. Sift soil and count wireworms.

Control. If you find an average of 1 wireworm per bait station (Method 1) or if you find 5 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 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 (10°C) and soil moisture is equivalent to that desired for planting. Frequently, the insecticide is applied immediately before planting. When early spring planting is contemplated, the fall treatment is suggested.

What to Use. The following insecticides are labeled for wireworm control:

- Aztec - (Sweet corn only; PA only). 6.7 oz 2.1 G/1,000 ft of row, or OLF.
- bifenthrin (Sweet corn only; PA only).
- Capture LFR (beans, Brassicas, cucurbits, eggplant, okra, pepper, spinach, tomato. Also white potato and sweet corn in PA only.) See label for rates and restrictions.
- Counter - (Sweet corn only). 8 oz 15G/1000 ft of row for any row spacing. Granules may be applied either in a 7-inch band over the row, in front of the press wheel and incorporated evenly into the top 1-inch of soil OR directly in the seed furrow behind the planter shoe.
- Cruiser - (Sweet corn, peas, snap beans, lima beans only). **Commercially applied seed treatment only.**
- diazinon - AG500 or OLF. See label for rates and application methods.
- Fortress - (Sweet corn only). 6.0-7.5 oz 2.5G/1000 ft of row.
- Furadan - (Sweet corn only). 2-5 oz 4F/1000 ft row
- imidacloprid (Sweet corn only). **Latitude - Planter-box seed treatments; Gaucho 480 – Commercially applied seed treatment only.** See label for use directions.
- Lorsban - (Sweet potatoes and sweet corn only). Pre-plant broadcast and incorporate 13.5 lb 15G/A or 4 pt 4E/A.
- Mocap 15G (Sweet corn, sweet potatoes and white potatoes only). See label for rates and application methods.
- Poncho 600 (Sweet corn only). **Commercially applied seed treatment only.**
- Thimet 20G (Sweet corn and white potatoes only). See label for rates and application methods.

Cutworms

A number of cutworm species 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 lights and can lay eggs into 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. In all cases, consult the label for application details. Where cutworms are suspected, a broadcast incorporation treatment may be necessary, just before planting. Diazinon is labeled on many vegetable crops for this purpose. The 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 may be 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.

Garden Centipedes (Symphylans)

Garden centipedes are arthropods that are related to insects. They feed on germinating seed and fibrous roots of many crop and noncrop plants, including practically all 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 postplanting 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 will have beaded antennae. Centipedes are not expected to be white in color and have large mandibles. Dry or cold (less than 45°F [7.22°C]) soil will reveal few, if any, symphylans. Control is warranted when there is an average of two symphylans per shovelful of soil.

When to treat. If samples are taken in the spring, control is generally warranted if there is an average of over two per shovelful of soil. Samples taken in September or October may average four or five per shovelful to 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 (12.8°C).

What to use. The following insecticides are recommended for control:

Counter - When applied at the rate suggested in the preceding "Wireworms" sections, Counter will control symphylans in soil to be planted to sweet corn.

Fortress - (Sweet corn only). 6-7.5 oz 2.5G/1,000 ft of row.

Lorsban - 2-4 pt 4E/A or 8 oz 15G/A (sweet corn only) or OLF.

Follow all label directions and restrictions when using these materials.

Grubs

Grubs are the larvae of various beetles and can be serious soil pests in vegetable crops. Most vegetables can be attacked, and serious problems have occurred in potatoes, sweet potatoes, beans, corn, spinach, and strawberries. Grubs cause damage by feeding on the roots and under-ground parts of the plant from one to several inches below the soil surface. The plants may yellow and wilt, which causes a 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 grub can be found in the soil.

Adult beetles lay eggs in the soil during June to 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. Clean fields may help prevent serious grub damage. Problems may occur in crops planted to fields that were previously sod.

Aztec 2.1G (PA only), Counter 15G, Force 3G, Fortress 2.5G, and Lorsban 15G, 4E are labeled for grub control in sweet corn. No effective insecticides are labeled for grub control in other vegetables.

Maggots

Several species of maggots attack either the seed or roots of vegetables during the growing season. The adult of the maggot (a fly) fluctuates in abundance in different areas in different years; since it is impossible to determine when and where maggots will attack and since nothing can be done once the injury is noted, preventive controls are good insurance before planting if you have previously had maggot problems.

Seed 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 rich in organic matter.

Control. Control may be achieved using seed treatments containing chlorpyrifos (Lorsban 50W), clothianidin (Poncho 600) labels can be used, see product for current label), imidacloprid (Latitude or Gaucho 480 for sweet corn only, Gaucho 600), (Kernel Guard Supreme, KickStart VP.) and thiamethoxam (Cruiser 5FS). The level of control will depend on crop, soil type, weather conditions, etc. Seed treatments are available as planter-box treatments or as commercially-treated seed. Cruiser, Gaucho, Lorsban and Poncho are only available as commercially-treated seed.

Refer to the specific crop sections of this manual for a listing of labeled seed treatments for each crop.

Note: Seed Treatments containing malathion or lindane will not control seed maggots. Seed commercially treated at low rates for seed storage will not control maggots.

IMPORTANT: Do not use treated seed for food or feed

Root Maggot

Plant roots become riddled with maggot tunnels, and under-ground fleshy parts soon become rotten. Above ground, plants appear off-color, wilt, and seldom reach full growth.

Transplant water treatments, in-furrow treatments, preplant broadcast, and postplant treatments may be recommended depending on the crop. Refer to crop section or call your county Extension agent for latest recommendations.

Slugs

Slugs are not insects, but are closely related to snails. All slugs require damp or humid surroundings for development and will avoid the drying effects of sun and wind. During the day, slugs seek shelter under protective debris. This is why weed control is a useful deterrent to any slug problem.

Control: What to use. Sevin bait is labeled for slug control. Broadcast 40 pounds bait per acre by ground equipment or aircraft when slugs become troublesome. Repeat treatment as needed.

Metaldehyde (Deadline M-Ps, Trails End LG and Metaldehyde 3.5% and 7%) is an effective slug-control chemical, and commercial preparations are available at farm supply centers. Metaldehyde should be applied at rates listed on the label. Be sure to follow all restrictions when using this material.

Insect Resistance and Control

Resistance develops because intensive pesticide use kills the susceptible individuals in a population, leaving only resistant ones to reproduce. Adopting the practices outlined below will help reduce the development of pest resistance.

- a. Crop rotation to a nonhost crop reduces the need for pesticide treatment and, thus, reduces the ratio of resistant to susceptible individuals in the breeding population.
- b. Spot treatment is an important practice. Early season insects are often concentrated in areas near their overwintering sites. Spot treating these areas, rather than the entire field, will reduce the resistance problem.
- c. Younger insect larvae, are more susceptible and less likely to develop resistance than are older crop pests. Control efforts should be concentrated against the early stages of development.
- d. Do not overspray. Attempts to destroy every pest in the field by multiple applications or by using rates higher than labeled rates often eliminate the susceptible but not the resistant pests.
- e. The way pesticides are used affects the development of resistance. Insecticides within a specific chemical group usually share a common target site within the

pest, and thus share a common Mode of Action (MoA). Resistance often develops based on a genetic modification of this target site. When this happens, the compound usually loses its pesticidal activity. Because all insecticides within the chemical grouping share a common MoA, there is a high risk that this resistance will automatically confer cross-resistance to all the compounds in that group. The MoA classification provides a guide to the selection of insecticides for an insecticide resistance management strategy. The MoA classification scheme below was developed and is endorsed by the Insecticide Resistance Action Committee (IRAC) to insure growers can effectively use insecticide alternations and rotations of insecticides with different modes of action. For more information, see the website www.irac-online.org/. Refer to Table E-7 for a listing of insecticides labeled for vegetables and the MoA group classification.

<u>Group</u>	<u>Mode of Action</u>
1	Acetylcholine esterase inhibitors
2	GABA-gated chloride channel antagonists
3	Sodium channel modulators
4	Nicotinic acetylcholine receptor agonists/antagonists
5	Nicotinic acetylcholine receptor agonists
6	Chloride channel activators
7	Juvenile hormone mimics
9	Unknown (selective feeding blockers)
11	Microbial disruptors of midgut membranes
12	Inhibitors of oxidative phosphorylation
15	Chitin inhibitors
17	Moulting disruptors
18	Ecdysone Agonists
20	Mitochondrial inhibitors
22	Voltage dependent sodium channel blockers
25	Neuronal inhibitors
26	Aconitase inhibitors

A list of insecticides and miticides registered for vegetables and the MoA of these pesticides is listed in the table E-7.

Table E-7. Insecticides and Miticides Registered for Vegetables (excluding seed treatments)

Vegetable	Acramite	acephate, Orthene	Actara, Platinum	abamectin	Asana XL	Assail	Avant	Aza-Direct, Azatin Ecozin, Neemix	Bacillus thuringiensis	Baythrod XL	Beleaf	bifenthrin	carbaryl, Sevin	Confirm	cyfluthrin	Danitol	diazinon	dimethoate	Empower	endosulfan, Thionex	Fulfill	imidacloprid
Insecticide MoA¹	25	1	4	6	3	4	22	26	11	3	9	3	1	18	3	3	1	1	3	2	9	4
Asparagus								X	X				X					X			X	
Beets			X					X	X	X			X									X
Broccoli			X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Brussels sprouts		X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cabbage			X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cantaloupes	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X ²
Carrots			X		X			X	X				X				X			X		X
Cauliflower		X	X		X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Celery				X		X	X	X	X	X	X		X	X						X	X	X ²
Chinese cabbage			X		X	X	X	X	X	X	X	X	X	X	X				X		X	X
Collards			X		X	X	X	X	X			X	X	X	X					X	X	X
Cucumbers	X		X	X	X		X	X	X	X	X	X	X			X			X	X	X	X ²
Eggplants	X		X	X	X	X	X	X	X	X	X	X	X	X	X				X	X	X	X
Endive				X		X	X	X	X	X	X		X	X			X	X			X	X
Escarole							X		X	X				X			X	X				X
Garlic								X	X													
Green onions									X								X					
Horseradish			X						X	X			X									X
Kale			X			X	X	X	X			X	X	X			X	X		X	X	X
Kidney beans								X ⁴	X	X			X				X	X	X	X	X	X
Kohlrabi			X		X	X	X	X	X	X	X	X	X	X	X	X			X		X	X
Lettuce, head		X		X		X	X	X	X	X	X	X	X	X					X	X	X	X
Lettuce, leaf				X		X	X	X	X	X			X	X			X	X		X	X	X
Lima beans		X						X ⁴	X			X	X				X	X	X	X	X	X
Mustard			X		X	X	X	X	X	X	X	X	X	X			X	X		X	X	X
Okra	X								X	X	X	X	X									X
Onions, bulb								X	X								X					
Parsley				X		X	X	X	X	X			X	X							X	X
Parsnips			X					X ⁵	X	X			X									X
Peas					X	X		X ⁴	X			X	X		X	X		X	X	X	X	X
Peppers	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Potatoes			X	X	X	X	X	X	X	X	X	X	X				X			X	X	X
Pumpkins	X		X	X	X		X	X	X	X	X	X	X		X	X			X	X	X	X ²
Radishes			X		X			X	X	X			X		X		X					X
Rhubarb				X		X	X		X	X	X			X							X	X ²
Snap beans		X			X			X ⁴	X			X	X				X	X	X	X	X	X
Spinach			X	X		X	X	X	X	X	X	X	X	X			X			X	X	X
Squash, summer	X		X	X	X		X	X	X	X	X	X	X	X	X				X	X	X	X ²
Squash, winter	X		X	X	X		X	X	X	X	X	X	X	X	X				X	X	X	X ²
Strawberries	X			X					X				X			X				X		X
Sweet corn					X		X		X	X		X	X		X				X			
Sweet potatoes			X			X	X	X	X	X		X	X							X	X	X
Tomatoes	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
Turnips			X		X			X	X	X				X			X	X			X	X
Watermelons	X		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X ²

¹Mode of Action. Refer to the preceding section for complete explanation. ²Admire only ³15G only ⁴Aza-direct, Ecozin, Neemex only. ⁵Aza-direct, Azatin, Neemex only. ⁶Bell-peppers only. * = Unknown

Table E-7. Insecticides and Miticides Registered for Vegetables (excluding seed treatments)

Vegetable	Intrepid	Knack	Kryocide	Lannate	Larvin	Lorsban	malathion, Cythion	Metasystox-R	Mocap	Mustang MAX	Pennacap-M	permethrin	Proaxis	Proclaim	pyrethrins	Oberon	Radiant	Rimon	SpinTor, Entrust	Thimet	Trigard	Venom	Vydate	Warrior	
Insecticide MoA ¹	18	17	9	1	1	1	1	1	1	3	1	3	3	6	3	*	5	15	5	1	17	4	1	3	
Asparagus				X		X	X					X			X		X		X						
Beets	X			X		X	X								X		X		X	X					
Broccoli	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X	X	X			X	X		X
Brussels sprouts	X	X	X	X		X	X	X		X		X	X	X	X	X	X	X	X			X	X		X
Cabbage	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X			X	X		X
Cantaloupes	X	X	X	X			X	X				X			X	X			X			X	X	X	
Carrots	X			X			X								X		X		X					X	
Cauliflower	X	X	X	X	X	X	X	X		X		X	X	X	X	X	X	X	X			X	X		X
Celery	X			X	X		X					X		X	X		X		X			X	X		
Chinese cabbage	X	X		X		X				X		X	X	X	X	X	X		X			X	X		X
Collards	X	X	X	X		X	X			X				X	X	X			X						
Cucumbers	X	X	X	X			X	X	X			X			X	X			X			X	X	X	
Eggplants	X	X	X	X			X	X		X		X	X	X	X	X	X		X			X	X	X	X
Endive	X			X	X		X			X		X		X	X	X	X		X			X	X		
Escarole	X			X	X			X				X		X	X	X			X			X			
Garlic				X			X			X		X	X		X		X		X			X			X
Green onions				X		X	X			X	X				X		X		X			X			
Horseradish	X			X			X					X			X		X		X						
Kale	X	X		X		X	X			X				X	X	X			X			X			
Kidney beans	X	X		X		X	X			X	X		X		X				X	X		X			X
Kohlrabi	X	X	X			X				X		X	X	X	X	X	X	X	X			X	X		X
Lettuce, head	X		X	X	X		X	X		X		X	X	X	X	X	X		X			X	X		X
Lettuce, leaf	X		X	X	X		X					X	X	X	X	X	X		X			X	X		X
Lima beans	X	X		X		X	X	X		X	X		X		X		X		X	X		X			X
Mustard	X	X		X			X			X				X	X	X	X		X			X			
Okra	X	X					X								X		X		X						
Onions, bulb		X		X			X			X	X	X	X		X		X		X			X			X
Parsley	X			X	X		X					X		X	X	X	X		X			X	X		
Parsnips	X						X								X		X		X						
Peas	X	X		X		X	X			X			X		X		X		X			X			X
Peppers	X	X	X	X			X	X		X		X ⁶	X	X	X	X	X		X			X	X	X	X
Potatoes			X	X			X	X	X		X	X			X	X	X	X	X	X		X	X		
Pumpkins	X	X	X				X	X				X			X				X			X	X		
Radishes	X					X	X								X		X		X						
Rhubarb	X				X							X		X	X		X		X			X	X		
Snap beans	X	X		X		X	X	X	X ³	X			X		X		X		X	X					X
Spinach	X			X	X	X	X	X				X		X	X	X	X		X			X			
Squash, summer	X	X	X	X			X	X				X			X	X			X			X	X	X	
Squash, winter	X	X	X				X	X				X			X	X			X			X	X	X	
Strawberries	X			X		X	X								X	X			X						
Sweet corn	X			X	X	X ³	X	X	X ³	X	X	X	X		X		X		X	X					X
Sweet potatoes	X					X	X	X	X						X	X	X	X	X						X
Tomatoes	X	X	X	X			X			X			X	X	X	X	X		X			X	X	X	X
Turnips	X			X		X		X						X	X		X		X			X			
Watermelons	X	X	X	X			X	X				X			X	X			X			X	X	X	

¹Mode of Action. Refer to the preceding section for complete explanation ² Admire only ³ 15G only ⁴ Aza-direct, Ecozin, Neemex only. ⁵ Aza-direct, Azatin, Neemex only. ⁶ Bell-peppers only. * = Unknown

DISEASE MANAGEMENT

Resistance Management

Pathogens develop resistance to fungicides because of genetic changes in the organism through natural selection or by the intensive use of high-risk fungicides which kill only the susceptible individuals in a population, leaving resistant populations to reproduce and cause more disease. Use the practices outlined below to help reduce the chances for fungicide resistance development.

- a. Proper crop rotations with a non-host reduces the need for certain pesticide treatments and, thus, reduces the chances for resistance to develop to certain fungicide chemistries. This is especially important for controlling soil-borne pathogens.
- b. 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, but not the resistant pathogen population. Do not use less than labeled rates which allow low to moderately resistant populations to survive.
- c. Always rotate fungicides with different modes-of-action (MOA). (see below)
- d. Fungicides are organized according to FRAC groups, chemical structure and Mode of Action (MoA). Fungicides within a given FRAC group control fungi in a similar manner and share the same risk for fungicide resistance development. Fungicides in these FRAC groups are referred to as high- or at-risk fungicides. See Table E-8 for specific fungicides and fungicide FRAC groups. Groups of fungicides, such as the QoI's (FRAC group 11) or DMI's (FRAC group 3) are prone to resistance development due to very specific MoA's. Fungicides in high- or at-risk groups (in **BOLD** in table E-8) should be rotated and/or tank-mixed with broad spectrum, protectant fungicides to delay the development of resistant strains of fungi. High- or at-risk fungicides have seasonal application restrictions which should be followed precisely.
- e. Do not use high or at-risk fungicides as a rescue treatment for disease control. High-risk fungicides should be used according to labels in a full season disease control program or not at all. Applying high- or at-risk fungicides only after a disease is present in a field increases the chances for the development of resistant populations of plant pathogenic fungi.

List of FRAC codes and corresponding chemical groups for commonly-used fungicides in vegetable production

P1-Salicylic Acid Pathway
 M1-inorganic copper
 M2-inorganic sulfur
 M3-dithiocarbamate
 M4-phthalimide
 M5-chloronitrile
 1-benzimidazole
 2-dicarboximide

3-triazole
 4-phenylamide
 7-carboxamide
 9-pyridinamine
 11-quinone inside inhibitor (QoI)
 12-phenylpyrroles
 13-quinolines
 14-aromatic hydrocarbon
 17-hydroxylanilide
 21-quinone outside inhibitor (QiI)
 22-benzamides
 27-cyanoacetamideoximes
 28-carbamate
 29-dinitro-anilines
 30-organotin compounds
 33-phosphonates
 40-carboxylic acid amides

Seed Treatment

Seed treatment is essential to control seed-borne diseases in many transplanted crops. Failure to treat seed properly could lead to diseases in the plant bed that will reduce plant stands or that are carried into the field at transplanting. Crop failure could result. Seed treatment is especially important for asparagus, broccoli, brussels sprouts, cabbage, cauliflower, collards, eggplant, kale, kohlrabi, pepper, radish and tomato. In the case of peppers and tomatoes, a chlorine seed treatment is essential for prevention of bacterial diseases (bacterial canker, bacterial leaf spot and bacterial speck). See crop sections for specific seed treatment recommendations.

Plant Growing Mix

For the best control of all soil-borne diseases, use the plant-growing mix described in Table A-2 or A-3. If this is not possible, use one of the following procedures.

Disease Control in Plant Beds

Preplant

The only practice that ensures complete sterilization of soil is the use of steam. When steam is used, a temperature of 180°F (82.2°C) must be maintained throughout the entire mass of soil for a period of 30 minutes.

Soil fumigation is a method used to provide disease control in plant beds. The following materials are suitable for small lots of soil:

chloropicrin--5 cc/cu ft
metam-sodium (Vapam HL)--1 qt in 5 gal of water per 1/2 cu yd of soil

For larger areas, such as plantbeds or seedbeds, the following materials are suitable:

chloropicrin--50 gal/A (3 cc/injection)
methyl bromide (MC-2)--1-2 lb/100 sq ft
metam-sodium (Busan, Nemasol, Vapam HL)--
 drench--1 qt/100 sq ft
 injection--1 pt/100 sq ft

Potassium N-methyldithiocarbamate (K-Pam HL)—
 see label, rate varies with method of application

See the "Soil Fumigation" section below for proper application techniques.

Pre-and Postseeding Soil Treatment in Greenhouse

For *Pythium* and *Phytophthora* root rot in pepper, tomato, leaf lettuce, and cucurbits growing in soil and soilless media apply Previcur Flex (see label for rate) at seeding, after emergence or after transplanting.

Postplant

For damping-off on broccoli, cabbage, cauliflower, cucumbers, melons, squash, lettuce, spinach, onions, and tomatoes in open field beds caused by *Pythium* and/or *Phytophthora*, use mefenoxam (Ridomil Gold 4E or Ultra Flourish 2E).

Foliar diseases can be a problem in plant beds. To prevent foliar diseases, it may be necessary to apply fungicide sprays as plants become crowded in plant beds.

Refer to label clearance before use.

Nematodes

Some 100 species of plant-feeding nematodes can seriously damage various economic plants. Before starting any nematode management procedure, one should determine if the kinds of plant-feeding nematodes and the numbers present in the soil warrant action. Nematode kinds and numbers are determined from soil and root samples collected in the field.

How to Collect Soil and Root Samples for Nematode Detection

When nematode damage is suspected, both soils and roots should be examined to find out if and to what extent nematodes may be involved. The following procedure is suggested to ensure that samples are collected and handled properly so that the diagnosis made on that sample at a *Nematode Diagnostic Laboratory* is accurate

Collecting and Handling. Only a single composited sample should be collected in each field. Do not combine samples from several fields. Collect soil and roots from the edges of the affected area(s) in the field. Take a mixture of roots and soil from at least 10 scattered sites, or preferably, under 10 scattered plants in the affected area. Do not take samples from areas where plants are dead. One can dig plants with a shovel and take a small handful of soil and roots from each, or one can use a soil sampling tube (3/4-inch diameter). Combine the individual samples in a bucket to make a composite sample of at least one quart of soil. Mix the soil in the bucket, then place one pint of the mixed soil in a plastic freezer bag and seal it to prevent drying of the soil. Protect bagged samples from high temperatures and freezing which can kill the nematodes.

Take soil samples while the crop is still growing so that areas that are suspected of being stunted by nematodes can be seen and sampled because these areas may be missed in random sampling. In general, samples can be taken from June through November. However, to plan your cropping sequence, it is best to take these survey samples after harvest in the fall before any fall tillage and before cold weather arrives. The reason for this recommendation is that nematode populations are generally the highest in the fall, and the chance of detecting damaging levels of plant pathogenic nematodes by soil sampling is also high. This timing is especially important for growers who need to monitor root knot nematode populations. The worst time to sample to detect root knot nematodes is in late spring just before planting.

Survey samples should be taken at a depth of 8 to 10 inches, and several inches from the base of the plants, between plants in the row. Do not take samples if the soil is wet. The moisture level should be less than field capacity and there should not be any free water in the plastic bag after adding the sample. Use a soil sampling tube and take 20 to 25 cores per sample in a random pattern in the field. Mix soil cores in a plastic bucket and immediately place a pint of soil in a plastic bag or a nematode soil sample kit purchased from a nematode testing laboratory.

Submitting Samples for Nematode Analysis. Samples should be sent to a *Nematode Diagnostic Laboratory* as soon as possible after they are collected. However, if there is any delay, the samples should be refrigerated until shipment. Provide some insulation such as several layers of newspaper, a padded envelope or styrofoam peanuts, around the sample during shipment

The following information must be included with each sample:

1. name and address of the grower and of the person submitting the sample
2. date collected
3. name of the present crop, the crop to be planted, and history of the affected area
4. plant symptoms
(Check with the laboratory to see if any additional information is required).

Attach the paper with this information to the **OUTSIDE** of the bag of soil. Do **NOT** place the information in the bag with soil. Mark the samples: "For Nematode Analysis." Forward the samples and the information to your county Extension agent, or directly to the diagnostic laboratory. There is a fee for nematode analysis.

Nematode Management Strategies

Plant-parasitic nematodes are difficult to control after they have become established. The best strategy is to use preventive measures, including nematicides, soil fumigants, and / or cultural practices.

Chemical Management of Nematodes

Fumigants. Soil fumigation effectively controls plant-feeding nematodes. See the "Soil Fumigation" section for specific fumigants, rates, and application techniques.

Nonfumigant nematicides. Several nonfumigant nematicides are currently available for selected vegetable commodities. These nematicides are listed in the sections dealing with the vegetables on which they are labeled. Some nonfumigant nematicides are not labeled in all states within the mid-Atlantic region, so consult the label carefully before applying a chemical.

These nematicides do not volatilize in the soil as do fumigants. Consequently, these chemicals are effective over a wider range of soil temperature and moisture than are fumigants.

Chemicals which are registered for use on selected vegetables include Counter (20CR), Mocap (10G and 6EC), NemaCur (15G and 3SC), Temik (15G), and Vydate L. The first two are contact nematicides, and the last two act as both contact and systemic nematicides. Consult the label before applying any of these chemicals.

Factors Affecting the Efficacy of Nematicides. As with any pesticide, the two factors that determine efficacy are concentration and exposure time. If toxic concentrations of a nematicide do not come in contact with the nematode for a sufficient period of time, then acceptable levels of control will not occur. Many factors can dilute the concentration of nematicide available in the soil and/or effectively shorten the time that nematodes are exposed.

Good site preparation is extremely important. The soil should be thoroughly tilled several weeks before application to break up clods and encourage decomposition of plant residues. Nematicides can adsorb to organic matter and thus reduce the amount of compound free in the soil. Soil clods can interfere with nematicide distribution and reduce efficacy.

Fumigant nematicides such as Telone or Vapam volatilize and move through the soil as a gas. The movement of a fumigant through the soil is strongly affected by factors such as temperature, moisture, and soil texture. Fumigants tend to move upwards through the soil and will dissipate quickly unless the surface is sealed after treatment. Follow the label to ensure that you are applying the correct dose for your conditions.

Almost all nonfumigant nematicides such as Nemacur and Vydate are organophosphate or carbamate pesticides, which are potent cholinesterase inhibitors. These compounds are extremely water-soluble, and their redistribution in the soil depends on water movement. Excessive rain or irrigation creates a risk of diluting the nematicide below the level needed to be effective. However, too little water may prevent the nematicide from being distributed effectively in the root zone.

Unlike fumigants, contact nematicides act relatively slowly. Although high concentrations are lethal, the lower concentrations in soil generally kill by behavior modification. The affected nematodes typically are unable to move, find a host, feed, or find a mate. Eventually they die. If exposure to the nematicide is too short or at a low concentration, however, these behavioral modifications can be reversed and the treatment is not effective.

Nonchemical Management of Nematodes

Prevention of spread. Plant-feeding nematodes move only short distances, a few inches to a few feet, under their own power. Nematodes are commonly spread by the movement of infested soil and/or infected plants by man. Sanitation and good cultural practices are the best preventive measures against nematodes. Obtain nematode-free transplants from reputable sources. Wash soil from machinery and tools before using them at another location. Nematodes may also be spread by wind, water, soil erosion, and animals.

Crop rotation. Rotation of crops is an effective and widely used cultural practice to reduce nematode populations in the soil. To be most effective, crops that are poor hosts or nonhosts of the target nematodes should be included in the rotation sequence.

Cover crops. Some plants commonly used as cover crops are naturally suppressive to certain nematode species, but no single crop is effective against all nematodes. The cover crop plant may be a nonhost and, therefore, the nematodes starve, their population being reduced as with fallow. Nematodes invade the roots of certain other cover crop plants, but they fail

to reproduce. Yet, other "antagonistic" plant species exude chemicals from their roots which are toxic to nematodes, including marigold and asparagus.

Green manures and soil amendments. In general, the incorporation of large amounts of organic matter into the soil reduces populations of plant-feeding nematodes. The decomposition products of some plants kill nematodes. These include butyric acid released during the decomposition of ryegrass and timothy, and isothiocyanates released during the decomposition of rapeseed and other plants in the genus *Brassica*. Maximum benefit of these "natural" nematicides is obtained when the plant material is incorporated into the soil as green manure. Green manure treatments are not equally effective against all plant-parasitic nematodes and therefore it is important to consult with a diagnostic lab or extension agent to make sure the treatment is appropriate for the nematode being controlled. For example, rapeseed is effective against dagger nematodes but not lesion nematodes. Recent research indicates that sudan grass is effective against root-knot nematodes, although this needs further verification before it becomes a recommendation.

For dagger nematode control, two years of rapeseed green manure is desirable, but it may be possible to get the same benefit by growing two crops of rapeseed within one year. The following timetable is suggested for producing two rotations of rapeseed within one year:

- Prepare seedbed and plant rapeseed by late April or early May. (Plant only recommended winter rapeseed varieties.)
- Turn under green rapeseed by early September. Prepare seedbed and plant second crop by mid-September.
- The second crop should be turned under in late spring after soil temperatures reach 45°F or higher.
- Ideal conditions for incorporating the cover crop are similar to those required for obtaining the maximum benefit from fumigation (i.e., the soil should be above 45°F and moist).
- Alternatively, planting dates may be reversed so that the first planting is in the fall followed by a second crop planted in the spring. This would end the rotation cycle in fall of the following year.

Some rapeseed varieties are more effective at suppressing nematode populations than others, and some varieties will not over-winter or they bloom too early in summer to be useful. The winter varieties 'Dwarf Essex' and 'Humus' work well for both spring and fall planting dates. If planted in the spring, these varieties grow vigorously to crowd out weeds and do not go to seed.

Tips:

- Rapeseed requires a firm, smooth seedbed that is free of weeds, heavy residue, and large clods.
- Seed may be drilled or broadcast. Seed at a depth of 3/8 inch and avoid planting too deep! If seed is broadcast, a cultipacker may be used to cover seed.
- A seeding rate of 7–8 pounds per acre works well.
- Rapeseed is sensitive to broadleaf herbicide carryover.
- Fall-planted rapeseed should have 8–10 true leaves and a 5- to 6-inch tap root with a 3/8-inch diameter root neck before the ground freezes.
- Sulfur is necessary for rapeseed to produce nematicidal compounds. Some soils may be deficient in sulfur. A soil test for sulfur may be beneficial.

Plant nutrition and general care of the plant. The harmful effects of nematodes on plants can be reduced by providing plants with adequate nutrition, moisture, and protection from stress. These tactics may sometimes be of limited usefulness, because if susceptible crops are grown continuously, the nematode population may increase to levels that cause serious damage.

Fallow. Fallow is the practice of keeping land free of vegetation for weeks or months by frequent tilling or applying herbicides. In the absence of a host, nematodes gradually die out; however, eggs of some nematodes may survive for years in the soil. Because fallow may be destructive to soil and the land is out of production during that time, extended periods of fallow are not recommended.

Integrated management practices. Each of the practices mentioned above reduces the soil population of plant-feeding nematodes to varying degrees. Each practice has limitations and the degree of nematode control achieved depends on environmental factors, as well as the particular nematode and crop being considered.

Maximum benefit is realized when several of these practices are employed in an integrated crop management program. Because the host range of different nematode varies, the selection of cover crops, rotation crops, and green manures will be determined by the kinds of nematodes present. No single practice is a "cure-all" for all nematode problems.

NOTES

Table E-8. Fungicides Registered for Vegetables

FRAC Group(s)*	Actigard (acibenzolar-S-methyl)	Alicette (fosetyl AI)	Botran (dichloran)	Chlorothalonil ^a	Cabrio (pyraclostrobin)	Captevate (fenhexamid + captan)	Curzate (cymoxanil)	Elevate (fenhexamid)	Endura (boscalid)	Fixed copper ^a	Flint (trifloxystrobin)	Forum (dimethomorph)	Gavel (zoxamide+mancozeb)	Gem (trifloxystrobin)	Headline (pyraclostrobin)	maneb, Manex	mancozeb ^a	ManKocide Mancozeb + copper	Mertect (thiabendazole)	MetaStar (metalaxyl)	Nova (myclobutani)	
	P1	33	14	M5	11	17+ M4	27	17	7	M1	11	40	22+ M3	11	11	M3	M3	M3+	1	4	3	
Crop																						
Asparagus								X								X ^b	X			X	X180	
Beans, snap			X2	X7				X7	X						X7					X	X	
Beans, lima				X7 ^c				X7	X						X7					X	X	
Beets					X				X											X		
Broccoli	X7	X3			X7			X								X7				X		
Carrots				X	X			X	X											X		
Celery		X3	X7	X7					X											X		
Chinese cabbage	X7	X3		X7					X							X7				X		
Cole crops	X7	X3		X7					X							X7				X		
Cucumbers			XGH	X	X		X3	X	X		X	X5				X5	X5	X5		X	X	
Eggplants					X			X	X	X3	X					X5				X		
Garlic					X7			X7			X									X		
Greens, mustard		X3			X3			X14	X		X											
Greens, turnip									X		X											
Horseradish					X															X		
Leeks			X14	X14	X7			X7			X									X		
Lettuce		X3	X14		X			X14	X		X					X10				X		
Muskmelons				X	X		X3	X	X		X	X5				X5	X5	X5		X	X	
Okra																						
Onions, dry			X14	X7	X7			X7	X		X					X7	X7			X		
Onions, green			X14	X14	X7			X7	X		X									X		
Parsley					X															X		
Parsnips				X10	X															X		
Peas									X						X7					X		
Peppers					X			X	X	X3						X7				X		
Pumpkins/ winter squash				X	X		X3		X		X					X5				X	X	
Radish					X															X		
Spinach	X7	X3			X				X											X		
Squash, summer				X	X		X3				X	X5				X5	X5	X5		X	X	
Strawberries		X			X	X		X													X	
Sweet corn				X14											X7	X7	X7					
Sweet potatoes			X ^b																X	X		
Tomatoes	X14	X14	XGH	X	X		X3	X	X	X3	X4	X5				X5	X5	X5		X	X	
Watermelon				X	X		X3		X		X	X5				X5	X5	X5		X	X	
White potatoes				X7			X14	X30	X		X4	X14 ^d	X7	X3	X3	X14	X14 ^d		X	X		

*Numbers and letters indicate fungicide class (FRAC group). Bold numbers in shaded boxes identify those fungicides that have a higher potential for fungicide resistance to develop if the fungicide is used on a continuous basis. These fungicides should be alternated or tank mixed (where recommended) with fungicides from another FRAC group in a spray program. ^aFixed coppers include: Champ, Kocide, Tenn-Cop, and Cuprofix Dispers. chlorothalonils includes Applause, Bravo, Echo and Equus; mancozeb include Dithane, Manex II, Manzate and Penncozeb (check specific labels for labeled crops) ^bSeed treatment or soil use only (not foliar). ^cNot labeled for fresh lima beans, only dry lima beans; ^dX3 for PA, DE; X = registered, Numbers = days to harvest, No number = 0 days to harvest, GH = greenhouse

Table E-8. Fungicides Registered for Vegetables²

FRAC Group(s)*	Omega (fluzinam)	Previcur Flex (propamocarb HCl)	Pristine (pyraclostrobin + boscalid)	Procure (triflumizole)	Quadris, Abound (azoxystrobin)	Quadris Opti, (azoxystrobin + chlorothalonil)	Quintec (quinoxifen)	Ranman (cyazofamid)	Reason (fenamidone)	Ridomil Gold, Ultra Flourish (mefenoxam)	Ridomil Gold Bravo, Flourolil (mefenoxam + chlorothalonil)	Ridomil Gold Copper (mefenoxam + copper)	Ridomil Gold MZ (mefenoxam + mancozeb)	Ridomil Gold PC (mefenoxam + PCNB)	Rovral (iprodione)	Sulfur (caution) ^c	Switch (cyprodinil + fludioxonil)	Tanos (famoxadone + cymoxanil)	Terraclor (PCNB)	Tilt (propiconazole)	Topsin M (thiophanate-methyl)	
	29	28	11+	3	11	11+	13	21	11	4	4+	4+M	4+	4+	2	M2	9+	11+2	14	3	1	
Crop																						
Asparagus					X100	X100				X												
Beans, snap					X	X14				X ^b				X	X	X			X ^a		X14	
Beans, lima			X21		X	X14				X ^b				X	X	X			X ^a		X14	
Beets					X					X												
Broccoli					X										X	X	X7		X			
Carrots			X		X	X				X ^b		X7			X	X	X7					
Celery					X	X7														X14	X7	
Chinese cabbage					X					X ^b	X7						X7		X			
Cole crops					X					X	X7								X			
Cucumbers		X2	X	X	X1	X1		X	X14	X	X	X5	X5			X		X3				X
Eggplants					X					X												
Garlic			X7		X					X ^a					X ^b	X			X			
Greens, mustard					X											X						
Greens, turnip					X					X ^b						X						
Horseradish					X					X ^a												
Leeks			X7		X			X7	X	X												
Lettuce		X2			X	X	X	X2	X ^a						X14	X		X3				
Muskmelons		X2	X	X	X1	X1	X	X14	X	X	X5	X5						X3				X ^a
Okra					X																	
Onions, dry			X7		X			X7	X	X7		X7			X7	X	X7					X ^a
Onions, green			X7		X	X14		X7	X	X21		X7				X	X7					X ^a
Parsley					X					X												
Parsnips					X					X												
Peas			X21		X			X		X ^b						X						
Peppers					X					X		X7				X		X3	X			
Pumpkins/ winter squash		X2	X	X	X1	X1		X	X14	X	X	X5				X		X3				X
Radish					X					X												
Spinach					X					X		X21										
Squash, summer		X2	X	X	X1	X1		X	X14	X	X	X5	X5					X3				X
Strawberries			X	X	X		X			X					X		X					X
Sweet corn					X																X14	
Sweet potatoes					X			X14	X										X			
Tomatoes		X5			X1	X1		X	X14	X	X	X7	X5			X		X3	X			
Watermelon		X2	X	X	X1	X1	X	X	X14	X	X	X5	X5					X3				X
White potatoes		X14				X14		X7	X14		X7	X7	X7		X14	X		X14	X ^a			

*Numbers and letters indicate fungicide class (FRAC group). Bold numbers in shaded boxes identify those fungicides that have a higher potential for fungicide resistance to develop if the fungicide is used on a continuous basis. These fungicides should be alternated or tank mixed (where recommended) with fungicides from another FRAC group in a spray program. X=registered, Numbers = days to harvest ^a Seed treatment or soil use only . ^bUltra Flourish is not labeled on these crops ^c Sulfur rates above 4 lb/A applied during high temperatures may cause crop injury.

Table E-9. Fungicides Registered for Seed Treatment

	42-S Thiram (thiram)	Allegiance (metalaxyl) ^a	Apron (mefenoxam) ^a	Captan 400 (captan)	Dividend Extreme (difenconazole + mefenoxam)	Dynasty (azoxystrobin)	Evolve (thiophanate methyl + mancozeb + cymoxamil)	Kodiak (<i>Bacillus subtilis</i> GB03)	Maxim (fludioxinil)	Maxim MZ (fludioxinil + mancozeb)	Moncoat MZ (flutolanil + mancozeb)	Potato Seed Treater (EBDC)	Pro-Gro (thiram + carboxin)	Tops MZ (thiophanate-methyl + mancozeb)	Trilex AL (trifloxystrobin + metalaxyl)	Yield Shield (<i>Bacillus pumilus</i> 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				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 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; ^aMefenoxam 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.

Specific Commodity Recommendations

ASPARAGUS

Varieties

Varieties¹

Jersey Giant* (RR,FT)	These varieties are recommended for DE, MD, NJ, PA, VA, WV
Jersey Knight* (RR,FT)	
Jersey Supreme* (RR, FT)	

¹Varieties listed alphabetically

*Indicates hybrid variety

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Asparagus	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med 100 ¹	Opt. 50 ¹	Low Pounds K ₂ O per Acre	Med 100 ¹	Opt. 50 ¹
Growing crowns	50 ¹ 50 ²	200 ¹ 200 ²	100 ¹ 100 ²	50 ¹ 50 ²	200 ¹ 200 ²	100 ¹ 100 ²	50 ¹ 50 ²
New plantings							
Crowns and transplants	75-100 ¹ 50 ³ 25-50 ⁴	200 ¹ 200 ³ 0	100 ¹ 100 ³ 0	50 ¹ 50 ³ 0	200 ¹ 200 ³ 0	100 ¹ 100 ³ 0	50 ¹ 50 ³ 0
Cutting beds							
	75-100 ¹ 75-100 ²	200 ¹ 200 ²	150 ¹ 150 ²	100 ¹ 100 ²	300 ¹ 300 ²	225 ¹ 225 ²	150 ¹ 150 ²

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Broadcast and plow down

⁴ Side dress 4 weeks after planting

Apply 1-2 pounds of boron (B) per acre every 3 years on most soils. See Table B-10 for more specific boron recommendations.

Seed Treatment

Check the tag or contact your seed supplier to determine if seed has been treated.

For New Jersey Only. Dip seed in a solution containing 1 pint of Clorox per gallon of water for 1 to 2 minutes. Provide constant agitation. Use at the rate of 1 gallon of Clorox solution per 2 pounds of seed. Prepare a fresh solution for each batch of seed. Wash seed for 5 minutes in running water and dry thoroughly.

Growing Crowns and Transplants

To grow crowns, sow seed 1½ inches deep at a rate of 6 to 8 pounds per acre (10 to 12 seeds per foot) in rows 24 to 30 inches apart. Field seed in mid-April in warmer, southern areas to mid-May in cooler areas. Crowns must be grown in

an area where asparagus has never been grown.

Grow asparagus transplants in 72-100 cell trays containing artificial growing media formulated for pepper transplants. Grow seedlings for 8-10 weeks in the greenhouse, then harden-off in a protected out-door area for two weeks before transplanting. **Timely irrigation, cultivation and application of herbicides are essential** for successful use of seedling transplants. Contact your County Extension Agent for specific herbicide suggestions.

Planting and Spacing

Plant crowns and transplants April 1 to May 20 when soil conditions are favorable. Early plantings produce more vegetative growth and more vigorous crowns than late plantings. Space 1-year-old crowns and transplants 12 inches apart in rows 4½ to 5 feet apart. Make furrows 6 to 8 inches deep, plant crowns 5 to 7 inches deep. Cover crowns with 1 to 2 inches of soil. Cultivate and move soil to seedlings carefully to avoid covering foliage with soil. Gradually fill trenches during the growing season and form a 2-inch ridge over the plants after the fern turns brown in the fall.

Harvest

Do not harvest asparagus the year of planting or the following year. Harvest for two weeks the third year. In subsequent years, stop harvesting by June 15 if fern vigor was good the previous fall. Prolonged cutting increases stress on the plant and can increase root and crown rot. If foliage diseases were severe or fern vigor was low the previous fall, stop harvesting 10 days sooner than normal. Leave soil unridged on young beds for the first 2 to 3 weeks of harvest. On old beds, and in fields where freezing of early emerged spears occurs frequently, begin ridging at start of harvest season. In areas where freeze damage to spears occurs frequently, mulch the beds with straw after herbicide application to delay spear emergence. Remove spears from field promptly after cutting to maintain freshness and a low fiber content.

Brush Removal

Burn brush during the winter to destroy fungi that cause diseases, such as rust and purple spot. (Be sure to obtain a permit in areas where required.) If burning is not done, then mow and disk brush and level ridges in February and March. Avoid damage to spear buds by shallow disking.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3 .

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Seedbeds, Seeded Fields and Newly Planted Crowns

Preplant or Preemergence

Glyphosate--Apply Glyphomax Plus, Roundup Ultra Max 4SC, or Touchdown prior to crop emergence for control of emerged annual and perennial weeds. Do not apply within a week before the first spears emerge. Rate of application depends upon weed species; see label.

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone Inteon 2SC. Band or broadcast prior to, during, or after planting but before emergence of crop. Add wetting agent as directed on label. Do not apply paraquat within 6 days before harvest.

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 9 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 1 day.

Fluazifop--0.125-0.188 lb/A. Apply 0.5 to 0.75 pints per acre Fusilade DX 2E plus oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge, wild onion, or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 365 days and apply no more than 6 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application.

Linuron--0.5-1 lb/A. Apply 1 to 2 pounds per acre Lorox 50DF when ferns are more than 6 inches tall for residual and postemergence control of many annual broadleaf weeds. Spray emerged weeds when they are less than 4 inches tall. Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. A second application can be made 1 to 3 months after the initial application, but observe the following precautions: DO NOT exceed 4 pounds of product per acre per year. DO NOT add surfactants, tank-mix with other pesticides, and DO NOT use FLOWABLE (liquid) formulation, or crop injury may occur. LABELED FOR USE IN NEW JERSEY ONLY.

Sethoxydim--0.2-0.5 lb/A. Apply 1 to 2.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) to control certain annual or perennial grass weeds. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** Use the lower rate to control seedling annual grasses with less than four leaves and no tillers. Use the higher rate to control established annual grasses with tillers; grasses under stress from heat or drought; or to control perennial grasses including Bermuda grass, quackgrass, or johnsongrass. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with

or apply within 2 to 3 days of any other pesticide unless labeled, or weed control may be reduced. Observe a minimum preharvest interval of 1 day before harvest. Do not exceed 5 pints of Poast per acre in one year.

Cutting Bed

Use a combination of grass and broadleaf weed herbicides to obtain control of a wide spectrum of weeds. Identify the weeds in your field and choose herbicides that control those weeds. Split the herbicide application. Spray part of your grass herbicide before harvest and the remainder after harvest, or switch to another grass herbicide after harvest. Rotate the use of Lexone/Sencor with Karmex or Sinbar to avoid repeated use of chemically related products. Choose Lexone/Sencor or Sinbar when weeds have emerged, unless another effective postemergence herbicide is used.

Before Spear Emergence and/or after Harvest Season

Paraquat--0.6-1 lb/A. Apply 2.4 to 4.0 pints per acre Gramoxone Inteon 2SC prior to crop emergence or immediately after the last cutting to control emerged annual weeds. Add wetting agent as directed on the label. Emerged spears sprayed after the last harvest will be killed but new growth from the crown will not be affected. Tank-mix with residual herbicides for full season control. DO NOT apply within 6 days of harvest.

Diuron--0.75-2 lb/A. Apply 1 to 2.5 pounds per acre Karmex 80DF before spear emergence or after harvest when the soil is disked and free of weeds. Karmex primarily controls broadleaf weeds. Tank-mix with Devrinol to control annual grasses. Use Sinbar or Sencor/Lexone after harvest when Karmex is used in early spring before spear emergence.

Linuron--1-2 lb/A. Apply 2 to 4 pounds per acre Lorox 50DF prior to spear emergence or after harvest for residual and postemergence control of many annual broadleaf weeds. Spray emerged weeds when they are less than 4 inches tall. Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. Additional applications can be made immediately after cutting, or as a post-directed spray at the base of the fern, but observe the following precautions: DO NOT exceed 4 pounds of product per acre per year. DO NOT apply within 1 day of harvest. DO NOT add surfactants, tank-mix other pesticides, and DO NOT use FLOWABLE (liquid) formulation, or crop injury may occur. LABELED FOR USE IN NEW JERSEY ONLY.

S-metolachlor--1.26-1.9 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in asparagus in New Jersey. The use of this product is legal ONLY if a waiver of liability provided by the local growers association has been signed by the grower, all fees have been paid, and a label has been provided by the association.** Apply 1.33 to 2 pints per acre Dual Magnum 7.62E to control annual grasses, yellow nutsedge, galinsoga, and certain other broadleaf weeds. Use as a surface-applied spray prior to spear emergence. Make only one application during the growing season. DO NOT apply within 16 days of harvest. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for use in NJ ONLY!**

Terbacil--1.2 lb/A. Apply 1.5 pounds per acre Sinbar 80W prior to spear emergence or after harvest. Sinbar controls annual grasses and many broadleaf weeds but does not control pigweed sp. and certain other broadleaf weeds. Tank-mix with Karmex for broader spectrum of weed control. This is not recommended for use at time of planting. **Do not use on soils containing less than 1 percent organic matter.**

Metribuzin--1 lb/A. Apply 1.33 pounds per acre Sencor 75DF or Lexone 75DF (or OLF) before spear emergence or after harvest. Sencor/Lexone primarily controls broadleaf weeds. Tank-mix with Devrinol to control annual grasses. Use Sinbar or Karmex after harvest when Sencor/Lexone is used in early spring before spear emergence.

Napropamide--4 lb/A. Apply 8 pounds per acre Devrinol 50DF per year to established asparagus. Apply before weeds emerge immediately after ridging in the spring. Split the application if ridges are leveled after harvest. Make the second application immediately after leveling the ridge following the harvest season. Incorporation may improve weed control if rainfall does not occur within 24 hours of application. Devrinol controls primarily annual grasses. Combine with Sinbar, Lexone/Sencor, or Karmex at the lower labeled rates for better broadleaf weed control.

Norflurazon--2-4 lb/A. Apply 2.5 to 5 pounds per acre Solicam 80DF at the end of the cutting season. Spray immediately after the field is cultivated to level the ridges, or use postemergence herbicides to control emerged weeds. Primarily controls grasses and suppresses yellow nutsedge. Use in combination with Karmex or Lexone/Sencor to improve the spectrum of weeds controlled. Solicam is a long lasting herbicide in the soil. Do not plant sensitive crops (see label) for 2 years after application.

Sethoxydim--0.2-0.5 lb/A. (See the preceding "Sethoxydim" paragraph.)

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 1 day.

Fluazifop--0.125-0.188 lb/A. Apply 0.5 to 0.75 pints per acre Fusilade DX 2E plus oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge, wild onion, or any broadleaf weed. Do not

tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe the minimum preharvest interval and apply no more than 6 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application. Labeled in Maryland and New Jersey with a 1-day preharvest interval. Labeled in Delaware and Virginia with a 7-month preharvest interval and in Pennsylvania with a 12-month preharvest interval.

Dicamba--0.25-0.5 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Banvel in New Jersey.** Apply 0.5 to 1 pint per acre Banvel 4SC to control many annual broadleaf weeds and to suppress or control many perennial broadleaf weeds. Multiple applications can be made during the growing season, provided the total applied in 1 year does not exceed 1 pint per acre. Some crooking or twisting of emerging spears contacted by the spray may occur. Discard crooked or twisted spears. Observe a minimum preharvest interval of 1 day (24 hours).

Warning: Banvel spray or vapor drift may injure sensitive crops growing adjacent to treated fields. Do not apply to fields adjacent to sensitive horticultural, fruit, or vegetable crops. Do not apply on days when the temperature is expected to exceed 85 degrees Fahrenheit. Spray residue is difficult to completely remove from sprayers used to apply Banvel. Do not apply Banvel with sprayers which will be used to apply pesticides to sensitive crops.

Glyphosate--Apply Glyphomax Plus, Roundup products or Touchdown products, or OLF (Other Labeled Formulations) as a spot treatment using a directed spray or shielded equipment immediately after the last harvest of the season when all spears have been removed or after ferns have developed. Do **NOT** allow spray to contact emerged spears or ferns, or severe crop injury may result. Rates and optimum application period depend on weed species (see label).

Halosulfuron 0.024-0.047 lb/A.--Apply 0.5 to 1.0 dry ounces of Sandea 75 DF plus nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) postemergence during or after the cutting season to control yellow nutsedge and certain annual broadleaf weeds. Emerged common lambsquarter will not be controlled. Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. Observe a one (1) day preharvest interval (PHI) when applying Sandea during harvest. Application of Sandea to the fern after harvest may cause temporary yellowing. Use drop nozzles after harvest to direct the spray under the fern to avoid risk of crop injury and improve coverage of target weeds. Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.

Linuron--0.5-1 lb/A. Apply 1 to 2 pounds per acre Lorox 50DF for residual and postemergence control of many annual broadleaf weeds. Spray emerged weeds when they are less than 4 inches tall before the cutting season, immediately after cutting, or as a directed spray toward the base of the fern. Use

the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. Additional applications can be made prior to spear emergence or after harvest, but observe the following precautions: DO NOT exceed 4 pounds of product per acre per year. DO NOT apply within 1 day of harvest. DO NOT add surfactants, tank-mix with other pesticides, and DO NOT use the FLOWABLE (liquid) formulation, or crop injury may occur. Labeled for use in New Jersey only.

2,4-D--1-2 lb/A. Use 1 to 2 quarts per acre Formula 40. Apply after a close harvest of asparagus when weeds have considerable foliage. Use no more than two applications spaced 1 month apart. If used after harvest, avoid spraying brush. Use low pressure; spray on calm days to avoid drift damage to surrounding plants.

Insect Control

Cutworms

Lannate--1.5-3 pt LV/A or OLF, or permethrin--2-4 fl oz 3.2EC/A or OLF, or Sevin Bait--20-40 lb 5% bait/A. Broadcast bait on cutting fields as needed. Wait 3 days between applications.

Note. Early spears are the most heavily damaged because they are the first to appear and grow the slowest. Dig up to 1/2 inch deep around crowns and use bait if you find 1 cutworm larva or 1 severely damaged spear per 20 plants.

Asparagus Aphid

Watch for tiny (1/16 inch long), bluish green aphids building up on brush. Protection may be important in newly seeded plantings and young cutting beds.

Fulfill--2.75 oz 50WDG/A(ferns only) or, Lorsban--2 pt 4E/A or OLF (ferns only), or malathion--1 qt 57EC/A

Asparagus Beetles

Apply insecticide when needed during cutting season and late summer.

Entrust--1.25-2 oz 80WP, (postharvest only) or, Lannate--1.5-3 pt LV/A or OLF, or Lorsban--2 pt 4E/A or OLF (ferns only) malathion--1 qt 57EC/A, or permethrin--2-4 fl oz 3.2 EC/A or OLF, or Radiant--4-8 oz SC/A (post harvest only), or Sevin--1.25 lb 80S/A or OLF Wait 3 days between applications, or SpinTor--4-6 fl oz 2SC/A (postharvest only)

Prevent large numbers of beetles from overwintering and laying eggs on spears in spring by spraying brush in early fall. Daily harvest will minimize exposure to these pests and reduce damage.

Thrips

Lannate--1.5-3 pt LV/A or OLF, or malathion--1 qt 57EC/A

NOTE: Use of SpinTor or Entrust for asparagus beetles control will reduce thrips.

Asparagus Fern Caterpillar (Beet Armyworm)

Lannate--1.5-3 pt LV/A or OLF

Note: Use of Spintor 2SC or Entrust for Asparagus Beetle control will reduce Beet Armyworm population.

Japanese Beetles

Apply to foliage after the cutting season:

permethrin--4.0 fl oz 3.2EC/A or OLF

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
INSECTICIDE			
Entrust	G	12	60
Fulfill	G	12	170
Lannate	R	48	1
Lorsban 4E/(75WG)	R/(G)	24	1
malathion	G	12	1
permethrin	R	12	1
Radiant	G	4	60
Sevin/Sevin Bait	G	12	1
SpinTor	G	12	60
FUNGICIDE (FRAC code)			
chlorothalonil (Group M5)	G	12	0
mancozeb (Group M3)	G	24	120
Nova (Group 3)	G	24	180
Ridomil Gold (Group 4)	G	-	at planting
Quadris (Group 11)	G	4	100

See Table D-6.

¹G = general, R = restricted

Nematode Control

While nematodes are generally not a major problem on asparagus, the use of Nematicur increases the vigor of the planting which reduces the incidence of Fusarium root and crown rot. Apply the following for control.

Nematicur--5.33 pt 3SC/A. *Nursery:* apply to soil surface and incorporate prior to seeding; *New planted crowns:* apply into the bottom of furrow prior to planting crowns; *Postharvest:* apply to the soil surface after the last harvest and incorporate by reshaping the beds (not for use in VA).

Disease Control

Fusarium Root Rot

For crown production, use treated seed and select a site where asparagus has never been grown.

For production fields, use disease-free crowns, transplants, or seed. Select well-drained fields where asparagus has never been grown. If this is not possible, select fields that have not been in asparagus for at least 8 years.

Phytophthora Crown and Spear Rot

In fields with poor drainage or extensive low areas, use 1 pt/A Ridomil Gold 4EC over the bed as follows:

Cutting fields: Apply 30 to 60 days before the first harvest and make a second application just prior to first cutting.

New plantings: Apply after planting seedlings or after covering crowns. This treatment will **not** control Fusarium root and crown rot.

Purple Spot

Burn brush in winter to destroy overwintering sources of the fungus. Fungicide application is not practical during the production season, because new spears emerge daily.

Once fernstalks are full size, apply the following and repeat every 2 to 4 weeks until frost:

Quadris--6.2-15.4 oz 2.08F/A or chlorothalonil--2-4 pt 6F/A or OLF

Alternate between fungicides if more than 2 applications are needed.

Asparagus Rust

Control is necessary in 1- and 2-year beds, even with the use of resistant varieties. Traditionally sprays begin in mid-August. However, scout fields particularly noncutting beds, for disease beginning in late June. Alternate between the following:

chlorothalonil--2-4 pt 6F/A or OLF, or mancozeb--2 lb 75DF/A or OLF, or Nova--5 oz 40WP/A

Repeat 3 to 4 times at 7- to 10-day intervals.

BEANS: SNAP AND LIMA

Varieties					
Varieties ¹	DE	MD	NJ	PA	VA
Snap Beans: Market (Green)					
Ambra (trial)					V
Bronco			N	P	V
Caprice (trial)					V
Carlo					V
Charon (trial)		M	N	P	V
Dusky					V
Embassy (trial)					V
Greencrop (flat, flavorful)				P	
Hialeah		M	N	P	V
Nash (trial)					V
Provider (early)		M		P	
Roma II (Italian flat pod)	D	M	N	P	V
Secretariat					V
Shade					V
Valentino					V
Snap Beans: Market (Wax)					
Eureka	D	M	N	P	V
Golden Rod		M	N	P	
Goldrush	D	M	N	P	
Rocdor					V
Snap Beans: Processing (Green)					
Brio	D		N	P	
Dandy (small sieve, 3" pods)	D		N	P	
Hystyle	D		N	P	
Roma II	D	M	N	P	
Slenderette ²	D	M	N	P	
Snap Beans: Horticultural					
French Horticultural	D	M	N	P	V
Supremo					V
Volcano	D		N		
Half-Runner (trellised)					
Volunteer (RR)					V
Mountaineer					V
State White Half-Runner					V
Lima Beans, Fordhook Type					
Concentrated Fordhook	D				

(table continued on next page)

Varieties (continued)

Varieties ¹	DE	MD	NJ	PA	VA
Lima Bean, Baby Type					
Cypress (Race A,B,C,D,E,DMR)	D	M	N	P	V
184-85 (Race A,B,C,E,DMR)	D	M	N	P	
Jackson Wonder (no resistance, speckled)		D			V
C-elite Select (Race A,B,C,D,E,DMR)	D	M	N		

¹ Snap bean varieties listed alphabetically. Lima bean varieties listed by maturity, earliest first.

² Eagle and Slenderette varieties are more resistant to blossom drop at high temperatures than other varieties and are suggested for plantings that mature between July 10 and August 10.

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Crop	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds per Acre	Med P ₂ O ₅ per Acre	Opt. P ₂ O ₅ per Acre	Low Pounds K ₂ O per Acre	Med Pounds K ₂ O per Acre	Opt. Pounds K ₂ O per Acre
Lima bean	60-80 ¹	100 ¹	60 ¹	20 ¹	140 ¹	100 ¹	60 ¹
Single crop	30-40 ²	100 ²	60 ²	20 ²	140 ²	100 ²	60 ²
	30 ³	50 ³	30 ³	10 ³	30 ³	15 ³	0 ³
	30-40 ³	0	0	0	0	0	0
After peas	20 ⁴	0	0	0	0	0	0
Snap bean	40-80 ¹	80 ¹	60 ¹	40 ¹	80 ¹	60 ¹	40 ¹
	20-40 ⁵	40 ⁵	40 ⁵	0 ⁵	40 ⁵	40 ⁵	0 ⁵
	20-40 ⁴	40 ⁴	20 ⁴	40 ⁴	40 ⁴	20 ⁴	40 ⁴
After peas	0-20 ⁶	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in, (or) Band-place with planter

³ Band-place with planter floowed by a sidedress with 30-40 lbs of N 3-5 weeks after emergence

⁴ Band-place with planter

⁵ Broadcast and disk-in

⁶ Sidedress at prebloom stage

Apply 1-2 pounds of boron (B) per acre every 3 years on most soils. See Table B-10 for more specific boron recommendations.

Seed Treatment

Use seed treated with Apron XL LS (0.16-0.64 fl oz/100 lb seed) for Pythium control plus either Maxim 4FS (0.08-0.16 fl oz/100 lb seed) for Rhizoctonia and Fusarium control or Dynasty (azoxystrobin--0.15-0.76 fl oz/100 lb seed) for Rhizoctonia control.

Rough handling of seed greatly reduces germination.

IMPORTANT: Do not use treated seed for food or feed.

Planting Dates

<i>Planting</i>	<i>Harvest</i>
Market snap--Apr. 10-Aug. 10	June 20-Oct. 20
Processing snap--Apr. 20-Aug. 10	July 1-Oct. 20
Fordhook lima--May 15-July 10	Aug. 1-Oct. 20
Baby lima--May 15-July 20	Aug. 1-Oct. 30

In Pennsylvania and normally cooler areas, delay start of planting by 10 days and stop planting 14 days sooner than indicated in the above table.

Spacing

Snap Beans. Rows 30 to 36 inches apart, 6 to 10 plants per foot. Plant 50 to 75 pounds seed per acre depending on seed size. Narrow rows increase yields but render late-season tillage difficult. Plant in rows 18 to 24 inches apart with 5 to 7 plants per foot. Plant 75 to 120 pounds of seed per acre, depending on seed size (smaller = lower rate). Calibrate planter according to seed size. Sow 1 to 1½ inches deep in light sandy soil; shallower in heavier soil.

Lima Beans, Fordhook Type. Rows 30 to 36 inches apart, 2 plants per foot. Plant 85 pounds per acre, 1½ inches deep.

Lima Beans, Baby Types. Rows 30 to 36 inches apart, 3 to 4 plants per foot. Plant 50 pounds per acre, 1½ inches deep (deeper if soil is dry). For mechanically harvested irrigated fields: Rows 18 to 30 inches apart, 4 to 5 inches between plants; plant 96 pounds per acre at close spacing and 78 pounds per acre at wider spacing.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in snap beans and lima beans.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

No-Till

Give consideration to bean variety, date of planting, soil fertility practices, insect control, planting equipment, mulch, and weed species in the field.

Preemergence

S-metolachlor--0.63-1.91 lb/A. Apply 0.66 to 2 pints per acre Dual Magnum 7.62E after seeding and before emergence. Tank-mix with Glyphomax Plus, Roundup Ultra Max 4SC, Touchdown, Gramoxone Max 3SC or Gramoxone Inteon 2SC to control emerged weeds. Bentazon, postemergence, may be required for adequate broadleaf weed control. A modified fertility program may be necessary, especially for nitrogen (such as early sidedressing). Do not use on black turtle soup beans. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Clomazone (snap beans only)--0.094-0.188 lb/A. (See the following "clomazone" paragraph in conventional tillage).

Glyphosate--0.75-1.1 lb acid equivalent/A. Apply 1.6 to 2.4 pints per acre Roundup Ultra Max, 2 to 3 pints per acre Touchdown, or 2 to 3 pints per acre Glyphomax Plus after seeding and before emergence. Tank-mix with

Dual Magnum 7.62E for residual weed control. Roundup Ultra Max 4SC controls many perennial weeds as well as annuals if applied when the weed is actively growing and has reached the stage of growth listed on the label.

Paraquat--0.6-1 lb/A. Apply 2.4 to 4.0 pints per acre Gramoxone Inteon 2SC after seeding but before emergence, or as a split application before and after seeding to control emerged annual weeds. Do not exceed the maximum total labeled rate when using the split application. Tank-mix with Dual Magnum 7.62E for residual weed control.

Conventional Tillage

Preplant Incorporated

EPTC (snap beans only)--2.5-3 lb/A. Apply 3 to 3.5 pints Eptam 7E or 15 pounds of Eptam 20G. Useful for nutsedge control, annual grasses, and some broadleaf weeds. Incorporate by disking twice into 3 to 4 inches of soil immediately after application. Tank-mix with Treflan to improve control of common lambsquarters. Combining Eptam with Dual Magnum may improve weed control but may increase the risk of crop injury when weather conditions are adverse.

Imazethapyr (lima beans)--0.024-0.047 lb/A. Apply 1.5 to 3 fluid ounces per acre Pursuit 2SC. Shallow, thorough incorporation improves consistency of performance when dry weather follows application. Primarily controls broadleaf weeds. Combine with another herbicide to control annual grasses. Pursuit residues persist in the soil after harvest and may affect following crops. DO NOT exceed 3 fluid ounces per acre of Pursuit 2SC at planting or make more than one application per acre per year. Follow label instructions pertaining to following crops.

S-metolachlor--0.63-1.91 lb/A. Apply 0.66 to 2 pints per acre Dual Magnum 7.62E. Incorporate 2 to 3 inches deep by disking twice with blades set 4 to 6 inches deep. Primarily controls annual grasses and nutsedge. Do NOT use on black turtle soup beans. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Pendimethalin (lima beans)--0.48 lb/A. Apply 1 pint of Prowl H₂O or OLF per acre and incorporate to mix thoroughly with the top 2 to 3 inches of soil. Primarily controls annual grasses and certain broadleaf weeds. Do not use when soils are cold and/or wet soil conditions are anticipated during emergence, or crop injury may result. **Not recommended in New Jersey.**

Trifluralin--0.5-0.75 lb/A. Apply 1 to 1.5 pints per acre of Treflan 4E or 10 to 15 pounds per acre of Treflan 5G. Incorporate it into 2 to 3 inches of soil within 8 hours after application. Primarily controls annual grasses and a few broadleaf weeds. Treflan may be applied up to 4 weeks prior to planting. Do not use or reduce the rate used when cold, wet soil conditions are expected, or crop injury may result.

Preemergence

Clomazone (snap beans only)--0.094-0.188 lb/A. Apply 4 to 8 fluid ounces per acre Command 3ME to control annual grasses and many broadleaf weeds including common lambsquarter, velvetleaf, spurred anoda, and jimsonweed.

Mustards, morningglory species, and pigweed species will not be controlled. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Combine with Dual Magnum 7.62E to control yellow nutsedge and pigweed. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in snap beans. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

DCPA (snap bean only)--6-10.5 lb/A. Apply 8 to 14 pints per acre Dacthal 6F. Primarily controls annual grasses and a few broadleaf weeds, including common purslane. Results have been most consistent when used in fields with coarse-textured soils low in organic matter and when the application was followed by rainfall or irrigation.

Halosulfuron 0.024-0.047 lb/A--Apply 0.5 to 1.0 dry ounces of Sandea 75 DF preemergence to control or suppress yellow nutsedge and many annual broadleaf weeds. Results have been most consistent when the application was followed by rainfall or irrigation. Use the lower rate on coarse-textured (sandy) soils low in organic matter, and the higher rate on fine-textured (silt and clay) soils. Observe a thirty (30) day preharvest interval (PHI). Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.

Imazethapyr (lima beans)--0.024-0.047 lb/A. Apply 1.5 to 3 fluid ounces per acre Pursuit 2SC. Weed control may be inconsistent when dry weather follows application. Primarily controls broadleaf weeds. Combine with another herbicide to control annual grasses. Pursuit residues persist in the soil after harvest and may affect following crops. DO NOT apply more than 3 fluid ounces of Pursuit 2SC per acre per year. Follow label instructions pertaining to following crops.

S-metolachlor--0.63-1.91 lb/A. Apply 0.66 to 2 pints per acre Dual Magnum 7.62E. Primarily controls annual grasses and a few broadleaf weeds. Do NOT use on black turtle soup beans. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Postemergence

Bentazon--0.5-1 lb/A. Apply 1 to 2 pints per acre Basagran 4SC when beans have fully expanded first trifoliolate leaves. Use lower rate to control common cocklebur, mustards, and jimsonweed and the higher rate to control

yellow nutsedge, common lambsquarter, common ragweed, and Canada thistle. Temporary, pronounced crop injury may be observed that can result in delayed maturity. The use of oil concentrate may increase the risk and severity of crop injury. To reduce the risk of crop injury, omit additives or switch to a nonionic surfactant when weeds are small and soil moisture is adequate. Do not spray when temperatures are over 90°F (32.2°C).

Clethodim--0.094-0.125 lb/A. Apply 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 21 days.

Fomesafen (snap beans only)--0.125-0.188 lb/A. Apply 0.5 to 0.75 pints per acre of Reflex 2SC when snap beans have one to two fully expanded trifoliolate leaves. The recommended rate is lower than the labeled rate to reduce the risk of crop injury. Use the lower recommended rate when weeds are small or when plentiful soil moisture, high humidity, and warm cloudy weather cause "soft" growing conditions. Add nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray). Tank-mix with bentazon (Basagran) to improve the control of common lambsquarter. Observe labeled plantback restrictions. Do NOT apply to any field more than once every two years.

Halosulfuron--0.024-0.031 lb/A. Apply 0.5 to 0.66 dry ounces of Sandea 75 DF plus nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control yellow nutsedge and certain annual broadleaf weeds. Use only the lower rate when treating snap beans. Applications should be sprayed when the crop has 2 to 3 trifoliolate leaves and annual weeds are less than 2 inches tall. Treatments applied when beans are younger increases the risk of temporary stunting, and applications after the 3 trifoliolate leaf stage increases the risk of a split set. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control

the target broadleaf weeds when growing other crops in the rotation. Observe a thirty (30) day preharvest interval (PHI). Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.

Imazamox (lima bean only) --0.031 lb/A. labeled and recommended for use in DE, MD, and VA only. Apply 4 fluid ounces of Raptor 1SC per acre to control annual broadleaf weeds when the crop has one to two fully expanded trifoliate leaves. Add nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray). Add one half to 1 pint of bentazon (Basagran) to reduce the expression of injury symptoms. Strictly observe all plantback restrictions. Raptor is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. ALS resistant weeds are present in the mid-Atlantic region and will not be controlled.

Quizalofop-P-ethyl (snap beans only)--0.04-0.08 lb/A. Apply 6 to 12 fluid ounces per acre Assure II/Targa 0.88EC postemergence to control most annual and perennial grasses. Add with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with other pesticides unless labeled, as the risk of crop injury may be increased or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 14 fluid ounces per acre in one season.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within one week before or after Basagran or any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 4 pints per acre in one season

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label**

has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia. Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Seed Maggot

Cruiser--1.28 oz 5FS/100 lbs of seed – Commercially applied seed treatment
Lorsban--2 oz 50W/100 lb seed. Available only as a commercially-applied seed treatment. Restrictions--do not use treated seed for food, feed or oil purposes. Do not let livestock graze or feed bean hay or pea hay grown from treated seed.

Cutworms (See Table E-6. Also, see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Asana XL (Snap beans only)--5.8-9.6 fl oz 0.66EC/A, or bifenthrin--2.1-6.4 oz 2EC/A or OLF, or lambda-cyhalothrin--1.92-3.20 fl oz/A or OLF, or Lannate--1.5 pt LV/A or OLF, or Mustang MAX--1.28-4 oz /A, or Proaxis--1.92-3.20 fl oz/A

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.

bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or Cruiser--1.28 oz 5FS/100 lbs of seed – Commercially applied seed treatment
Entrust--1.5-2 oz 80W, or imidacloprid (soil, foliar)--see label for rates and application methods, or lambda-cyhalothrin--2.56-3.84 fl oz /A or OLF, or Lannate--1.5-3 pt LV/A or OLF, or Orthene--0.5-1.0 lb 97S/A or OLF, or Proaxis--2.56-3.84 fl oz /A, or Radiant--5-8 fl oz SC/A, or Sevin--1.25 lb 80S/A or OLF, or Spintor – 4.5-6 fl oz 2SC/A, or Thimet--4.5-7.0 oz 20G/1000 ft of row (any row spacing – 30 inch minimum)

Note. Use of Sevin may result in mite population out-break. Do not use Sevin if mites are present

Mites

Spot-treat areas along edges of fields when white stippling along veins on underside of leaves is first noticed and 20 mites per leaflet are present.

bifenthrin--5.12-6.4 fl oz 2EC/A or OLF, or dimethoate--0.5-1 pt 4EC/A or OLF

Aphids

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

acephate (Orthene; generics available)--0.5-1.0 97S/A or OLF, or

dimethoate--0.5-1 pt 4EC/A or OLF, or
 imidacloprid (soil, foliar)--see label for rates and application
 methods, or
 Lannate--1.5-3 pt LV/A or OLF, or
 Provado (generics available)--3.5 fl oz 1.6F/A, or
 Thimet--4.5-7.0 oz 20G/1000 ft of row (any row spacing-30
 inch minimum)

Leafminers-Snap Beans Only

dimethoate--0.5-1 pt 4EC/A or OLF

Leafhoppers

Treat only if the number of adults plus nymphs exceeds
 100 per 20 sweeps during prebloom, 250 per 20 sweeps
 during bloom, or 500 per 20 sweeps during pod develop-
 ment. Orthene treatments timed for European corn borer
 control will reduce leafhopper populations.

Asana XL (Snap beans only)--5.8-9.6 fl oz 0.66EC/A, or
 bifenthrin--1.6-6.4 fl oz 2EC/A or OLF, or
 Cruiser--1.28 oz 5FS/100 lbs of seed – Commercially applied
 seed treatment
 dimethoate--0.5-1 pt 4EC/A or OLF, or
 imidacloprid (soil, foliar)--see label for rates and application
 methods, or
 lambda-cyhalothrin--2.56-3.84 fl oz /A or OLF, or
 Lannate--0.75-3 pt LV/A or OLF, or
 Mustang MAX--2.72-4 oz/A, or
 Orthene--0.5-1.0 lb 97S/A or OLF. Lima beans harvested in
 succulent form may be treated up to day of harvest, or
 Proaxis--2.56-3.84 fl oz /A, or
 Provado (generics available)--3.5 fl oz 1.6F/A, or
 Sevin--1.25 lb 80S/A or OLF, or
 Thimet--4.5-7.0 oz 20G/1000 ft of row (any row spacing-30
 inch minimum)

Stink bugs, Tarnished Plant Bug (TPB)

Treat only if the number of adults and/or nymphs exceeds
 15 per 50 sweeps from the pin pod stage until harvest.

bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
 dimethoate--0.5-1 pt 4EC/A (TPB only) or OLF, or
 lambda-cyhalothrin--2.56-3.84 fl oz /A or OLF, or
 Lannate--1.5-3 pt LV/A (Plant bug only) or OLF, or
 Mustang MAX--3.2-4 oz/A (Stink bug) or 2.72-4 oz/A (TPB
 only), or
 Proaxis--2.56-3.84 fl oz /A, or
 Thimet--4.5-7.0 oz 20G/1000 ft of row (any row spacing-30
 inch minimum)

Mexican Bean Beetle

Treat if defoliation exceeds 20 percent during prebloom or
 10 percent during podding and there is a population potential
 for further defoliation. These levels of defoliation may result
 in earlier maturity of the crop. Wait until hatch or adult
 emergence when eggs and pupae are present. On farms with
 a succession of bean plantings, the release of the larval
 parasitoid, *Pediobius foveolatus*, may provide effective
 biological control.

Asana XL (Snap beans only)--2.9-5.8 fl oz 0.66EC/A, or
 azadirachtin (Azatin, Ecozin, Neemix) – (larvae only) Note:
 activity is enhanced when a pyrethrin is added.
 See labeled rate, or
 dimethoate--0.5-1 pt 4EC/A or OLF, or
 lambda-cyhalothrin--1.92-3.20 fl oz/A or OLF, or
 Lannate--0.75-3 pt LV/A or OLF, or

Mustang MAX--2.72 oz/A, or
 Orthene--0.5-1.0 lb 97S/A or OLF. Lima beans harvested
 in succulent form may be treated up to day of harvest, or
 Sevin--0.625-1.25 lb 80S/A or OLF, or
 Thimet--4.9-9.4 oz 20G/1000 ft of row (any row spacing-30
 inch minimum)

Bean Leaf Beetle

(Use the same treatment guidelines as for Mexican bean
 beetle.)

bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
 Cruiser--1.28 oz 5FS/100 lbs of seed – Commercially applied
 seed treatment
 dimethoate--0.5-1 pt 4EC/A or OLF, or
 lambda-cyhalothrin--2.56-3.84 fl oz /A or OLF, or
 Mustang MAX--2.72-4.0 fl oz/A, or
 Proaxis--2.56-3.84 fl oz /A, or
 Sevin--0.625-1.25 lb 80S/A or OLF

Beet Armyworm

Bacillus thuringiensis--consult labels for rates and
 restrictions, or
 Entrust--1.25-2.0 oz 80W/A, or
 Intrepid--4-8 fl oz 2F/A (early season), 8-16 fl oz 2F/A(late
 season), or
 Radiant--4-8 fl oz SC/A, or
 SpinTor--4-6 fl oz 2SC/A

Cabbage Looper

Treat if the total number of any worm pests averages 30
 per 3 feet of row.

Asana XL (Snap beans only)--5.8-9.6 fl oz 0.66EC/A, or
Bacillus thuringiensis--consult label for rates and restrictions,
 or
 bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
 Entrust--1.25-2.0 oz 80W/A, or
 Intrepid – 4-8 fl oz 2F/A (early season), 8-16 fl oz 2F/A(late
 season), or
 lambda-cyhalothrin--2.56-3.84 fl oz /A or OLF, or
 Lannate--1.5-3 pt LV/A or OLF, or
 Mustang MAX--3.2-4.0 fl oz/A, or
 Orthene--0.5-1.0 lb 97S/A or OLF, or
 Proaxis--2.56-3.84 fl oz /A, or
 Radiant--4-8 fl oz SC/A, or
 SpinTor--4-6 fl oz 2SC/A

European Corn Borer (ECB)--Processing Snap Beans

The most critical times for corn borer treatment are at the
 bloom and pin stages. Begin treatment when moths are first
 detected in local blacklight traps. The first application should
 be applied during the bud-early bloom stage and the second
 application during the late bloom-early pin stage. After the
 pin spray, the following thresholds and spray intervals should
 be used:

Number ECB Moths(BLT)/5 Days Spray Interval (Days)	
Less than 10	No spray
11-25	7
26-50	6
51-75	5
76-250	4
250+	3

European Corn Borer (ECB)--Fresh Market Snap Beans

As a general guideline, treatment should begin when blacklight trap catches average five or more per night. Treatments should be applied on a 7-day schedule from the pin stage until harvest. In general, one to three applications will be needed.

Asana XL (Snap beans only)--5.8-9.6 fl oz 0.66EC/A, or bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or Entrust--1.0-2.0 oz 80W/A, or lambda-cyhalothrin--2.56-3.84 fl oz /A or OLF, or Lannate--1.5-3 pt LV/A, or Mustang MAX--2.72-4 oz/A or Orthene--0.75-1.0 lb 97S/A, or OLF, or Proaxis--2.56-3.84 fl oz /A, or Radiant--3-8 fl oz SC/A, or SpinTor--3-6 fl oz 2SC/A

Whiteflies

Admire Pro--7.0-10.5 fl oz 4.6F/A or Admire (generics available)--16-24 fl oz 2F/A, or bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or imidacloprid (soil, foliar)--see label for rates and application methods, or M-Pede--See label for use directions, or Orthene--0.5-1.0 lb 97S/A, or OLF, or Provado (generics available)--3.5 fl oz 1.6 F/A

Corn Earworm (CEW)

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.

For Fordhook lima beans, treat when CEW populations exceed two per 6 feet of row up to 4 weeks from harvest or three per 6 feet of row thereafter.

For baby 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 percent or more of the CEW populations reaches a length of 1/2 inch or longer. Treating too early for young CEW populations will eliminate natural control and may result in additional sprays for reinfestations. See "How to Improve Pest Control" for insect sampling techniques. Consult your pest management specialist for more refined decision-making.

Asana XL (Snap beans only)--5.8-9.6 fl oz 0.66EC/A, or bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or lambda-cyhalothrin--2.56-3.84 fl oz /A or OLF, or Lannate--1.5-3 pt LV/A, or Mustang MAX--2.72-4 fl oz/A, or Proaxis--2.56-3.84 fl oz /A, or Radiant--4-8 fl oz SC/A

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Asana XL	R	12	3
azadirachtin	G	4	0
<i>Bacillus thuringiensis</i>	G	4	0
bifenthrin	R	12	3
dimethoate	R	48	0
Entrust	G	4	3
imidacloprid(soil/foliar)	G	12	21/7

(table continued)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE (continued)			
Intrepid	G	4	7
Lannate	R	48	3
lambda-cyhalothrin	R	24	7
M-Pede	G	12	0
Mustang MAX	R	12	1
Orthene	G	24	Lima: 0 Snap: 14
Proaxis	R	24	7
Radiant	G	4	3
Sevin	G	12	3
SpinTor	G	4	3
Thimet	R	48	60
FUNGICIDE (FRAC code)			
chlorothalonil (snap bean only) (Group M5)	G	12	7
Contans WG (biological)	G	4	0
copper, fixed (Group M1)	G	24	0
Endura (Group 7)	G	12	7
Headline (Group 11)	G	12	7
iprodione (Group 2)	G	12	0
Nova (Group 3) (snap bean)	G	24	0
Phostrol (Group 33)	G	4	3
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	48	0
Ridomil Gold Copper (4 + M1)	G	48	5
Rovral (Group 2)	G	12	0
thiophanate-methyl (Group 1)	G	12	14
Switch (Groups 9 + 12)	G	12	7

See Table D-6.

¹ G = general, R restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL. For bifenthrin: 9 days = fresh, 24 hrs = processing.

³ 14 = snap beans, 28 = lima beans

Nematode Control

See "Nematodes" section of Soil Pests-Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or Mocap 15G at 13-20 lb/A (0.9 to 1.4 pound per 1000 linear feet of row) or Mocap 6EC at 1.33 to 2 quarts per acre. Apply in a 12-inch band on the row. Do not use as an in-furrow treatment.

Races 1,3,5 and 9 of the soybean cyst nematode are present in soybeans in Delaware, Maryland, Virginia, and New Jersey. Snap beans are susceptible, but baby 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. Soil sampling for SCN and root knot nematode is highly recommended

Disease Control

Anthracnose and Web Blight (*Rhizoctonia*)

Use western-grown seed and rotate to allow 2 years between bean plantings. When disease appears and/or environment conditions favors disease development, use the following:

azoxystrobin (Quadris--6.2-15.4 oz 2.08F/A) (*Rhizoctonia* only), or Headline--6-9 fl oz 2.1EC/A (snap beans only)

Pythium blight (Cottony leak)

Select varieties with good plant architecture that keep the pods off the soil. Narrow row spacing may help keep plants erect and pods from touching the soil. Select fields with good drainage and do not overwater.

Bacterial Blight

Use western-grown seed. Fixed copper (1 lb ai/A) is of some value in reducing spread where incidence is low. See label for rates.

Bacterial Brown Spot

This seed-borne disease occurs primarily on lima beans and is more troublesome in irrigated fields. Fixed copper (1 lb ai/A) is of some value in reducing spread where incidence is low. See label for rates.

Common Bean Rust (*Uromyces appendiculatus*) of Snap Bean

Rust is a problem only in late summer. Plant resistant varieties whenever possible. For susceptible varieties, spray when the disease first appears, and repeat every 7 days.

Quadris--6.2-15.4oz 2.08F/A, or
Nova--4-5 oz 40W/A, or
Headline--6-9 fl oz 2.1EC/A, or
chlorothalonil--2-4 pt 6F/A or OLF

Materials with different modes of action (FRAC code) should be alternated

Soybean Rust (*Phakopsora pachyrhizi*)

It has not been determined yet if soybean rust is going to be a production problem in the Mid-Atlantic area on snap bean and lima bean. If soybean rust should threaten these crops, experience on soybean indicates that preventative applications are best.

azoxystrobin (Quadris--6.2 fl oz 2.08F/A), or
Headline--6-9 fl oz 2.1EC/A, or
Nova--4-5 oz 40W/A (Section 18 for DE only)

Section 18 registrations may be available for other fungicides for soybean rust on legumes other than soybean. Check with Extension or your pesticide dealer for updates.

Root Rots

Rotate beans with non-legume crops. Avoid poorly drained soils. Plow under previous crop residue rather than discing. Root rot is caused by a complex of soilborne fungi including *Rhizoctonia*, *Pythium* and *Fusarium*. The primary cause of root rot in the mid-Atlantic region is *Pythium*. *Pythium* causes extensive damage in July and August during periods of warm, humid weather. *Pythium* can also cause extensive pod rot on snap beans. Select varieties that set high in the plant and use a close row spacing to avoid pod contact with the soil to reduce disease incidence. Apply one of the following at planting:

Ridomil Gold--0.5-1 pt 4E/A. Apply in a 7-inch band over the row at seeding. (for *Pythium* only)

To provide control of root rot caused by *Pythium* and *Rhizoctonia*, apply the following:

Ridomil Gold PC--12 oz 11G/1,000 foot of row. Adjust application equipment so that granules are uniformly applied in the furrow at planting.

To provide control of root rot caused by *Rhizoctonia*, apply the following in a band up to 7 inches wide:

Quadris--0.4-0.8 fl oz 2.08F/1000 ft of row.

Lima Bean Downy Mildew

Races B, D, E, and F have been found in the mid-Atlantic

area during the past 10 years. **Race F was the predominant race detected on susceptible varieties in 2003 and 2004 and the only race detected in 2006.** Use resistant varieties where possible. Conditions for disease are favorable when fields receive 1.2 inches or more of rain within 7 days and when the average daily temperature during this period is 78°F (25.6°C) or less. If a period of 90°F (32.2°C) occurs during this period, the cycle is broken, and an additional 7-day period with the above weather conditions is necessary to start infection. Periods of fog or heavy dew can lower the amount of rain necessary for infection to occur. Since environmental conditions vary from field to field and in different locations within a field, use the above information as a guideline. Fields that are not rotated and planted to susceptible varieties should be scouted regularly for disease occurrence. When weather conditions are favorable for disease or when disease is observed in the field, use the following:

copper, fixed (Champ DP, KocideDF)--2 lb 58DF/A or OLF,
or
Ridomil Gold Copper--2 lb 65WP/A, or
Phostrol--2-4 pts 6.69L/A

If lima bean downy mildew is observed in the field apply either Ridomil Gold Copper or Phostrol.

Section 24 (c) registrations in DE and MD are in effect for the use of Ridomil Gold Copper (2lb/A). Phostrol also has a 24 (c) registration in DE. Other states should check with Extension or their chemical supplier for updates.

Lima Bean Pod Blight (*Phytophthora capsici*)

Rotate away from other susceptible crops such as peppers, cucurbits or tomatoes. Avoid heavy irrigations and irrigating at night. In fields with a history of *Phytophthora* blight on peppers and cucurbits, applications of a fixed copper fungicide every 7-10 days may be beneficial for control.

copper, fixed--(Champ DP, Kocide DF)--2 lb 58DF/A or OLF

White Mold (*Sclerotinia*) and Gray Mold (*Botrytis*)

Preplant: For white mold only, the following biological fungicide has been tested in some states; however, limited information is available on effectiveness in the Mid-Atlantic region. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce levels of sclerotia inoculum in the soil. Following application, incorporate to a depth of 1 to 2 inches but **do not plow** before seeding beans to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.

Contans--2-4 lb 5.3WG/A

Post seeding: Close spacing of snap beans may increase the potential for white mold in Pennsylvania. Fungicide sprays are needed *only* when the soil has been wet for 6 to 10 days before bloom. For snap beans, a fungicide should be applied at 10-20% bloom. A second spray should be made 7-10 days after the first spray, if the soil remains wet and blossoms are still present. Check labels for details on fungicide timing. For lima beans, later fungicide applications have been beneficial if favorable environmental conditions persist. Use one of the following:

Endura--8-11 oz 70W/A, or
Endura--5 oz/A plus thiophanate-methyl (0.7-1.05 lb/A active ingredient) (snap beans only), or

iprodione (Rovral--1.5-2 pts 4F/A or OLF), or thiophanate-methyl (Topsin M--1.5-2 lb 70WP/A) or OLF, or thiophanate-methyl (Topsin M 11.2 oz 70WP) or OLF plus chlorothalonil--1.5 pts 6F/A (snap bean only), or Switch--11-14 oz/A 62.5WG, or Switch--6-11 oz/A 62.5WG plus thiophanate-methyl (0.7-1.05 lb/A active ingredient) (snap beans only)

BEETS

Beets are frost tolerant and produce the best commercial quality when grown during cool temperatures (50° to 65°F [10° to 18.3°C]). Lighter color and wider zoning occur during rapid growth in warm temperatures. Beets will form seedstalks if exposed to 2 or 3 weeks of temperatures below 50°F (10°C) after several true leaves have formed. Beets have a high boron requirement. See Plant Nutrient Recommendations below and Table B-10.

Varieties

Varieties¹

Market

Crosby (greens and roots)
 Early Wonder*
 Scarlet Supreme*
 Red Cloud*
 Chariot*
 Red Ace*
 Excalibur*
 Ruby Queen
 Rosett*
 Centurion*

These varieties are recommended for DE, MD, NJ, PA, VA, WV

¹ Varieties listed by maturity, earliest first.

* Indicates hybrid variety

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Beets	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
	75-100 ¹	150 ¹	100 ¹	50 ¹	150 ¹	100 ¹	50 ¹
	50 ²	150 ²	100 ²	50 ²	150 ²	100 ²	50 ²
	25-50 ³	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress 4-6 weeks after planting

Apply 1 ½-3 pounds of boron (B) per acre in mixed fertilizer. See Table B-10 for more specific boron recommendations.

Seed Treatment

Use seed treated with thiram 75WP (3 oz/100 pounds; 1 level teaspoon/lb) or Apron XL LS (0.32 to 0.64 fl.oz/100 pounds) plus Maxim 4FS (0.08-0.16 fl oz/100 pounds).

Seeding and Spacing

The crop is seeded from early April to late July. Optimum germination temperatures range between 50° to 85°F (10° to 29.4°C). Sow seed 1/2 inch 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.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Preplant Incorporated

Cycloate--2.5-3 lb/A. Apply 1.67 to 2 quarts Ro-Neet 6E. Incorporate into 3 to 4 inches of soil immediately after application. Plant anytime after treatment.

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Clopyralid--0.047-0.188 lb/A. Apply 2 to 8 fluid ounces of Stinger 3A per acre in a single application to control certain annual and perennial broadleaf weeds. Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 8 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days. Stinger is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover.

Phenmedipham--0.5-0.67 lb/A. Apply 3 to 4 pints per acre

Spin-Aid--1.3EC. For use in Maryland only. See label for application restrictions, mixing instructions, and weather restriction to prevent crop injury or herbicide failure.

Sethoxydim--0.2-0.5 lb/A. Apply 1 to 2.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 60 days and apply no more than 5 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Flea Beetles

Baythroid XL--1.6-2.8 fl oz/A, or imidacloprid (soil, foliar)--see label for rates and application methods, or Sevin--0.67-1.25 lb 80S/A or OLF

Aphids, Leafminers (LM)

Diazinon--0.5 pt 4EC/A, or OLF, or Entrust--2-3 oz 80W/A, (LM only), or imidacloprid (soil, foliar)--see label for rates and application methods (aphids only), or Lannate--1.5-3 pt LV/A or OLF, or Radiant--6-10 fl oz SC/A (LM only), or SpinTor--6-10 fl oz 2SC/A (LM only)

Beet Armyworm

Entrust--1.25-2.5 oz 80W/A, or Intrepid--6-16 fl oz 2F/A, or Radiant--5-10 fl oz SC/A, or SpinTor--4-8 fl oz 2SC/A

Garden Webworms

Bacillus thuringiensis--consult label for rates and restrictions.

Disease Control

Damping-Off (caused by *Pythium* or *Phytophthora*).

Apply the following preplant incorporated or as a soil-surface spray after planting

mefenoxam--1-2 pt Ridomil Gold 4EC/A or 2-4 pt Ultra Flourish 2E/A

Leaf Spot

Rotate to allow 2 or 3 years between beet plantings. Plow under beet refuse at end of season. Apply one of

the following when disease threatens and repeat every 7 to 10 days. Do not make more than two sequential applications of Cabrio or Quadris before alternating with a copper fungicide.

Quadris--6.2--15.4 fl oz 2.08F/A, or copper, fixed (Champ DP, Kocide 2000)--1.33-2.66 lb 58DP/A or OLF, or Cabrio--8-12 oz 20EG/A

Pocket Rot (*Rhizoctonia*)

Quadris--0.40--0.80 fl oz 2.08F/1000 row ft

Black Spot

Can be caused by boron deficiency. Use boron at planting according to soil test results.

Harvesting

Market beets are hand-harvested when 1-3/4 to 2 inches in diameter

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
<i>Bacillus thuringiensis</i>	G	4	0
Baythroid XL	R	12	0
Entrust	G	4	3
imidacloprid(soil/foliar)	G	12	21/7
Intrepid	G	4	14
Lannate (roots)	R	48	0
Lannate (tops)	R	48	10
Radiant	G	4	3
Sevin	G	12	7
Spintor	G	4	3
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
copper, fixed (Group M1)	G	12,24,48	0
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	48	0
Ultra Flourish (Group 4)	G	48	0

See Table 3.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

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

Varieties ¹	Varieties				
	DE	MD	NJ	PA	VA
Broccoli					
Captain*	D		N		V
Major*	D		N		V
Everest*			N	P	V
Barbados*			N	P	
Durango*	D		N		
Belstar*			N		V
Arcadia*			N	P	V
Lucky*	D		N		V
Laguna*			M	N	P
Gypsy*			N		V

(table continued on next page)

Varieties (continued)

Varieties ¹	DE	MD	NJ	PA	VA
Broccoli (continued)					
Fiesta*			N		
Pinnacle*			N	P	
Eureka* (fall production)			N	P	
Pacman				P	
Liberty*	D		N	P	V
CMS Liberty (trial)					V
Sultan*			N	P	
Diplomat*			N	P	
Windsor*			N	P	
Brussels Sprouts					
Oliver*			N	P	
Jade Cross E*	D	M	N	P	V
Prince Marvel*	D	M	N	P	V
Franklin			N	P	
Vancouver			N	P	
Cabbage: Early-Midseason					
Early Thunder					V
Charmant* (YR)		M	N		V
Morris* (YR)			N	P	
Blue Gem* (YR,BRT)			N	P	
Dynamo* (small head) (SpR)			N		V
Blue Vantage* (YR)			N	P	
Green Cup* (YR)	D		N	P	
Quisto*			N		
Emblem* (SpR)			N		
Platinum Dynasty* (SpR)					V
Charm Dynasty*					V
Bronco*			N	P	V
Thunderhead					V
Bravo* (YR, BRR)	D		N	P	V
Blue Thunder* (SpR)	D		N	P	V
Constana*			N		V
Platinum Dynasty*			N	P	
Blue Dynasty (SpR)*			N	P	
Green Laker (SpR)*				P	
Cheers (SpR)*				P	
Blue Thunder (SpR)*			N	P	
Superstar (SpR)*			N	P	
Bobcat (SpR)*			N	P	
Cabbage: Red					
Ruby Ball*		M		P	V
Red Head*	D	M	N	P	V
Red Dynasty (SpR)*			N	P	V
Super Red 80 (SpR)*			N	P	V
Super Red 90 (SpR)*			N		
Cario (SpR)*			N	P	
Cabbage: Savoy					
Savoy Express (early trial)				P	V
Savoy Ace*			N	P	V
Chieftain	D		N		V
Cabbage: Chinese					
Blues* (Napa type)	D		N	P	
Jade Pagoda*	D	M	N	P	V
Michihli	D	M	N		V
Mount (SpR)			N	P	
Pak Choi					
Joi Choi* (white, flat petiole)	D	M		P	
Mei Quing Choi* (green, flat petiole)	D	M		P	
Prize Choi* (white, round petiole)	D			P	
Cauliflower					
Snow Crown* (spring or fall)	D	M	N	P	V
Icon*			N		
Cheddar* (bright orange)			N	P	V
Amazing*			N	P	V
Majestic*			N		

(table continued)

Varieties (continued)

Varieties ¹	DE	MD	NJ	PA	VA
Cauliflower (continued)					
Apex*			N	P	
Cassius*	D		N		
Fremont*	D			P	
Candid Charm*	D		N	P	V
Rushmore*			N		
White Sails*			N		
Cashmere*				P	
Panther*				P	
Wentworth*			N	P	V
Concert*			N		
Graffiti* (lavender-purple)				P	
Collards					
Top Bunch*			N	P	
Top Pick					V
Flash*			N	P	
Blue Max				P	
Champion	D	M	N	P	V
Kale					
Dwarf Blue Curled (Vates strain)	D	M	N	P	V
Dwarf Siberian (overwinter)	D	M	N		
Kohlrabi					
Grand Duke*				P	
Purple Danube*				P	
Kohlrabi (lilac purple)				P	

Varieties listed by maturity, earliest first. *Indicates hybrid varieties. Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests
 Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Crop	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds per Acre	Med P ₂ O ₅ per Acre	Opt. P ₂ O ₅ per Acre	Low Pounds K ₂ O per Acre	Med Pounds K ₂ O per Acre	Opt. Pounds K ₂ O per Acre
Broccoli	150-200 ¹	200 ¹	100 ¹	50 ¹	200 ¹	100 ¹	50 ¹
	50-100 ²	150 ²	100 ²	50 ²	150 ²	100 ²	50 ²
	50 ³	50 ³	0	0	50 ³	0	0
	50 ⁴	0	0	0	0	0	0
Brussels Sprouts,	100-150 ¹	200 ¹	100 ¹	40 ¹	200 ¹	100 ¹	50 ¹
Cabbage, and	50-75 ²	200 ²	100 ²	50 ²	200 ²	100 ²	50 ²
Cauliflower	25-50 ³	0	0	0	0	0	0
	25-50 ⁵	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress 2-3 weeks after planting

⁴ Sidedress 4-6 weeks after planting

⁵ Sidedress if needed, according to weather

Apply 1 ½-3 pounds of boron (B) per acre in mixed fertilizer for **broccoli only**. Apply 1 ½-3 pounds of boron (B) per acre and 0.2 pound molybdenum (Mo) applied as 0.5 pound sodium molybdate per acre with broadcast fertilizer for **Brussels sprouts, cabbage, and cauliflower**. See Table B-10 for more specific boron recommendations.

Seed Treatment

Check with seedsmen to determine if seed is hotwater-treated for blackrot. If not, soak seed at 122°F (50°C). Use a 20-minute soak for broccoli, cauliflower, collards, kale, and Chinese cabbage. Soak brussels sprouts and cabbage for 25 minutes.

Note. Hot water seed treatment may reduce seed germination. An alternative to hot water seed treatment is to use 1 part Alcide (sodium chlorite), 1 part lactic acid, and 18 parts water as a seed soak. Treat seed for 1 to 2 minutes and rinse for 5 minutes in running water.

Following either treatment above, dry the seed, then dust with captan 50WP or thiram 75WP at 1 level teaspoon per pound of seed (3 ounces per 100 pounds).

Planting and Spacing

Broccoli. *Field seeding:* Rows 36 inches apart; plants 12 to 18 inches apart in row; seed: 1/2 to 1 pound per acre; time: June 20 to July 20 (June 20 to July 5 in Pennsylvania and northern New Jersey). *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); time: seed June 25 to July 10; transplant July 20 to August 15, depending on location.

For fall plasticulture double cropping, remove previous crop debris and set broccoli transplants 12-21 inches apart in double rows 10-12 inches apart. For larger heads allow greater in-row spacing. Set plants in late July through mid-August, depending on variety maturity and location.

Brussels Sprouts. *Transplants:* Rows 3 feet apart; plants 15 inches apart in row. Start planting transplants June 20. Start field seeding July 1.

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 (0°C) or 5 days at 66°F (19°C) 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. Transplants are set 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. Transplants are set 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 between July 15 and August 20, depending on location.

Note. In Pennsylvania and other cool areas, Snow Crown, Snow Grace, and White Cloud can be grown in the spring. Transplant to the field in early April.

Collards. Seed at the rate of 2 pounds per acre if field-seeded or 4 ounces per acre for transplants. Seed 3 to 4 weeks before transplanting. Transplants are set in rows 16 to 24 inches apart and 6 inches apart in the row. Collards for spring

and early summer harvest can be transplanted or seeded starting April 1 in Virginia and warmer, southern areas and April 20 in Pennsylvania and normally cooler areas. Collards can be seeded starting in mid-July through late August for fall harvest.

Kale. Usually seeded directly in the field, but it can be grown in frames and transplanted. Sow seed at 3 pounds per acre in rows spaced 16 to 24 inches apart. Thin to 4 to 5 inches apart in the row. Seed kale at the same time as indicated for collards.

Kohlrabi. Transplants may be used for a spring crop. Seed 6 weeks before expected transplant date. Plant in the field at the same time as broccoli or cabbage. Fall crops can be established by direct-seeding between June 25 and July 15. Seed open-pollinated varieties at the rate of 2 to 3 pounds per acre and thin to 6 to 8 inches between plants in the row. Precision seed hybrid varieties. Set transplants July 20 to August 15. Space rows 18 to 24 inches apart.

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 (1.67° to 10°C). However, the sensitivity to bolting depends upon the variety.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables 28 and 29.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Seeded and Transplanted

Preplant Incorporated

Trifluralin--*Seeded:* 0.5-0.75 lb/A. Use 1 to 1.5 pints per acre Treflan 4E. *Transplants:* 0.5-1 lb/A. Use 1 to 2 pints per acre Treflan 4E. Incorporate 2 to 3 inches into soil by double-disking within 8 hours after application. **Labeled for broccoli, brussels sprouts, cabbage, cauliflower, collards, and kale only.**

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence, followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Preemergence or Post-Transplant

DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre Dacthal 6F. Apply after seeding or transplanting to a clean, weed-free soil. Use good agitation in tank. Dacthal controls annual grasses, common purslane, and lambsquarter, and suppresses or controls certain other annual broadleaf weeds. Preplant incorporate Treflan to improve control of prostrate pigweed, or use in combination with Dual Magnum to control galinsoga.

S-metolachlor--0.48-1.27 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E in Delaware, Maryland, New Jersey,**

Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability provided by the local growers' association has been signed by the grower, all fees have been paid, and a label has been provided by the association. Apply 0.5 to 1.33 pints per acre Dual Magnum 7.62E before weeds emerge, to control annual grasses, yellow nutsedge, and certain broadleaf weeds, including galinsoga. Dual Magnum will NOT control emerged weeds. Use the lower rate on coarse-textured soils low in organic matter, and the higher rate on fine-textured soils with high organic matter. Treat **direct-seeded** cabbage postemergence, after three to four leaves have developed. Emerged weeds should be controlled by cultivation, hoeing, or postemergence herbicides prior to Dual Magnum application. Treat **transplanted** cabbage with either a pretransplant, surface-applied application or spray post-transplant within 2 days of planting. Read and follow all notes and precautions on the label. DO NOT incorporate Dual Magnum prior to planting. DO NOT apply to direct-seeded cabbage prior to the three- to four-leaf growth stage or the risk of crop injury may be increased. Certain varieties may be more sensitive to injury. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for cabbage ONLY!**

Postemergence

Clopyralid--0.047-0.188 lb/A. Apply 2 to 8 fluid ounces of Stinger 3A per acre in one or two applications to control certain annual and perennial broadleaf weeds. Do not exceed 8 fluid ounces in one year. Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 8 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days. Stinger is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications

may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season. **Labeled for broccoli, cabbage, and cauliflower only.**

S-metolachlor--0.48-1.27 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability provided by the local growers' association has been signed by the grower, all fees have been paid, and a label has been provided by the association.** Apply 0.5 to 1.33 pints per acre Dual Magnum 7.62E before weeds emerge, to control annual grasses, yellow nutsedge, and certain broadleaf weeds, including galinsoga. Dual Magnum will NOT control emerged weeds. Use the lower rate on coarse-textured soils low in organic matter, and the higher rate on fine-textured soils with high organic matter. Treat **direct-seeded** cabbage postemergence, after three to four leaves have developed. Emerged weeds should be controlled by cultivation, hoeing, or postemergence herbicides prior to Dual Magnum application. Treat **transplanted** cabbage with either a pretransplant, surface-applied application or spray posttrans-plant within 2 days of planting. Read and follow all notes and precautions on the label. DO NOT incorporate Dual Magnum prior to planting. DO NOT apply to direct-seeded cabbage prior to the three- to four-leaf growth stage or the risk of crop injury may be increased. Certain varieties may be more sensitive to injury. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for cabbage ONLY!**

Napropamide--1 lb/A. Apply 2 pounds per acre Devrinol 50DF preplant incorporated before seeding or transplanting. Primarily controls annual grasses and certain broadleaf weeds. Tank-mix with minimum recommended rate of Treflan 4EC to improve the spectrum of broadleaf weeds controlled. Use only on fine-textured soils such as silt or clay loams with more than 2 percent organic matter. Crop injury has occurred when used on coarse-textured soils low in organic matter. **Labeled for broccoli, Brussels sprouts, cabbage, and cauliflower. Recommended in Pennsylvania ONLY!**

Transplanted Only

Oxyfluorfen--0.2-0.5 lb/A. Apply 0.8 to 2 pints per acre Goal 2XL or Galigan 2E, or 0.8 to 1 pint per acre GoalTender 4FL before transplanting and transplant through the herbicide on the soil surface to control broadleaf weeds including common lambsquarter, common purslane, common ragweed, pigweed sp., and galinsoga. Use lower rates on coarse-textured soils low in organic matter. Cold, wet conditions in early spring may increase the risk of temporary crop injury which could delay maturity. Annual grasses will not be adequately controlled by Goal. Use Dacthal posttransplant or Poast 1.5EC postemergence to control grasses. Treflan or Dual Magnum may increase the potential for crop injury, especially when conditions are cold and wet, and it is not recommended for use prior to Goal application. Delay cultivation after Goal application, when possible, to reduce deactivation of the Goal by incorporation. **Labeled for broccoli, cabbage, and cauliflower only.**

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Note: Not all pesticides are labeled for each crop in this section. Refer to Days to Harvest Table at the end of the Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Collards, Kale, and Kohlrabi Section and/or pesticide label to determine which pesticide are labeled on specific crops.

Cabbage Root Maggot

Direct-Seeded Treatments

Lorsban--1.6-2.75 fl oz 4E/1,000 ft of row (all crops except cauliflower) or 1.6-2.4 fl oz 4E/1,000 ft of row (cauliflower only). All Lorsban treatments should be applied in a 4-inch band across the seed row behind the planter shoe and ahead of the press wheel.

Transplant Water Treatment

diazinon--4-8 oz 50WP or 4-8 oz 4EC in 50 gallons of water. Apply 4-8 oz of solution per transplant either by hand or mechanical transplanter.

IMPORTANT: Repeated agitation of solution is necessary to prevent settling-out of wettable powder.

Postplanting Spray Treatment **Airblast sprayers are NOT recommended for maggot control.**

Note. When yellow-rocket (mustard family) first blooms, cabbage maggot adults (flies) begin laying eggs on roots or soil near roots.

Lorsban--1.6-2.75 oz 4E/1,000 ft of row (all crops except cauliflower); 1.6-2.4 fl oz 4E/1000 ft of row (cauliflower). Apply as a water based spray directed to the base of plants immediately after setting. Use a minimum of 40 gallons of total spray per acre. Do not apply as a foliage application.

Cutworms

(Also see the "Cutworms" section in Soil Pests-Their Detection and Control.)

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--0.8-1.6 fl oz /A, or OLF, or
bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
diazinon--2-4 qt 4EC/A (broadcast application) or OLF, or
lambda-cyhalothrin--1.92-3.2 fl oz/A or OLF, or
Lannate--1.5 pt LV/A or OLF, or
Lorsban--2 lb 50W/A. **Note.** To avoid phytotoxicity, do not mix Lorsban 50W with other pesticides or treat plants under extreme heat or drought stress, or
Mustang MAX--2.4-4.0 fl oz, or
Proaxis--1.92-3.2 fl oz /A, or
Renounce--1-2 oz 20WP or OLF, or
Sevin Bait--40 lb 5% bait/A

Thrips

Field observations indicate that the variety Market Prize may be more attractive to thrips than other varieties.

Actara--3-5.5 oz 25 WDG, or
Assail--4 oz 30SG/A, or OLF, or
Baythroid XL--0.8-1.6 fl oz /A, or
bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
Mustang MAX--3.2-4.0 fl oz 2E/A, or
permethrin--2-4 fl oz 3.2EC/A or OLF, or
Radiant--6-10 fl oz SC/A, or
Renounce--1-2 oz 20WP or OLF, or
SpinTor--4-10 fl oz 2SC/A

Aphids

Actara--1.5-3.0 oz 25 WDG, or
Assail--2-3 oz 30SG/A, or
Beleaf--50 SG (see label for rates), or
diazinon--1 pt 4EC/A or OLF, or
Fulfill--2.75 oz 50W/A, or
imidacloprid (soil, foliar)--see label for rates and application methods, or
Metasystox-R--1 qt 2SC/A, or
Orthene--0.5-1.0 lb 97S/A or OLF (green peach aphid only), or
Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A

Flea Beetles, Harlequin Bugs

Actara--1.5-3.0 oz 25 WDG (fleas beetles only), or
Asana XL--5.8-9.6 fl oz 0.66EC/A (flea beetles only), or
Assail--2-3 oz 30 SG/A, or
Baythroid XL--2.4-3.2 fl oz /A, or
bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
lambda-cyhalothrin--2.5-3.84 fl oz/A or OLF, or
Mustang MAX--2.24-4.0 fl oz 2E/A, or
Proaxis--2.5-3.84 fl oz/A, or
imidacloprid (foliar only)--see label for rates and application methods, or
Renounce--3-3.5 oz 20WP or OLF, or
Sevin--0.625-1.25 lb 80S/A or OLF, or
Thionex (only one application per season on collards and kale)--1 qt 3EC/A, or

Worm Pests

Cole crops may require multiple treatments per season. Rotation of insecticides with different modes of action is recommended to reduce the development of resistance.

Treat cabbage when 20 percent or more of the plants are

infested with any species before heading. Once heads are formed, treat when 5 percent of the plants are infested.

Note. Underleaf spray coverage is essential to control newly hatched worms. With boom-type rigs, apply spray with at least 3 nozzles per row—one directed downward and one directed toward each side. Evaluate effectiveness to consider need for further treatment.

Cabbage Looper (CL), Imported Cabbageworm (ICW)

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
 Avaunt--2.5-3.5 oz 30WDG/A, or
Bacillus thuringiensis--consult label for rates and restrictions, or
 Baythroid XL--1.6-2.4 fl oz /A, , or
 bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
 Confirm--6-8 fl oz 2F/A, or
 Danitol--10.66-16 fl oz 2.4 EC/A, or
 Entrust--1.0-2.0 oz 80W/A, or
 Intrepid--4-8 fl oz 2F/A, (early season), 8-10 fl oz 2F/A (late season), or
 lambda-cyhalothrin--1.92-3.2 fl oz/A or OLF, or
 Lannate--1.5-3 pt LV/A or OLF.

For fresh-market collards only: Lannate--1.5 pt LV/A or OLF. Do not apply to collards when minimum daily temperatures are anticipated to be 50°F (10°C) or lower or when plants are less than 10 inches tall, or

Larvin--16-40 fl oz 3.2F/A, or
 Mustang MAX--3.2-4 oz /A, or
 Orthene--1.0 lb 97S/A or OLF, or
 Proaxis--1.92-3.2 fl oz/A, or
 Proclaim--2.4-4.8 oz 5SG/A.(ICW); 3.2-4.8 oz 5SG/A (CL), or
 Radiant--5-10 fl oz SC/A, or
 Renounce--2-3 oz 20WP or OLF, or
 Rimon--6-12 fl oz 0.83EC/A, or
 SpinTor--3.0-6.0 fl oz 2SC/A. Use the higher labeled rate for CL

Diamondback Moth (DBM)

Note. Several of these insecticides may no longer be effective in certain areas due to DBM resistance. Consult your local county Extension office for most effective control.

Avaunt--3.5 oz 30WDG/A, or
Bacillus thuringiensis--consult label for rates and restrictions.

Note. *Bacillus thuringiensis* preparations are toxic only when they are eaten by the larvae. *B.t. aizawai* may be a more effective strain than *B.t. kurstaki* against DBM. Good coverage is essential and the use of a spreader-sticker with *B.t.* is recommended. Apply when worms first appear and at weekly intervals thereafter as required. *B.t. materials are most effective when temperatures are above 75°F (23.9°C) at application,* or

Entrust--0.5-1.25 oz 80W/A, or
 Orthene--1.0 lb 97S /A, or OLF, or
 Proclaim--2.4-4.8 oz 5SG/A, or
 Radiant--5-10 fl oz SC/A, or
 Rimon--6-12 fl oz 0.83EC/A, or
 SpinTor--1.5-4 fl oz 2SC/A.

Beet Armyworm (BAW), Fall Armyworm (FAW), Yellow Striped Armyworm (YSAW)

Avaunt--3.5 fl oz 30 WDG/A, or
Bacillus thuringiensis--consult label for rates and restrictions.

Note: *Bacillus thuringiensis* preparations are toxic only when they are eaten by the larvae. *B.t. aizawai* may be a more effective strain than *B.t. kurstaki* against DBM. Good coverage is essential and the use of a spreader-sticker with *B.t.* is recommended. Apply when worms first appear and at weekly intervals thereafter as required. *B.t. materials are most effective when temperatures are above 75°F (23.9°C) at application,* or

Confirm--6-8 fl oz 2F/A (early season) or 8 fl oz 2F/A (mid to late season), or
 Entrust--1.25-3.0 oz 80W/A, or
 Intrepid--4-8 fl oz 2F/A (early season), 8-10 fl oz 2F/A (late season), or
 Larvin--16-40 fl oz 3.2 F/A, or
 Proclaim--2.4-4.8 fl oz 5 SG/A, or
 SpinTor--4.0-10.0 fl oz 2 SC/A

Cabbage Webworm (CWW), Cross-Striped Cabbageworm (CSCW)

Avaunt--2.5-3.5 oz 30 WDG/A, or
 Baythroid XL--1.6-2.4 fl oz/A (CWW only), or
 Confirm--6.8 fl oz 2 F/A (early season) or 8 fl oz 2F/A (mid to late season), or
 lambda-cyhalothrin--1.92-3.2 oz /A (CWW only) or OLF, or
 Mustang MAX--3.2-4.0 oz /A (CWW only), or
 Proaxis--1.92-3.2 oz /A (CWW only), or
 Proclaim--2.4-4.8 oz 5 SG/A, or
 Renounce--2-3 oz 20WP or OLF, or
 Rimon--6-12 fl oz 0.83EC/A (CWW only)

Nematode Control

See "Nematodes" section of Soil Pests-Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or Nematicur 15G at 30 pounds per acre broadcast or 10 pounds per acre in a 12-inch band over the row. Incorporate 2 to 6 inches before seeding or transplanting.

Disease Control

Damping-Off

Plantbed: Use 0.5 pound Terraclor 75WP per 100 gallons of solution for control of Rhizoctonia. Apply to the soil at the rate of 100 gallons per 2,000 square feet of bed surface.

Field: Use the following as a banded application after seeding. See label for banded rates based on row spacing. Apply the following in a band up to 7 inches wide:

mefenoxam + azoxystrobin (Ridomil Gold--1-2 pt 4EC/A plus Quadris at 0.4-0.8 fl oz 2.08F/1000 row ft).

Black Rot and Blackleg

Use resistant varieties and hot water seed treatment.. Select site not previously planted to crucifers for seedbeds. (See the "Disease Control in Plantbeds" section.) Rotate to allow 2 years between cole crop plantings for black rot control and 4 years between cole crop plantings for blackleg control.

For blackleg control in broccoli only, use iprodione (Rovral 50WP at 2 pounds per acre or OLF) immediately after thinning as a directed spray to the base of the plant and adjacent soil surface. A second application may be made up to the day of harvest.

For black rot control, fixed copper sprays (1 pound active ingredient per acre) will aid in reducing spread of black rot if

treatments are started when disease first becomes evident. Bravo and Blue Gem are cabbage varieties with field resistance to black rot.

Bacterial Head Rot

Bacterial head rot is a problem on broccoli. The only effective control strategy is to use tolerant varieties.

Clubroot

Use of irrigation water containing spores of this fungus is the principal way the disease is spread into new fields. If clubroot occurs, clean and disinfect any equipment to be used in other fields to prevent spread. Adjust soil pH with hydrated lime to as close to 7 as possible. Improve the drainage in the field and grow the crop on raised beds. Use Terraclor 75WP in one of the following ways. Do NOT use the Terraclor 2EC formulation.

1. Use 30 lb/A or 37 oz/1000 ft of row. Apply in a 12 to 15-inch band and incorporate 4 to 6 inches deep before planting, or
 2. Use 40 lb/A acre broadcast and incorporate 4 to 6 inches deep before planting, or
- Use 2 pounds per 100 gallons of solution and 0.5 pint per plant as a transplant solution.

Downy Mildew and Alternaria

Use one of the following at the first sign of disease and continue every 7 to 10 days (Refer to the pesticide table for this section to determine which fungicide is labeled for each specific cole crop.):

Quadris--6.2-15.4 fl oz 2.08F/A, or
 chlorothalonil--1.5 pt 6F/A or OLF, or
 Cabrio--12-16 oz 20EG/A, or
 Endura--6-9 oz 70WG/A (Alternaria only), or
 maneb--1.5-2 lb 75DF/A or OLF, or
 Ridomil Gold Bravo--1.5 lb 76.5WP/A (14-day schedule), or
 Switch--11-14 oz 62.5WG/A (Alternaria only)

Materials with different modes of action (FRAC code) should be alternated.

For downy mildew only, use:

Actigard--1 oz 50WG/A. (Begin applications 7-10 days after thinning and reapply every 7 days for a total of 4 applications per season), or
 Aliette--3-5 lb 80WDG/A (14-day schedule)

White Mold

The following biological fungicide has been tested in some states; however, limited information is available on effectiveness in the mid-Atlantic region. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches but **do not plow** before seeding cole crops to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.

Contans--2-4 lb 5.3WG/A

Alternatively, during seasons when soils remain wet for extended periods of time apply the following preventatively:

Endura--6-9 oz 70WG/A (Do not make more than two applications per season.)

Yellows (*Fusarium*).

Use resistant varieties when possible and practice long crop rotations.

Harvesting and Storage

Cauliflower is harvested while the heads are pure white and before the curds become loose and ricey. Heads are blanched (for varieties that are not self-blanching) 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.

The late plantings of Danish Ballhead strains are stored at 32° to 34°F (0° to 1.11°C) and 90 to 95 percent relative humidity.

Kale is harvested by cutting off entire plant near ground level, or lower leaves may be stripped from plant. Collards may be harvested at any stage of growth.

Pesticide	Use Category ²	Hours to Reentry ³	Days to Harvest ¹							
			Broccoli	Brus. Sprt.	Cabbage	Cab. ⁴ (Chin.)	Cauliflower	Collards	Kale	Kohlrabi
INSECTICIDE										
Actara	G	12	0	0	0	0	0	7	7	7
Asana XL	R	12	3	--	3	3	3	7	--	--
Assail	G	12	7	7	7	7	7	7	7	7
Avaunt	G	12	3	3	3	3	3	--	--	3
<i>Bacillus thuringiensis</i>	G	4	0	0	0	0	0	0	0	0
Baythroid XL	R	12	0	0	0	0	0	--	--	0
Beleaf	G	12	0	0	0	0	0	0	0	0
bifenthrin	R	12	7	7	7	7	7	--	--	7
Confirm	G	4	7	7	7	7	7	7	7	7
Danitol	R	24	7	7	7	7	7	--	--	7
Diazinon	R	247	7	21	10	5	10	10	--	--
dimethoate	R,G	48	7	--	7	--	7	14	14	--
Entrust	G	4	1	1	1	1	1	1	1	1
Fulfill	G	12	7	7	7	7	7	7	7	7
imidacloprid (soil/foiliar)	G	12	21/7	21/7	21/7	21/7	21/7	21/7	21/7	21/7
Intrepid	G	4	1	1	1	1	1	1	1	1
lambda-cyhalothrin	R	24	1	1	1	1	1	--	--	1
Lannate	R	48	3	3	1	10	3	10	10	--
Larvin	R	48	7	--	7	--	7	--	--	--
Lorsban 15G	R(NJ),G	24	AP	AP	AP	AP	AP	AP	AP	AP
Lorsban 4E, 75WG	R,G	24	21	21	21	--	21	21	21	21
Mustang MAX	R	12	--	--	1	--	--	--	--	--
Orthene	G	24	--	14	--	--	14	--	--	--
permethrin	R	12	1	1	1	1	1	1	--	1
Proaxis	R	24	1	1	1	1	1	--	--	1
Proclaim	R	48	7	7	7	7	7	14	14	7
Radiant	G	4	1	1	1	1	1	1	1	1
Renounce	R	12	0	0	0	0	0	0	0	0
Rimon	R	12	7	7	7	7	7	--	--	7
Sevin/Sevin Bait	G	12	3	3	3	--	3	14	14	3
SpinTor	G	4	1	1	1	1	1	1	1	1
Thionex	R	24	7	14	7	--	14	21	21	--
Venom (soil/foiliar)	G	12	21/1	21/1	21/1	21/1	21/1	--	--	21/1
FUNGICIDE (FRAC code)										
Actigard (Group P1)	G	12	7	7	7	7	7	7	7	7
Alette (Group 33)	G	12,24	3	--	3	3	3	3	3	3
Cabrio (Group 11)	G	12	7	7	7	7	7	7	7	7
chlorothalonil (Group M5)	G	12	0	0	0	7	0	--	--	--
Contans WG (biological)	G	4	0	0	0	0	0	0	0	0
Endura (Group 7)	G	12	0,14 ⁵	0	0	0,14 ⁵	0	14	14	0
iprodione (Group 2)	G	24	0	0	0	0	0	0	0	0
maneb (Group M3)	G	24	7	7	7	7	7	--	10	7
Quadris (Group 11)	G	4	--	--	--	0	--	0	0	--
Ridomil Gold (Group 4)	G	48	AP	AP	AP	AP	AP	AP	AP	AP
Ridomil Gold Bravo (Groups 4 + M5)	G	48	7	7	7	7	7	--	--	--
Switch (Groups 9 + 12)	G	12	7	7	7	7	7	7	7	7
Terraclor (Group 14)	G	12	AP	AP	AP	AP	AP	AP	AP	AP

¹ AP = At-planting time only

² G = general, R = restricted

³ Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

⁴ Tight-heading varieties of Chinese cabbage

⁵ See label for specific recommendations

Dash (-) in table indicates pesticide is **not** labeled for that crop

CARROTS

Varieties

Varieties¹

Processing: Dicing

Spartan Bonus 80*
Danvers 126

These varieties are recommended for DE, MD, NJ, PA, VA, WV

Processing: "Coins"

Nantes types

Market

Scarlet Nantes
Hybrid Nantes* types

¹ Varieties listed by maturity, earliest first

* Indicates hybrid variety

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Carrots	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
	50-80 ¹	150 ¹	100 ¹	50 ¹	150 ¹	100 ¹	50 ¹
	50 ²	150 ²	100 ²	50 ²	150 ²	100 ²	50 ²
	25-30 ³	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress if needed

Apply 1-2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations

Seed Treatment

Use seed treated with Maxim 4FS (0.08-0.16 fl oz/100 lb seed) for Rhizoctonia & Fusarium control and Apron XL LS (0.16-0.64 fl oz/100 lb seed) for Pythium control.

Seeding Dates

For early harvest (July to September), sow March 20 to April 30; for late harvest, sow May 1 to July 5 (May 1 to June 15 in Pennsylvania and northern New Jersey). Practice crop rotation, and plant after a small grain crop for highest yields.

Spacing

Processing: Rows 20 to 30 inches apart; "coins," sow for 16 plants per foot; dicing, sow for 6 plants per foot (8 if soil is on the fine-textured side).

Seeding rate: Dicers, 12 to 14 ounces per acre using 2-inch scatter shoe; "coins," sow 2 to 4 pounds per acre using 4-inch scatter shoe. Depth of seeding should be no deeper than one-fourth inch.

Cultivation

Hill with 2 inches of soil to cover shoulders to minimize greening.

Storage

Topped: 4 to 5 months at 32°F (0°C) and 90 to 95 percent relative humidity.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Preplant Incorporated

Trifluralin--0.5-0.75 lb/A. Apply 1 to 1.5 pints per acre Treflan 4EC. Preferably, use two diskings to incorporate treatment into the top 3 inches of soil within 8 hours after application. Plant carrots immediately. Trifluralin is particularly effective on barnyardgrass, foxtail, crabgrass, all panicum, and other annual grasses. It will not control ragweed or jimsonweed.

Preemergence

Linuron--0.5-1.5 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Linex 4L preemergence in New Jersey.** Apply 1 to 3 pints per acre Linex 4L after seeding, but before crop emergence. Sow seed at least one-half inch deep. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur. Primarily controls annual broadleaf weeds. Annual grasses may only be suppressed. Do NOT exceed a total of 2 pounds of active ingredient linuron per acre per season.

S-metolachlor--1.26-1.9 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E in New Jersey. The use of this product is legal ONLY if a waiver of liability provided by the local growers' association has been signed by the grower, all fees have been paid, and a label has been provided by the association.** Apply 1.33 to 2 pints per acre Dual Magnum 7.62E preemergence to control annual grasses, yellow nutsedge, and certain broadleaf weeds, including galinsoga. Dual Magnum will NOT control emerged weeds. **Use ONLY on high organic matter (>20%) muck soils.** Read and follow all notes and precautions on the label. DO NOT incorporate Dual Magnum prior to planting. Make only on application per crop. Observe a minimum preharvest interval of 64 days after application. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Postemergence

Sethoxydim--0.2-0.5 lb/A. Apply 1 to 2.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For

best results, treat annual grasses when they are actively growing and before tillers are present. Tepeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 5 pints per acre in one season.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Fluazifop--0.125-0.188 lb/A. Apply 0.5 to 0.75 pints per acre Fusilade DX 2E with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge, wild onion, or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 45 days and apply no more than 6 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application.

Linuron--0.75-1.5 lb/A. Apply 1.5 to 3 pounds per acre Lorox 50DF or 1.5 to 3 pints per acre Lorox 4L. Apply when carrots are approximately 3 to 6 inches tall. Avoid postemergence applications when daily temperatures are 90°F (32.2°C) or above or during a period of cloudy weather or just after rain or irrigation. Linuron is effective on most weeds including ragweed. Do not plant treated area to crops not on the label within a 4-month period after treatment.

Metribuzin--0.25 lb/A. Apply 0.33 pound per acre Sencor 75DF postemergence to carrots with a minimum of six true leaves to control many broadleaf weeds, including tropic croton, spotted spurge, and horseweed. Do not use to control triazine-resistant weeds. Do not apply within 3 days after periods of cool, wet, cloudy weather. Do not tank-mix with

any other pesticide or apply within 3 days, or excessive crop injury may result. Do not apply to carrots with less than six true leaves or excessive crop injury may result. Varietal differences exist in carrot tolerance to Sencor. Use caution when treating new varieties.

Postharvest

Paraquat--0.6 lb/A. A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia. Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Leafhoppers (LH), Aphids

Begin spraying when true leaves first appear. Repeat every 14 days or as needed.

Leafhoppers transmit aster yellows. Seedling protection from leafhoppers is important.

Asana XL--5.8-9.6 fl oz 0.66EC/A (LH only), or Baythroid XL--1.6-2.8 fl oz /A (LH only), or imidacloprid (soil, foliar)--see label for rates and application methods, or Lannate--1.5-3 pt LV/A or OLF, or malathion--2 pt 57EC/A

Cutworms

Asana XL--5.8-9.6 fl oz 0.66EC/A, or Baythroid XL--1.6 – 2.8 fl oz/A, or Lannate--1.5-3 pt LV/A or OLF, or Renounce--3.5 oz 20WP or OLF, or Sevin Bait--20-40 lb 5% bait/A

Carrot Weevil

Begin treatment when weevils become active.

Asana XL--9.6 fl oz 0.66EC/A, or Baythroid XL--2.8 fl oz /A, or Renounce--2-3.5 oz 20WP or OLF, or Vydate L--2-4 pt 2L/A (directed spray)

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
INSECTICIDE			
Asana XL	R	12	7
Baythroid XL	R	12	0
imidacloprid(soil/foliar)	G	12	21/7
Lannate	R	48	1
malathion	G	12	7
Renounce	R	12	0
Sevin Bait	G	12	0
Vydate L	R	48	14
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
Contans WG (biological)	G	4	0
Endura (Group 7)	G	12	0
iprodione (Group 2)	G	24	0
Mertect (Group 1)	G	12	0
Pristine (Groups 11 + 7)	G	12	0
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	48	0
Rovral (Group 2)	G	24	0

(table continued next page)

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
FUNGICIDE (FRAC code) (continued)			
Switch (Groups 9 + 12)	G	12	7
Ultra Flourish (Group 4)	G	48	0

See Table D-6. ¹ G = general, R = restricted

Nematode Control

Nematode control is essential for successful production. See "Nematodes" section of Soil Pests-Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or use Vydate L. Heavy rainfall following application and prior to emergence can result in less effective control with Vydate L. Consult label before use

Disease Control

Damping-Off (*Pythium* and *Phytophthora*)

Apply the following preplant incorporated or as a soil-surface spray after planting.

mefenoxam--1-2 pt Ridomil Gold 4EC/A or 2-4 pt Ultra Flourish 2E/A

Aster Yellows

Use insecticides to control leafhoppers, and keep weed populations down on periphery of field early in the season to prevent transmission by leafhoppers from the weeds into the crop.

Leaf Blights (*Alternaria*, *Cercospora* and Powdery Mildew)

Several varieties such as Bolero, Calgary, Carson, Cheyenne, and Choctaw exhibit tolerance to leaf blight and should be grown where adapted. For susceptible varieties, begin applications when disease threatens or early July and continue every 7 to 10 days until frost. For powdery mildew make preventative applications on a 5 to 7 day schedule. Do not make more than one sequential application of Cabrio, Pristine or Quadris before alternating with chlorothalonil. Under severe defoliation, add urea (10 pounds per acre) to encourage new leaf growth.

Quadris--9.0-15.5 fl oz 2.08F/A (for *Alternaria* and *Cercospora* only), or Cabrio--8-12 oz 20EG/A, or chlorothalonil (*Alternaria* and *Cercospora* only)--1.5-2 pt 6F/A or OLF, or Endura (*Alternaria* only)--4.5 oz 70W/A, or Pristine--8-10.5 oz 38WG/A, or iprodione--(*Alternaria* only; crop rotation restrictions exist--see labels for details) Rovral--1-2 lb 50WP/A or OLF, or Switch (*Alternaria* only)--11-14 oz 62.5WG/A

White Mold

The following biological fungicide has been tested in some states; however, limited information is available on effectiveness in the Mid-Atlantic region. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches. **Do not plow** before seeding cole crops to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.

Contans--2-4 lb 5.3WG/A

Storage Rots (*Botrytis*, *Sclerotinia*)

Remove all damaged roots before placing in storage.

Remove roots from field and place in storage at 32°F (0°C) and 90 to 95 percent relative humidity immediately after digging. As carrots are placed into storage, dip into the following fungicide solution for 5 to 10 seconds.

Mertect 340F--41 fl oz/100 gal

CELERY

Celery is a cool-season crop with high moisture requirement. Muck soils or well-drained, medium-textured mineral soils with irrigation are best suited for celery. The crop will withstand light freezes, but it is damaged by several moderate freezes. Seedstalk development, rather than normal growth, will occur if young plants are exposed to temperatures below 55°F (12.8°C) for 10 days or more.

Varieties

Varieties ¹	
Florida 683	These varieties are recommended for PA and other areas where climatic conditions are favorable for celery production.
Utah 52-70 strains	
Penncrisp (trenching)	

¹ Varieties listed by maturity, earliest first.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Celery	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med P ₂ O ₅ per Acre	Opt. P ₂ O ₅ per Acre	Low Pounds K ₂ O per Acre	Med Pounds K ₂ O per Acre	Opt. Pounds K ₂ O per Acre
	150-175 ¹	250 ¹	150 ¹	100 ¹	250 ¹	150 ¹	100 ¹
	50-75 ²	250 ²	150 ²	100 ²	250 ²	150 ²	100 ²
	25-50 ³	0	0	0	0	0	0
	25-50 ⁴	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress 2-3 weeks after planting

⁴ Sidedress 6-8 weeks after planting

Apply 1 1/2 -3 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Seed Treatment

Use seed at least 2 years old. Soak newer seed in hot water at 118°F (47.8°C) for 30 minutes.

Soil Fertility and pH (for Pennsylvania)

Lime to a pH of 6.2 to 6.8. Apply a total of 200 pounds per acre nitrogen to the crop. Apply phosphate, potash, magnesium, boron, and lime as directed by soil test results. Apply 1 to 2 pounds of boron per acre.

Transplant Production

Because of the long growing season required, celery is

usually treated as a transplant crop. Sow seed in the greenhouse 10 to 12 weeks before field planting. About 35,000 plants can be produced from 2½ ounces of seed. Temperatures between 70° to 75°F (21.1° to 23.9°C) should be maintained until the plants emerge, then 65° to 70°F (18.3° to 21.1°C) for steady growth. To reduce the production of "seeders," night temperatures should not drop below 55°F (12.8°C). Plants for the early crop should not be set in the field until danger of a prolonged cold period or actual freeze is over.

If plants become too tall or spindly before field setting, they can be clipped back to a 5- or 6-inch height. Plants can be hardened by withholding water 7 to 10 days after setting in field. Never harden celery plants by lowering temperatures.

Planting

Celery is a cool-season crop that grows most rapidly, yields best, and develops top quality at moderately cool temperatures (55° to 75°F [12.8° to 23.9°C]), good soil moisture, and relatively high humidity. It will withstand light freezes, but both young and old plants are damaged by moderate freezes. Celery, a biennial, initiates seed stalk (bolts) after being exposed to temperatures below 55°F (12.8°C) for a number of days.

Satisfactory crops can be produced on fertile, medium-textured mineral soils with irrigation. Since celery is expensive to grow, experience in both production and marketing is desirable before large-scale operations are attempted.

The usual planting period is May 1 to June 30. Transplants are grown in greenhouses or imported from Florida. Under satisfactory growing conditions, celery reaches usable size 85 to 100 days from transplanting. Special blanching practices can improve color and eating quality.

Field Spacing

Rows: 16 to 32 inches apart; *plants:* 8 inches apart in row. Set from 30,000 to 45,000 plants per acre.

Special Precautions

Celery should be cooled quickly to temperatures below 45°F (7.2°C) by hydrocooling, vacuum-cooling, icing, or other means of refrigeration. It can be held a few weeks if storage is near 32°F (0°C) with high humidity.

A physiological disorder called "brown check," is characterized by russetting and cracking on the inner side of the petiole. There is evidence that brown check may be caused by excessive amounts of potassium in the soil, although boron nutrition may also be involved. Plant resistant varieties, particularly Utah 52-70. Brown check may appear if varieties other than Utah 52-70 or related lines are planted on soils with high potassium levels and if a heavy rate of potassium fertilizer is used.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and

activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Postemergence

Linuron--0.75-1.5 lb/A. Apply 1.5 to 3 pounds per acre Lorox 50DF. Make a single application after celery transplants are established, but before celery is 8 inches tall to control most broadleaf weeds. Spray before target weeds reach 6 inches in height. DO NOT exceed 40 psi or apply when temperatures exceed 85°F. DO NOT add surfactants, oil concentrate, or liquid fertilizer. Use only the Lorox 50DF formulation of linuron. For use on celery grown on muck soils only!

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone

Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Cutworms

Baythroid XL--0.8-1.6 fl oz /A, or
Lannate--1.5 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A or OLF

Leafhopper

Baythroid XL--0.8-1.6 fl oz /A, or
Lannate--1.5-3 pt LV/A or OLF, or
Sevin--0.67-1.25 lb 80S/A (for aster leafhopper, use 1.25-
1.88 lb 80S/A), or
Venom--5-6 oz (soil); 1-3 oz (foliar) 70SG/A

Leafminer

abamectin (Agri-mek; generics available)--8-16 fl oz
0.15EC/A, or
SpinTor--6-10 fl oz 2SC/A, or
Trigard--0.17 lb 75WSP/A, or
Venom--5-6 oz (soil); 1-3 oz (foliar) 70SG/A

Cabbage Looper

Avaunt--3.5 oz WDG/A, or
Bacillus thuringiensis--consult label for rates and restrictions,
or
Baythroid XL--1.6-2.4 fl oz /A, or
Fulfill--2.75 fl oz 50 W/A, or
Lannate--3 pt LV/A or OLF, or
Larvin--24-30 fl oz 3.2F/A, or
Orthene--1.0 lb 97S/A, or OLF, or
permethrin--2-8 fl oz 3.2EC/A or OLF, or
Proclaim--2.4-4.8 oz 5SG/A, or
Radiant--5-10 fl oz SC/A, or
SpinTor--4-8 fl oz 2SC/A

Tarnished Plant Bug (*Lygus*)

Look for bugs on leaves shortly after transplanting and when nearby alfalfa or grain is cut.

Baythroid XL--2.4-3.2 fl oz /A, or
Sevin--1.25-1.88 lb 80S/A

Aphids

Assail--2-4 oz 30SG/A, or
Beleaf--50 SG/A (see label for rate), or
Fulfill--2.75 oz 50 WDG/A, or
Guthion--2 pt 2L/A or OLF, or
Orthene--0.5-1.0 lb 97S/A or OLF (green peach aphid only),
or
Venom--1-3 oz (foliar); 5-6 oz (soil) 70SG/A

Mites

abamectin (Agri-mek; generics available)--8-16 fl oz
0.15EC/A

Beet Armyworm (BAW), Fall Armyworm (FAW)

Larvin--16-30 fl oz 3.2F/A, or
Orthene--1.0 lb 97S/A, or OLF, (FAW only), or
permethrin--4-8 fl oz 3.2EC/A or OLF, or
Proclaim--2.4-4.8 oz 5SG/A, or
Radiant--5-10 fl oz SC/A, or
Sevin--1.25-2.5 lb 80S/A, or
SpinTor--4-8 fl oz 2SC/A

Slugs

metaldehyde bait--Follow label instructions.
Sevin Bait--Follow label instructions.

DO NOT contaminate edible parts with bait.

Disease Control

Damping-Off

Use multipurpose soil fumigants listed in the "Nematodes" section of Soil Pests--Their Detection and Control, or steam sterilize the plant bed. If soil is not sterilized, apply Thiram75WP at 1.3 pounds in 15 to 25 gallons of water per 1,200 square feet at 3-day intervals (plant beds only).

Crater Rot (*Rhizoctonia*)

At weekly intervals, alternate

Quadris--9.2-15.4 oz 2.08F/A *plus* chlorothalonil at 2-3 pt
6F/A or OLF, or
Quadris Opti--2.4-3.7 pt/A

Pink Rot (*Sclerotinia*)

Apply chlorothalonil at 2 to 3 pints 6F per acre, shortly after plants emerge and repeat on a 7-day schedule.

Preplant: The following biological fungicide has been tested in some states; however, limited information is available on effectiveness in the Mid-Atlantic region. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches; however, to avoid the chance of infesting the upper soil layer with untreated sclerotia from the lower soil layer, **do not plow** between treatment and planting times.

Contans--2-4 lb 5.3WG/A

Leaf Blights

Begin applications in seedbed and continue every 7 to 10 days until harvest.

Alternate:

Quadris (azoxystrobin)--9.2-15.4 oz 2.08F, or
Quadris Opti (azoxystrobin+chlorothalonil)--2.4-3.7 pt /A

With one of the following:

chlorothalonil--2-3 pt 6F/A or OLF, or
copper, fixed--manufacturer's recommendation, or
Tilt--4 fl oz 3.6EC/A

Fusarium Yellows

Do not obtain plants from areas of known infestation. There are no means of chemical control. Avoid seeding or transplanting into infested soil or use resistant varieties.

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
INSECTICIDE			
abamectin (Agri-mek)	R	12	7
Assail	G	12	7
Avaunt	G	12	3
<i>Bacillus thuringiensis</i>	G	4	0
Baythroid XL	R	12	0
Beleaf	G	12	0
Fulfill	G	12	7
Lannate	R	48	7
Larvin	G	12	14

(table continued next page)

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
INSECTICIDE (continued)			
Orthene	G	24	21
permethrin	R	12	1
Proclaim	R	48	7
Radiant	G	4	1
Sevin/Sevin Bait	G	12	14
SpinTor	G	4	1
Trigard	G	12	7
Venom (soil/foliar)	G	12	21 /7
FUNGICIDE (FRAC code)			
chlorothalonil (Group M5)	G	12	7
Contans WG (biological)	G	4	0
copper, fixed (Group M1)	G	24	0
Quadris (Group 11)	G	4	0
Quadris Opti (Groups 11+M5)	G	12	7
Thiram (Group M3)	G	24	3
Tilt (Group 3)	G	24	14

See Table D-6.

¹ G = general, R = restricted

CUCUMBERS

For earlier cucumber production and higher, more concentrated yields, use gynoecious varieties. A gynoecious plant produces only female flowers (the ones that produce fruits). To produce pollen, 1 to 15 percent of pollinator must be planted; seedsmen add this seed to the gynoecious variety. Both pickling and slicing gynoecious varieties are available. For machine harvest of pickles, high plant populations concentrate pickle maturity.

Varieties

Varieties ¹	
Slicers (Gynoecious)	
Encore* (ALSR,DMR,PMR,SMR)	These varieties are recommended for DE, MD, NJ, PA, VA, WV
Raider* (SMR)	
Speedway* (ALSR,AR,DMR,PMR,SMR)	
Indy (ALSR,AR,DMR,PMR,SMR)	
Stonewall* (CMVR,AR,SMR,DMR,ALSR,PMR)	
Dasher II* (ALSR,AR,DMR,PMR,SMR)	
Thunder* (DMR,PMR,SMR,ZYMVR)	
Turbo* (ALSR,AR,DMR,PMR,SMR)	
Meteor* (ALSR,DMR,PMR,SMR)	
Striker* (ALSR,AR,DMR,PMR,SMR)	
Slicers (Monoecious)	
Medalist (SMR,DMR,PMR)	
Cyclone* (AR,DMR,PMR,SMR)	
Marketmore 76 (SMR)	
Pickles (F₁-Gynoecious)	
Expedition (trial)	These varieties are recommended for DE, MD, NJ, PA, VA, WV
Lafayette* (DMR)	
Vlaspik* (DMR)	
Fanci Pak*	
Jackson Supreme*	
Sassy*	

(table continued next page)

Varieties (continued)

Varieties ¹	
Pickles (F₁-Monoecious)	
Magic* (ALSR,DMR,PMR,SMR)	These varieties are recommended for DE, MD, NJ, PA, VA, WV
Eureka* (trial)(ALSR,AR,DMR,PMR,PRSV,SMR,W MV,ZYMV)	
Pickles (F₁-Gynoecious)	
Hand Picked	
Fanci Pak*	
Jackson Supreme*	

¹ Cucumbers and slicers listed by maturity, earliest first. Pickles listed alphabetically. Most pickle varieties have multiple disease resistance.

* Indicates hybrid varieties

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Cucumbers	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
	100-125 ¹	150 ¹	100 ¹	50 ¹	200 ¹	150 ¹	100 ¹
	25-50 ²	125 ²	75 ²	25 ²	175 ²	125 ²	75 ²
	25 ³	25 ³	25 ³	25 ³	25 ³	25 ³	25 ³
	25-50 ⁴	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Band-place with planter

⁴ Sidedress when vines begin to run, or apply in irrigation water

Seed Treatment

Check with seedsmen to determine if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 75WP (½ teaspoon per pound or 3 ounces per 100 pounds) and an approved commercially available insecticide.

Planting Dates

Start seeding in mid-April in warmer, southern areas and May 10 in Pennsylvania and other cool areas. Successive plantings can be made through early August.

Container-grown plants are planted through the plastic when daily mean temperatures have reached 60°F (15.6°C). Planting dates vary from May 1 in southern regions to June 20 in northern areas. Early plantings should be protected from winds with hot caps, tents, or row covers.

Spacing

Slicers: Space rows 3 to 4 feet apart with plants 9 to 12 inches apart. Seeding rate: 1.5 pounds per acre. *Machine Harvest Pickles:* Research and field experience has shown that 55,000 to 65,000 plants per acre is the optimum population for yield and quality. To accommodate a harvester width of 84 inches, three rows 26 to 28 inches apart should be planted on each bed. Plants should be 4 to 5 inches apart in the row. If the harvester has a 90-inch head, space rows 30

inches apart and space plants 3 to 4 inches apart in the row. *Hand Harvest Pickles*: Space rows 3 to 4 feet apart with plants 6 to 8 inches apart. Seeding rate: 1.5 to 2 pounds per acre.

Mulching

Fumigated soil aids in the control of weeds and soil-borne diseases. Clear, plastic mulch laid before field planting conserves moisture, increases soil temperature, and increases early and total yield. Plastic and fumigant--Vapam HL (30 to 37 gallons per acre)--should be applied on well-prepared planting beds 30 days before field planting. Plastic should be 4 feet wide (4,000-foot rolls) and laid on 5- or 6-foot centers 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. Consult your county agent for latest recommendations. Black plastic or paper can be used without a herbicide. Fertilizer must be applied during bed preparation. At least 50 percent of the nitrogen (N) should be in the nitrate (NO₃) form.

Foil and highly reflective mulches can be used to repel aphids that transmit mosaic in fall-planted (after July 1) cucurbits. Direct seeding through the mulch is recommended for maximum virus protection. Transplants should not be used with foil mulches. Also, a herbicide is not necessary. Fumigation will be necessary when there is a history of soil-borne diseases in the field.

Growers may wish to consider trickle irrigation. See the section on "Irrigation" in this publication.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in cucumbers.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. See "Mulching" section above for further information on weed control under clear plastic mulch.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tube left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tube several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic

mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.

3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Condensation that forms on the underside of the mulch will activate the herbicide. Delay seeding or transplanting the crop for 7 days after the application of Sandea under plastic mulch. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. DO NOT exceed a total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.**

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for cucumbers to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and

recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**

3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²). Recalibrate and reduce herbicide rates for banded applications.

Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E as a banded directed shielded spray preemergence to the weeds and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Clomazone--0.094-0.188 lb/A. Apply 4 to 8 fluid ounces per acre Command 3ME preemergence to direct-seeded cucumbers to control annual grasses and many broadleaf weeds including common lambsquarter, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfuralin--0.38-0.75 lb/A. Apply 1 to 2 pints per acre Curbit 3E preemergence to control annual grasses and certain

annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarter, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. **DO NOT** preplant incorporate. **DO NOT** apply under plastic mulch or tunnels. **DO NOT** use when soils are cold or wet. Crop injury may result!

Ethalfuralin plus Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfuralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart below to determine the amount of each herbicide at commonly used rates:

Curbit and Command Active Ingredients (ai) in Commonly Used Strategy Rates

Strategy pints/A	Ethalfuralin (Curbit) lb ai/A	Clomazone (Command) lb ai/A
1.5	0.3	0.094
2	0.4	0.125
3	0.6	0.188
4	0.8	0.25
5	1.0	0.312
6	1.2	0.375

Labeled for use in all the mid-Atlantic states. Read and follow all the recommendations and warnings (above) for ethalfuralin (Curbit) and clomazone (Command).

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season before the vines begin to run. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. **DO NOT** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a**

total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. DO NOT exceed total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.

Postemergence

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed a total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied preemergence and postemergence to multiple crops in one year.**

Naptalam--1 lb/A. Apply 2 quarts per acre Alanap 2SC when the crop is ready to vine to extend residual weed control and to suppress or control smooth pigweed. Do not use Alanap early in the season when growing conditions may be cold or wet. Do not apply if rainfall is expected within 6 hours. Do not mix with liquid fertilizer.

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Max 3SC or Gramoxone Inteon 2SC postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 1.5 pints per acre Gramoxone Max 3SC or 2.4 pints per acre Gramoxone Inteon 2SC as a directed spray to control emerged weeds between the rows after crop establishment. Add nonionic

surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

For Seeding Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Seeding into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall

does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preplant Incorporated

Naptalam--2 lb/A. Apply 1 gallon per acre Alanap 2SC as a preplant incorporated (2 inches) treatment before seeding or transplanting. Weed control may not be satisfactory on sandy soils with less than 1 percent organic matter.

Bensulide *plus* naptalam--4-6 lb/A *plus* 2 lb/A. Apply 1 to 1.5 gallons of Prefar 4EC *plus* 1 gallon Alanap 2SC as a preplant incorporated (2 inches or less) treatment before seeding or transplanting. Tank mix is approved.

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Preemergence

Clomazone--0.094-0.188 lb/A. Apply 4 to 8 fluid ounces per acre Command 3ME preemergence to a direct-seeded crop to control annual grasses and many broadleaf weeds including common lambsquarter, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfuralin--0.38-0.75 lb/A. Apply 1 to 2 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed

sp. Control of many other broadleaf weeds, including common lambsquarter, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfuralin *plus* Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfuralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart under Ethalfuralin *plus* clomazone (jug-mix) in the section **For soil strips between rows of plastic mulch** to determine the amount of each herbicide at commonly used rates.

Read and follow all the recommendations and warnings (above) for ethalfuralin (Curbit) and clomazone (Command).

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. DO NOT exceed a total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.**

Postemergence

Halosulfuron--0.023-0.031 lb/A. Apply 0.5 to 0.66 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control

common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). Do NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. Do NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied preemergence and postemergence to multiple crops in one year.**

Naptalam--1 lb/A. Apply 2 quarts per acre Alanap 2SC when the crop is ready to vine to extend residual weed control and to suppress or control smooth pigweed. Do not use Alanap early in the season when growing conditions may be cold or wet. Do not apply if rainfall is expected within 6 hours. Do not mix with liquid fertilizer.

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Max 3SC or Gramoxone Inteon 2SC postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 1.5 pints per acre Gramoxone Max 3SC or 2.4 pints per acre Gramoxone Inteon 2SC as a directed spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Selectmax 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select 2EC will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions

prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

Postharvest With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings. **Note.** All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for proper set and pollination. 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 the section on "Pollination" in the General Production Recommendations and/or Table D-6 for relative toxicity of various pesticides for hazard to bees.

Insect Control

Seed Corn Maggot

See "Maggots" section in Soil Pests--Their Detection and Control.) Lorsban 50W is approved as a seed treatment. Use 2 ounces per 100 pounds of seed as a slurry treatment prior to planting (see note below).

Note: The use of imidacloprid at planting may reduce seed corn maggot populations.

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 percent stand losses. On farms with a history of bacterial wilt infections and where susceptible varieties are used, insecticides should be used to control adult beetles before they feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence and repeat applications at weekly intervals if new beetles continue to invade fields. Treatments may be required until vines begin to run (usually about 3 weeks after plant emergence).

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--2.4-2.8 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Furadan--A Special Local-Needs Label 24(c) is in effect for the use of liquid Furadan at 3.8 fl oz 4F/1,000 ft of row at planting. Consult your local county Extension office for current restrictions.

Note: Use of Furadan at planting frequently leads to spider mite outbreaks later in the season, or imidacloprid--see label for rates and application methods, or lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or Lannate--1.5-3 pt LV/A or OLF, or permethrin--4-8 fl oz 3.2EC/A, or OLF
Platinum--5-8 oz 2SG/A.

Sevin--1.25 lb 80S/A or OLF, or
Thionex--0.67-1.33 qts 3EC/A or OLF

Cutworms (Also see "Cutworms" section in Soil Pests--Their Detection and Control.)

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--0.8-1.6 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A or OLF

Pickleworm, Melonworm

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

Asana XL--5.8-9.6 fl oz 0.66EC/A (pickleworm only), or
Avaunt--2.5-6 oz 30 WDG/A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Baythroid XL--1.6-2.4 fl oz /A, or
Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-10 fl oz 2F/A, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A, or OLF, or
Radiant--5-10 fl oz SC/A, or
Sevin--1.25 lb 80S/A or OLF, or
SpinTor--4-8 fl oz 2SC/A, or
Thionex--0.67-1.33 pt 3EC/A or OLF

Thrips

Entrust--2-2.5 oz 80W/A, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
SpinTor--6-8 fl oz 2SC/A, or

Venom--1-4 oz (foliar); 5-6 oz (soil) 70SG/A, or
Vydate--2-4 pt 2L/A

Aphids

Note. Aphids transmit mosaic virus. 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.

Actara--1.5-3.0 oz 25 WDG/A, or
Beleaf--50 SG (see label for rate), or
Fulfill--2.75 oz 50WP/A, or
imidacloprid--see label for rates and application methods, or
Lannate--1.5-3 pt LV/A or OLF (Melon Aphid only), or
Metasystox-R--1.5-2 pt 2SC/A (GPA only), or
Platinum--5-8 oz 2SG/A, or (see label for application directions), or
Thionex--0.67-1.33 qts 3EC/A or OLF, or
Venom--1-4 oz (foliar); 5-6 oz (soil) 70SG/A

Leafminers

abamectin (Agri-mek;generics available)--8-16 fl oz 0.15EC/A, or
Entrust--2-2.5 oz 80W/A, or
SpinTor--6-8 fl oz 2SC/A, or
Trigard--0.167 lb 75WSP (one packet)/A, or
Venom--1-4 oz (foliar); 5-6 oz (soil) 70SG/A, or
Vydate L--2-4 pt 2L/A

Cabbage Looper

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Bacillus thuringiensis--Consult label for rates and restrictions, or
Baythroid XL--1.6-2.4 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Entrust--1.25-2.5 oz, or
Intrepid--4-10 fl oz 2F/A, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A, or
Radiant--5-10 oz 80W/A, or
SpinTor--4-8 fl oz 2SC/A

Mites

Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot-treated. Begin treatment when 10 to 15 percent of the crown leaves are infested early in the season, or when 50 percent of the terminal leaves are infested later in the season.

Note. Continuous use of Furadan, Sevin, or a pyrethroid may result in mite outbreaks.

Acramite--0.75-1.0 lb 50WS/A, or
abamectin (Agri-mek;generics available)--8-16 fl oz 0.15EC/A, or
bifenthrin--5.12-6.4 fl oz 2EC/A or OLF, or
Danitol--10.66-16 fl oz 2.4 EC/A, or
Metasystox-R--1.5-2 pt 2SC/A, or
Oberon--7.0-8.5 oz 2SC/A

Nematode Control

See "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or Mocap--10G or 6E (follow label for rates), or

Vydate L--1-2 gal 2L/A. Incorporate into top 2 to 4 inches of soil or 2 to 4 pints 2L per acre applied 2 weeks after planting and repeat 2 to 3 weeks later.

Disease Control

Damping-Off

Apply the following in a 7-inch band after seeding. Use formula given in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold or Ultra Flourish needed per acre.

mefenoxam (Ridomil Gold--1-2 pt 4E/A or Ultra Flourish--2-4 pt 2E/A)
metalaxyl--4-8 pt MetaStar 2E

Viruses (CMV, WMV2, PRSV, ZYMV)

Use resistant varieties when possible. Plant fields as far away from existing cucurbit plantings as possible to help reduce aphid transmission of viruses from existing fields into new fields.

Bacterial Wilt

Controlling striped and spotted cucumber beetles are essential for preventing of wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage season long, therefore, additional foliar insecticide applications may be necessary.

Angular Leaf Spot

At first sign of disease, apply the labeled rate of fixed copper *plus* mancozeb (1 lb active ingredient per acre). Repeat every 7 days. To minimize the spread of disease, avoid working in field while foliage is wet.

Powdery Mildew

The fungus that causes cucurbit powdery mildew can develop resistance to several different groups of fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern US, therefore proper fungicide resistance management should be followed.

Powdery mildew generally occurs from mid-July until the end of the season. Excellent resistance is available in all recommended cucumber varieties. Observe fields for the presence of powdery mildew. If one lesion is found on the underside of 45 old leaves, begin the following fungicide program:

Alternate one of the following tank mixes:

Nova--5 oz 40WP/A *plus* chlorothalonil--2-3 pt 6F/A or OLF, or
Procure--4-8 oz 50WS/A *plus* chlorothalonil--2-3 pt 6F/A or OLF

With:

a tank mix containing Pristine--12.5-18.5 oz 38WG/A *plus* chlorothalonil

Downy Mildew

Cultivars that were resistant in the past may no longer be sufficiently resistant because of recent shifts in the pathogen population. Scout fields for disease incidence beginning in early summer. Refer to the Cucurbit Downy Mildew Forecasting website (www.ces.ncsu.edu/depts/pp/cucurbit/) for current status of the disease. Begin sprays when

vines start to run or if disease occurrence is predicted for the region. Preventative applications are much more effective than applications made after disease is detected.

The following are the most effective materials (always tank mix these products with a protectant such as chlorothalonil--1.5-3 pt 6F/A or OLF):

Ranman--2.1-2.75 fl. oz. 400SC/A, or
Previcur Flex--1.2 pt 6F/A, or
Gavel--1.5-2 lb 75DF/A (Gavel contains mancozeb, which is a protectant, and does not need a tank mix partner.)
Curzate--3.2 oz 60DF/A, or
Tanos--8 oz 50WDG/A

Materials with different modes of action (FRAC codes) should always be alternated.

Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced if label allows.

Anthracnose

Excellent resistance is available in some varieties and should be used when possible. Begin fungicide applications when vines begin to run, or earlier if symptoms are detected. Alternate chlorothalonil or mancozeb with Cabrio, Tanos or Quadris every 7 days. This is especially important to delay the development of resistant strains of the pathogen to Cabrio or Quadris.

Alternate:

chlorothalonil--1.5-3 pt 6F/A or OLF (use low rate early in season), or
mancozeb--2-3 lb 75DF/A or OLF,

With:

a tank mix containing chlorothalonil or mancozeb *plus* azoxystrobin (Quadris--11-15.4 fl oz 2.08F/A), or
Cabrio--12-16 oz 20EG/A, or
Pristine--18.5 oz 38WG/A, or
Tanos--8 oz 50DF/A

To improve the performance of chlorothalonil, combine it with:

thiophanate-methyl--0.5 lb 70WP/A

Gummy Stem Blight

Gummy stem blight occurs primarily in the late summer. Fungicides with a high-risk for resistance development such as FRAC code 11 fungicides (Cabrio, Pristine and Quadris) should be tank-mixed with a low-risk protectant fungicide to reduce the chances for resistance development (see Table E-8).. When tank-mixing use at least the minimum labeled rate of each fungicide in the tank mix. Do not apply FRAC code 11 fungicides more than 4 times total per season. If resistance to FRAC code 11 fungicides exists in the area, do not use. Apply fungicides from a different FRAC code.

Begin sprays when vines begin to run.

Alternate:

chlorothalonil--2 pt 6F/A, or
mancozeb--2-3 lb 75DF/A

With:

a tank mix containing either chlorothalonil or mancozeb *plus* one of the following FRAC code 11 fungicides:
Quadris--11.0-15.4 fl oz 2.08F/A, or

Cabrio--12-16oz 20EG/A, or
Pristine--12.5-18.5 oz 38WG/A

Belly Rot

Apply the following at the 1- to 3-leaf stage. Make a second application 10 to 14 days later or just prior to vine tip or whichever occurs first.

Quadris--11.0-15.4 fl oz 2.08F/A

Scab

Scab typically occurs during cool periods. Excellent resistance is available in some varieties and should be used when possible. Apply one of the following as true leaves form and repeat every 5 to 7 days.

chlorothalonil--2-3 pt 6F/A or OLF, or
mancozeb--2-3 lb 75DF/A

Cottony Leak (*Pythium*)

At planting apply:

mefenoxam--1-2 pt Ridomil Gold 4EC/A or 2-4 pt Ultra Flourish 2E/A. Apply in a 7-inch band after seeding. Use formula in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold or Ultra Flourish needed per acre.

Phytophthora Fruit Rot

To minimize the occurrence of this disease, rotate away from susceptible crops (such as cucurbits, peppers, lima and snap beans, eggplants, and tomatoes) for as long as possible. Fields should be adequately drained to ensure that soil water does not accumulate around plants. When conditions favor disease development, apply the following for suppression only and always tank mix with a fixed copper.

Forum--6 oz 4.18SC/A, (must be tank mixed with another fungicide active against Phytophthora blight on pumpkins and winter squash such as fixed copper), or

Gavel--1.5-2 lb 75DF/A, or

Tanos--8-10 oz 50DF/A, or

Ranman--2.75 fl oz 400SC/A (*plus* an adjuvant, see label for details)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Acramite	G	12	3
abamectin (Agri-mek)	R	12	7
Asana XL	R	12	3
Actara	G	12	0
Admire	G	12	21
Avaunt	G	12	3
<i>Bacillus thuringiensis</i>	G	4	0
Baythroid XL	R	12	0
Beleaf	G	12	0
bifenthrin	R	12	3
Danitol	R	24	7
Entrust	G	4	1
Fulfill	G	12	0
Furadan	R	48	AP
imidacloprid	G	12	21
Intrepid	G	4	3

(table continued)

Pesticide (<i>continued</i>)	Use Category ¹	Hours to Reentry ²	Days to Harvest
lambda-cyhalothrin	R	24	1
Lannate	R	48	3
Metasystox-R	R	48	3
Oberon	G	12	7
permethrin	R	12	0
Platinum	G	12	30
Radiant	G	4	1
Sevin	G	12	3
SpinTor	G	4	1
Thionex	R	24	2
Trigard	G	12	0
Venom (soil/foliar)	G	12	21/1
Vydate L	R	48	1
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Forum (Group 40)	G	12	0
Gavel (Groups 22+ M3)	G	48	5
mancozeb (Group M3)	G	12,24	5
Metastar	G	48	AP
Nova (Group 3)	G	24	0
Previcur Flex (Group 28)	G	12	2
Pristine (Groups 11 + 7)	G	12	0
Procure (Group 3)	G	12	0
Quadris (Group 11)	G	4	1
Ranman (Group 21)	G	12	0
Ridomil Gold (Group 4)	G	48	0
Tanos (Groups 11 + 27)	G	12	3
thiophanate-methyl (Group 1)	G	12	0
Ultra Flourish (Group 4)	G	48	0

See Table 3.

¹ G = general, R = restricted, AP=at planting

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

EGGPLANTS

Varieties

Varieties ¹	Specialty
Orient Express* (early oriental type)	
Ichiban* (oriental type)	
Machiaw (oriental type)	
Orient Charm (light purple)	
Ghostbuster (white)	
Cloud Nine (white)	
Millionaire* (oriental type)	
Viserba*	
Bharta (Indian type)	
Pushpa (Indian type)	
Rosita (lavender)	
Zebra* (lavender/ purple,white stripes)	

These varieties are recommended for DE, MD, NJ, PA, VA

(table continued next page)

Varieties

Varieties¹

Standard

Classic*	These varieties are recommended for DE, MD, NJ, PA, VA, WV
Nadia*	
Night Shadow*	
Classy Chassis*	
Santana*	

Local Hibush Selections

¹ Varieties listed by maturity, earliest first.

*Indicates hybrid varieties

Eggplant is a warm-season crop that makes its best growth at temperatures between 70° to 85°F (21.1° to 29.4°C). Temperatures below 65°F (18.3°C) result in poor growth and fruit set.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Eggplants	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
	125-150 ¹	250 ¹	150 ¹	100 ¹	250 ¹	150 ¹	100 ¹
	50-100 ²	250 ²	150 ²	100 ²	250 ²	150 ²	100 ²
	25-50 ³	0	0	0	0	0	0
	25-50 ⁴	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress 3-4 weeks after planting

⁴ Sidedress 6-8 weeks after planting

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Note: If crop is to be mulched with plastic but not drip/trickle fertilized, broadcast 225 pounds of nitrogen (N) per acre with recommended P₂O₅ and K₂O and disk-in or incorporate prior to laying mulch.

Drip/Trickle Fertilization: see below for drip/trickle fertilization guides.

Seed Treatment

Soak seed in hot water at 122°F (50°C) for 25 minutes. Dry seed then slurry or dust with thiram 75WP at the rate of 2/3 teaspoon per pound of seed (4 ounces per 100 pounds).

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 (21.1° to 23.9°C). 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 with a Thionex aerosol bomb before transplanting to field.

Transplanting Dates

Harden plants for a few days at 60° to 65°F (15.6° to 18.3°C) and set in field after danger of frost and when average daily temperatures have reached 65° to 70°F (18.3° to 21.1°C). Usual transplanting dates are May 15 to June 5.

Spacing

Rows: 4 to 5 feet apart; *plants:* 2 to 3 feet apart in the row. Space plants 18 to 30 inches apart in Pennsylvania and for late plantings in other areas

Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5 and then apply enough farm-grade fertilizer to supply 60 pounds per acre of N, P₂O₅ and K₂O. Then thoroughly incorporate into the soil. If soil tests medium or less in soil potassium, apply a fertilizer with a ratio of 1-1-2 or 1-1-3 carrying 60 pounds of nitrogen per acre.

After mulching and installing the trickle irrigation system, apply completely soluble fertilizers to supply 40 pounds (10 to 20 pounds in Pennsylvania) of N, P₂O₅ and K₂O per fertilized-mulched acre during each application (a description of a fertilized-mulched acre may be found in the "Irrigation" section of this publication). On soils testing low and low to medium in boron and that have not received any preplant boron fertilizer, include 0.25 pound of actual boron per fertilized-mulched acre in each soluble fertilizer application. For convenience, rates of fertilizer nutrients can be converted from a mulched acre to linear foot basis. See Table C-8.

The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting the eggplants. The same rate of soluble fertilizer should be applied about every 3 weeks during the growing season for a total of six to seven applications. In Pennsylvania, do not exceed 120 pounds of nitrogen per acre per season.

Mulching

Yields of eggplant can be increased up to 300 percent and maturity hastened by using clear plastic as a mulching material. Best results are obtained by fumigating with Vapam HL (45 gallons per acre) and immediately applying plastic (4 feet wide laid on 5 or 6-foot centers) about 30 days before crop is to be transplanted. Fumigation alone may not provide satisfactory weed control under clear plastic. Herbicides labeled and recommended for use on eggplants may not provide satisfactory weed control when used under clear plastic mulch on nonfumigated soil. Consult your county agent for latest recommendations. Container-grown plants are then planted through the plastic. At least 50 percent of the nitrogen (N) should be in nitrate form (NO₃) when planting in fumigated soil under plastic mulch.

Staking

High intensity eggplant production may benefit from staking. Consider the costs and economic returns. Use a staking system similar to that described in the "Tomatoes" section of this manual. Eggplants require a stake at each plant to support the plant and fruit load.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. See "Mulching" section above for further information on weed control under clear plastic mulch.

Apply postemergence herbicides when crop and weeds are within recommended size and/or leaf stage.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tube left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tube several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil

and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**

3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preemergence

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

Postemergence

DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre Dacthal 6F as a banded directed shielded spray 4 to 6 weeks after transplanting for preemergence weed control. Emerged weeds will not be controlled. Dacthal will not injure crop foliage. Spray broadcast when eggplants are grown without plastic mulch, or band between the rows when plastic mulch is used. Controls late season annual grasses, common purslane, and certain other broadleaf weeds.

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a **banded directed shielded spray to the soil strips between rows of plastic mulch ONLY**, to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). **DO NOT** use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. **DO NOT** apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate

(OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied in one year.**

Paraquat--0.6 lb/A. Apply 1.5 pints per acre Gramoxone Max 3SC or 2.4 pints per acre Gramoxone Inteon 2SC **as a banded directed shielded spray between the rows ONLY**, to control emerged grass and broadleaf weed seedlings. DO NOT allow the spray to contact plants as injury or residues may result. Use shields to prevent spray contact with crop plants. DO NOT exceed a spray pressure of 30 psi. Add a wetting agent as per label.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

For Transplanting Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **planting into soil without plastic mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Preplant Incorporated

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or and activate with one-half inch of sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

Trifluralin--0.5-1 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Trilin in Maryland.** Apply 1 to 2 pints per acre Trilin prior to transplanting. Incorporate to a depth of 3 inches. Use the lower rate on coarse-textured soils low in organic matter, and the higher rate on fine-textured soils with high organic matter. Avoid planting during periods of cold, wet weather to reduce the risk of temporary stunting.

Postemergence

DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre Dacthal 6F 4 to 6 weeks after transplanting for preemergence weed control. Emerged weeds will not be controlled. Dacthal will not injure crop foliage. Spray broadcast when eggplants are grown without plastic mulch, or band between the rows when plastic mulch is used. Controls late season annual grasses, common purslane, and certain other broadleaf weed.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

**Postharvest
With or Without Plastic Mulch**

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Insect Control

Aphids

Actara--2-3 oz 25WDG/A, or
 Assail--2-4 oz 30SG/A, or
 Beleaf--50 SG (see label for rate)
 Fulfill--2.75 oz 50WDG/A, or
 imidacloprid (soil, foliar)--see label for rates and application methods, or
 Knack--6-8 fl oz 0.86E/A (use only in combination with 0.66-1.33 lb Orthene 75S), or
 Lannate--1.5-3 pt LV/A (green peach aphid only) or OLF, or
 malathion--1 pt 57EC/A, or
 Metasystox-R--2 pt 2SC/A, or
 Platinum--5-8 oz 2SG/A, or
 Thionex--1.33 qt 3EC/A or OLF, or
 Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A, or
 Vydate L--1-2 qt 2L/A

Colorado Potato Beetle (CPB)

CPB has the ability to rapidly develop resistance to insecticides; thus, see the section on "How to Improve Pest Control" for information on resistance management practices. The use of the egg parasitoid, *Edovum puttleri*, has been shown to control CPB effectively in eggplant.

Actara--2-3 oz 25WDG/A or
 Assail--1.5-2.5 oz 30SG/A, or
 Admire (generics available)--16-24 fl oz 2F/A, or
 Assail--1.5-2.5 oz 30SG/A, or
Bacillus thuringiensis tenebrionis (small CPB larvae only—

Novodor, Raven)--Consult label for rates and restrictions. **Note.** Larval reduction may not be noticeable for 48 to 72 hours after application.

Make first application when eggs begin to hatch and repeat applications at 5- to 7-day intervals if small larvae are present. NOT effective against medium larvae and adults. If rainfall occurs within 24 hours post-treatment, reapplication may be necessary, or

cryolite (Kryocide, Prokil cryolite)--10-12 lb 96WP/A, or Entrust--1-2 oz 80W/A,
 imidacloprid (soil, foliar)--see label for rates and application methods, or
 Platinum--5-8 oz 2SC/A, or
 Radiant--5-10 fl oz SC/A, or
 SpinTor--3-6 fl oz 2SC/A, or
 Thionex--1.33 qt 3EC/A or OLF, or
 Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A, or
 Vydate L--1-2 qt 2L/A

Flea Beetles (FB)

Actara--2-3 oz 25WDG/A or
 Baythroid XL -- 2.8 fl oz/A, or
 cryolite (Kryocide, Prokil cryolite)--10-12 lb 96WP/A or imidacloprid (soil, foliar)--see label for rates and application methods, or
 lambda-cyhalothrin--2.56-3.84 fl oz or OLF, or
 Mustang MAX--2.24 - -4.0 fl oz/A, or
 Platinum--5-8 oz 2 SC/A, or
 Proaxis--2.56-3.84 fl oz, or
 Thionex--1.33 qt 3EC/A or OLF, or
 Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A, or
 Vydate L--1-2 qt 2L/A

Leafminers, Eggplant Lacebug

Entrust--2-2.5 oz 80W/A, (leafminer only), or
 malathion--1 qt 57EC/A (lacebug only), or
 Radiant--6-10 fl oz SC/A (LM only), or
 SpinTor--6-8 fl oz 2SC/A(leafminer only), or
 Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A, (leafminer only), or
 Vydate L--1-2 qt 2L/A

Mites

Acramite--0.75-1.0 lb 50WS/A, or
 bifenthrin--5.12-6.4 fl oz 2EC/A or OLF, or
 Metasystox-R--2 pt 2SC/A, or
 Oberon--7.0-8.5 oz 2SC/A, or
 Vendex--2-4 pt 4L/A or 2-4 lb 50WP/A, or
 Vydate L--1-2 qt 2L/A

Thrips

Entrust--1.25-2.5 oz 80W/A, or
 Spintor--4-8 oz 2SC/A

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
INSECTICIDE			
Acramite	G	12	12
Actara	G	12	0
Assail	G	12	7
<i>Bacillus thuringiensis</i>	G	4	0
Baythroid XL	R	12	7
Beleaf	G	12	0
bifenthrin	R	12	7

(table continued on next page)

Pesticide (continued)	Use Category ¹	Hours to Reentry	Days to Harvest
cryolite	G	12	0
Entrust	G	4	1
Fulfill	G	12	0
imidacloprid (soil/foliar)	G	12	21/7
Mustang MAX	R	12	1
Knack	G	12	14
Lannate	R	48	5
lambda-cyhalothrin	R	24	5
malathion	G	12	3
Metasystox-R	R	24	7
Oberon	G	12	7
Platinum	G	12	30
Proaxis	R	24	5
Radiant	G	4	1
SpinTor	G	4	1
Thionex	R	24	1
Vendex	R	48	3
Venom (soil/foliar)	G	12	21/1
Vydate L	R	48	1, 7 ²
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
copper, fixed (Group M1)	G	24	0
Flint (Group 11)	G	12	0
Forum (Group 40)	G	12	0
maneb (Group M3)	G	12	5
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	12	7
Ultra Flourish (Group 4)	G	12	7

See Table D-6.

1 G = general, R = restricted

2 1 day (foliar application) or 7 day (soil application)

Nematode Control

See "Nematodes" section of Soil Pests-Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section, or

Disease Control

Damping-Off

Control is obtained by using the seed treatment previously stated and planting in a sterile mix. Consideration should be given to using soilless mixes containing microorganisms that suppress damping-off fungi.

SoilGard 12G--1-1.5 lb/cu yd of soilless mix.

SoilGard is a naturally occurring soil fungus which is an antagonist to plant pathogenic fungi. Uniformly add SoilGard 12G when soilless mixes are being blended by mechanical devices. After one day of incubation, seed or transplants can be added to the treated mix.

Verticillium Wilt

Best control can be accomplished by a 4- to 5-year rotation with crops other than tomato, potato, pepper, strawberry, or any of the brambles. Varieties which appear to maintain yield in infested fields include Classic, Epic, Vernal, and Viserba.

Soil fumigation will provide some control by delaying symptom expression. Refer to the "Soil Fumigation" section for details on application. Use metam-sodium (Vapam HL at 56 to 75 gallons per acre) with a plastic seal.

Broadcast treatments are superior to row treatments.

Grafting Verticillium resistant tomato rootstocks to susceptible eggplant varieties is a viable strategy to reduce the impact of disease.

Before grafting: 1) expose the scion and rootstock to sunshine for two to three days, 2) withhold water from the plants to avoid spindly growth and 3) make sure that the scions and rootstock have stems of a similar diameter. Grafted plants are usually healed and acclimated in a plastic tunnel. The healing and acclimatization are very important for grafted plants to survive. The tunnel is covered with materials that provide shade and maintain a high relative humidity inside the tunnel.

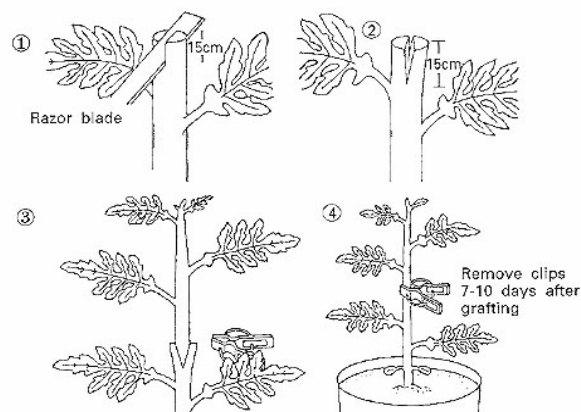


Figure F-1 Schematic Diagram of Cleft Grafting

Leaf Spots and Fruit Rots

Begin sprays when disease first appears and repeat every 7 to 10 days. Use the following:

Alternate one of the following FRAC code 11 fungicides:

Quadris -- 6.2 to 15.4 fl oz 2.08F/A, or
Cabrio--8-12 oz 20EG/A (leaf spots only), or
Flint--2-4 oz 50 WDG/A

With:

maneb--1.5-2 lb 75DF/A or OLF

Do not make more than 4 total applications of the FRAC code 11 fungicide group in a year

Tomato Spotted Wilt Virus (TSWV)

TSWV is spread by thrips from flowering ornamental plants to eggplant. Do not grow any ornamental bedding plants in the same greenhouse as eggplant transplants. Monitor and scout greenhouses for thrips and begin an insecticide control program once observed.

Phytophthora Blight (Phytophthora capsici)

The pathogen causes collar rot, fruit rot, and stem cankers. To minimize the occurrence of this disease, rotate away from susceptible crops (cucurbits, peppers, eggplants, and tomatoes) for as many years as possible. For control of collar rot, plant onto raised beds and use the following:

mefenoxam--1 pt Ridomil Gold 4EC/A or 1 qt Ultra Flourish 2E/A. Apply broadcast prior to planting or in a 12- to 16-inch band over the row before or after transplanting.

Make two supplemental post-directed applications at 1 pt/A Ridomil Gold or 1 qt/A Ultra Flourish to 6 to 10 inches of soil on either side of the plants at 30-day intervals. Use formula in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold or Ultra Flourish needed per acre when band applications are made.

For suppression of the stem and fruit rot phase of *Phytophthora* blight, apply the following on a 7 to 10 day schedule. When environmental conditions are conducive for disease shorten the interval to 5-7 days:

Forum--6 fl oz 4.18SC/A plus copper, fixed--2 lb 77WP/A or OLF

Harvesting

Fruits should be harvested when the outside color is still a glossy purple and the seed and pulp are white. Soft fruit and dark seed indicate overmaturity. Fruits must be harvested as they reach maturity to ensure continued fruit set.

GARLIC

Varieties

Obtain the best strains of Italian or German (late or pink-skinned type) "Rocamboles" garlic, or Polish softneck (no hard seed stalk) types that will braid, or elephant types from a local grower who has had success with fall-planted garlic. Unlike many strains sold commercially, such a strain will be hardy and, therefore, will overwinter very well. Avoid the Creole types (also called Early, Louisiana, White Mexican, etc.), since 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. The Italian and Elephant types take about 220 days to mature.

Many of the most productive Italian garlic strains will produce seed stalks prior to harvest. Snap these seed stalks just as they begin to coil for best yields. "Rocamboles" types have coiled seedstalks that are perfectly normal and not the result of any poor cultural practice or herbicide contamination.

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 per acre nitrogen (N), 150 pounds per acre phosphate (P₂O₅) and 150 pounds per acre potash (K₂O) and disk about 6 inches deep before planting. When plants are approximately 6 inches tall (about March 15), topdress with 25 pounds per acre nitrogen and repeat the topdressing about May 1. Apply all topdressings to dry plants at midday to reduce chance of fertilizer burn.

Since sulfur may be partially associated with the extent of pungency, you may wish to use ammonium sulfate for the last topdressing (May 1).

Although garlic is commonly grown on muck or light soils, heavier soils will do fine, as long as they are loose and friable (through use of organic matter or cover cropping).

Planting

Garlic cloves should be planted between about September 15 and October 25 in Central Pennsylvania. They could be planted up to 10 days earlier in the cool, short-season areas and up to 3 weeks later in the warm, long-season areas. Fall-planted garlic establishes an excellent root system and receives a natural cold treatment that produces the highest possible garlic yields. Cloves must be exposed to temperatures between 32° and 50°F (0° and 10°C) for about 2 months prior to the long day-length periods that induce bulbing. Therefore, spring-planted garlic (e.g., Elephant type) may be fairly successful where it can be planted by early March.

Garlic yields tend to increase as the size of the mother bulb increases. The long, slender cloves in the center of the bulb, cloves weighing less than 1 gram, and bulbs with side growths and very poor skin covering of cloves should not be used for planting.

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 1½ 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 optimum results. Cloves dropped into furrows are likely to lie in all positions and may produce plants with crooked necks.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crops and weeds are within recommended size and/or leaf stage.

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Postemergence

Bromoxynil—0.125-0.25 lb/A. Apply 4 to fluid ounces per acre Buctril 4E when weeds are 1 to 2 inches tall and the garlic is less than 12 inches tall. Use the lower rate on small weeds and the higher rate on larger weeds or when they are under stress. Use 40 to 100 gallons of spray solution per acre.

Concentrated spray solutions increase the risk of crop injury. Good coverage of the weeds is essential for good control. Do not apply within 112 days of harvest when garlic is grown on mineral soil. Do not apply within 60 days of harvest when garlic is grown on muck soil.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 45 days and apply no more than 32 fluid ounces per acre in one season.

Fluazifop--0.125-0.188 lb/A. Apply 0.5 to 0.75 pints per acre Fusilade DX 2E with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge, wild onion, or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 45 days and apply no more than 6 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for

postharvest desiccation of the crop in Delaware, New Jersey and Virginia. Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Beet Armyworm (BAW)

Entrust--1-2 oz 80W/A, or
Lannate--1.5 pt LV/A or OLF, or
Radiant--5-10 oz SC/A, or
Spintor--3-6 fl oz 2SC/A

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 "Insect Control" section under Onions. Read and follow specific label directions for use on garlic; if not listed, do not use.)

lambda-cyhalothrin--3.84 fl oz/A or OLF, or
Mustang MAX--4.0 fl oz/A, or
malathion--2 pt 57EC/A, or
permethrin--12 fl oz 3.2 EC/A, or OLF, or
Proaxis--3.84 fl oz/A

Note: Use of Entrust or Spintor for BAW control will suppress Thrip population.

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Entrust	G	4	1
lambda-cyhalothrin	R	24	14
Lannate	R	48	7
Mustang MAX	R	12	7
malathion	G	12	3
permethrin	R	12,24	1
Proaxis	R	24	14
Radiant	G	4	1
Spintor	G	4	1
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	7
chlorothalonil (Group M5)	G	12	7
Endura (Group 7)	G	12	7
Forum (Group 40)	G	12	0
Pristine (Groups 11 + 7)	G	12	7
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	12	7
Rovral (Group 2)	G	24	0

See Table 3.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Disease Control

Damping-off.

Apply the following in a 7-inch band after seeding. Use formula given in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating

Granular Application Equipment to determine amount of Ridomil Gold needed per acre.

Ridomil Gold--0.5-1 pt 4EC/A

White Rot

At planting, apply a furrow treatment of iprodione (Rovral 50WP--2.67 pounds in 50 to 100 gallons per acre or OLF) based on a 38 to 40 inch row spacing; spray both the cloves and the covering soil used to fill the furrow. In treated fields, do not grow crops other than garlic and leafy vegetables during the harvest year, and do not grow garlic, leafy vegetables, tomatoes, root crops, cereal grains, or soybeans during the following year.

Botrytis Leaf Blight (Blast)

Apply the following when conditions favor disease development and repeat twice at 7- to 10-day intervals.

chlorothalonil--1.5 to 3 pt 6F/A or OLF, or
Endura--6.8 oz 70WG/A, or
Pristine--14.5-18.5 oz 38WG/A

Do not make more than 2 consecutive applications of Endura or Pristine before switching to a fungicide with a different mode of action.

Purple Blotch and Downy Mildew

Apply one of the following when conditions favor disease development and repeat at 7 to 10 day intervals.

Forum--6.0 fl oz 4.18SC/A (for downy mildew only; must be tank-mixed with chlorothalonil), or
Quadris--6.2--12.3 fl oz 2.08F/A for Purple blotch or 9.2--15.4 fl oz 2.08F/A for Downy mildew
Cabrio--8-12 oz 20EG/A, or
chlorothalonil--1.5-3 pt 6F/A or OLF, or
Endura--6.8 oz 70WG/A, or
Pristine--18.5 oz 38WG/A

Do not make more than 2 consecutive applications of either Cabrio, Endura, Forum, Pristine or Quadris before switching to a fungicide with a different mode of action.

Harvesting and Storage

Fall-planted garlic in central Pennsylvania is ready to harvest about the second week in July. 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 optimum garlic harvest. Before then, the garlic is unsegmented like an onion; 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.

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. 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 (15.6° to 32.2°C) is satisfactory. However, garlic is best stored under temperature and humidity conditions required for onions (32° to 35°F [0° to 1.67°C] and 65 percent relative humidity). Garlic cloves sprout quickly after bulbs have been stored at temperatures near 40°F (4.4°C), so avoid pro-longed storage at this temperature. Garlic stored at above 70 percent relative humidity at any temperature not only molds but also begins to develop roots.

Marketing

New growers should develop a local retail market (road-side 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, DC; 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 big 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

Varieties¹

Mustard Greens

Tendergreen (Fall only)
Savanna*
Green Wave (Fall only)
Southern Giant Curled (Fall only)

These varieties are
Recommended for DE,
MD, NJ, PA, VA, WV

Turnip Greens

All Top (Fall processing)
Alamo* (processing)
Top Star* (Fall) (trial)
Shogoin (Fall only)(DMR,MR)
Topper* (Fall)

¹ Varieties listed by maturity, earliest first.

* Indicates hybrid variety

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Greens, (Mustard, Turnip)	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
	50-80 ¹	150 ¹	100 ¹	50 ¹	150 ¹	100 ¹	50 ¹
	50 ²	150 ²	100 ²	50 ²	150 ²	100 ²	50 ²
	25-30 ³	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress if needed

Seeding

Seed in early- to mid-August. In Pennsylvania and other cool areas, the Savanna variety can be seeded March 15 to April 20. Sow 3 to 4 pounds of seed per acre in rows 16 to 24 inches apart.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil types and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within recommended size and/or leaf stage.

Preplant Incorporated

Trifluralin--0.5-0.75 lb/A (processing turnip greens only and all mustard greens). Apply and incorporate Treflan 4EC before planting at a broadcast rate of 1 pint per acre on coarse and medium soils and 1.5 pints per acre on fine soils. Incorporate within 8 hours into top 2 to 3 inches of soil.

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre of Dacthal 6F as a preemergence treatment at seeding

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated

applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Clopyralid--0.047-0.188 lb/A. Apply 2 to 8 fluid ounces of Stinger 3A per acre in one (turnip greens) or two (mustard greens) applications to control certain annual and perennial broadleaf weeds. Do not exceed 8 fluid ounces in one year. Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 8 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days. Stinger is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season. **Labeled for use in mustard greens only! Do not use for weed control in turnip greens.**

Postharvest

Paraquat--0.6 lb/A. A **Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control**Aphids**

Actara--1.5-3.0 oz 25WDG/A, or imidacloprid (soil, foliar)--see label for rates and application methods (mustard and rape greens only), or Assail--2-3 oz 30SG/A (mustard and rape greens only), or Beleaf--50SG (see label for rate), or Thionex--1-1½ qt 3EC/A (mustards only) (one application per season)

Leafhoppers

Baythroid XL--0.8-1.6 fl oz /A, or dimethoate--0.5 pt 4EC/A or OLF, or Sevin--0.67-1.25 lb 80S/A

Leafminers

Entrust--1.25-3 oz 80W/A
dimethoate--0.5 pt 4EC/A or OLF, or Radiant--6-10 fl oz SC/A, or SpinTor--6-10 fl oz 2SC/A

Flea Beetles

Actara--1.5-3.0 oz 25WDG/A, or Baythroid XL--2.4-3.2 fl oz/A, or Sevin--0.67-1.25 lb 80S/A or OLF

Note. Use of imidacloprid for aphids will reduce flea beetle populations.

Beet Armyworm

Avaunt--3.5 oz 25WDG/A, or Confirm (mustards only)--6-8 fl oz 2F/A, or Entrust--1.25-3.0 oz 80W/A, or Lannate--3 pt LV/A or OLF, or Proclaim--2-4-4.8 5SG/A, or Radiant--5-10 fl oz SC/A, or SpinTor--4-8 fl oz 2SC/A

Cabbage Looper (CL), Imported Cabbageworm (ICW)

Avaunt--2.5-3.5 oz 25WDG/A, or *Bacillus thuringiensis*--Consult label for rates and restrictions, or Baythroid XL--1.6-2.4 fl oz /A or Entrust--1.0-2.0 oz 80W/A, or Intrepid--4-8 fl oz 2F/A, (early season), 8-10 fl oz 2F/A (late season), or Lannate--1.5-3 pt LV/A or OLF, or Radiant--5-10 fl oz SC/A, or SpinTor--4-8 fl oz 2SC/A

Diamondback Moth Caterpillar

Avaunt--3.5 oz 25WDG/A, or *Bacillus thuringiensis*--Consult label for rates and restrictions, or Entrust--0.5-1.25 oz 80W/A, or Lannate--1.5-3 pt LV/A or OLF, or Proclaim--2.4-4.8 5SG/A, or Radiant--5-10 fl oz SC/A, or SpinTor--4-8 fl oz 2SC/A

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Actara	G	12	7
Assail	G	12	7
Avaunt	G	12	3
<i>Bacillus thuringiensis</i>	G	4	0
Baythroid XL	R	12	0
Beleaf	G	12	0
Confirm	G	4	7
dimethoate	R	48	14
Entrust	G	4	1
imidacloprid (soil/foliar)	G	12	21/7
Intrepid	G	4	1
Lannate	R	48	10
Proclaim	R	48	14
Radiant	G	4	1
Sevin	G	12	14
SpinTor	G	4	1
Thionex	R	24	21
FUNGICIDE (FRAC code)			
Aliette (Group 33)	G	12,24	3
Cabrio (Group 11)	G	12	0/3
copper, fixed (Group M1)	G	24	0
Forum (Group 40)	G	12	0
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	12	0

See Table D-6.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Disease Control

Damping-Off (caused by *Pythium* or *Phytophthora spp.*).

Apply the following preplant incorporated or as a soil-surface spray after planting.

Ridomil Gold--1-2 pt 4EC/A (turnip greens only)

Downy Mildew

Apply the following during periods of high moisture and moderate temperatures (for disease suppression) and continue every 14 days.

Forum--6.0 fl oz 4.18SC/A *plus* fixed copper, or Aliette--3 lb 80WDG/A (for mustard greens only)

Leaf Spot

Practice crop rotation with crops other than crucifers. When conditions favor disease development, alternate the following every 7 to 10 days.

Quadris--6.2-15.4 oz 2.08F/A, or Cabrio--8-16 oz 20EG/A, or copper, fixed--0.75-1.5 lb 53.8DF/A or OLF

HORSERADISH

Horseradish is a hardy perennial belonging to the mustard family. The fleshy, white root roughly resembles the parsnip in shape. Use local selected strains that are adapted to the area.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Horseradish	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
Horseradish	150-200 ¹	200 ¹	150 ¹	100 ¹	200 ¹	150 ¹	100 ¹
Loamy sands and Sandy loams	50 ²	200 ²	150 ²	100 ²	200 ²	150 ²	100 ²
	50-100 ³	0 ³	0 ³	0 ³	0 ³	0 ³	0 ³
	50 ⁴	0 ⁴	0 ⁴	0 ⁴	0 ⁴	0 ⁴	0 ⁴
Loams and silt loams	100-150 ¹	200 ¹	150 ¹	100 ¹	200 ¹	150 ¹	100 ¹
	100 ²	200 ²	150 ²	100 ²	200 ²	150 ²	100 ²
	50 ⁵	0 ⁵	0 ⁵	0 ⁵	0 ⁵	0 ⁵	0 ⁵

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

¹ Total amount nutrient recommended

² Suggested method of application broadcast and disk-in

³ Sidedress 3-5 weeks after planting

⁴ Sidedress later in season if needed

⁵ Sidedress 4-6 weeks after planting if needed

Sets for Planting

Sets are selected roots from the previous crop. They should be 10 to 12 inches long and 1/4 to 5/8 inch in diameter. To ensure proper orientation of roots at planting, make a square cut at the end of the root nearest the main root, and at the other end make a slanting cut.

Planting and Spacing

Plant in late April to early May. Place sets at an angle in a furrow so the top end will be 1 inch deep and the bottom 2 inches deep. Sets should point in the same direction that the cultivator will go, e.g., for two-row cultivator, two rows in one direction and the next two rows in the opposite direction. Space rows 34 to 36 inches apart with 18 inches between sets in the row.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil types and percent organic matter in each field.

Preemergence

DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre Dacthal 6F immediately after planting to control annual grasses and some broadleaf weeds.

Oxyfluorfen--0.5 lb/A. Apply 2.5 pints per acre Goal 2XL immediately after planting to control certain broadleaf weeds. Emerged plants which receive direct or indirect (drift) spray contact will be injured. It may be desirable to cultivate immediately prior to application to remove germinated weeds. Delay cultivation after Goal application, when possible, to reduce deactivation of Goal by incorporation. Do not use Goal 2XL herbicide on horseradish plantings which

are weak or under stress due to temperature, disease, fertilizer, nematodes, insects, pesticides, drought, or excessive moisture.

S-metolachlor--0.95-1.9 lb/A. A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E in New Jersey. The use of this product is legal ONLY if a waiver of liability provided by the local growers' association has been signed by the grower, all fees have been paid, and a label has been provided by the association. Apply 1 to 2 pints per acre Dual Magnum 7.62E after planting, but before weeds or crop emerge to control annual grasses, yellow nutsedge, and certain broadleaf weeds, including galinsoga. Dual Magnum will NOT control emerged weeds. Use the lower rate on coarse textured soils low in organic matter, and the higher rate on fine textured soils and soils high in organic matter. Read and follow all notes and precautions on the label. DO NOT incorporate Dual Magnum prior to planting. Make only one application per crop. Observe a minimum preharvest interval of 64 days after application. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Sethoxydim--0.2-0.5 lb/A. Apply 1 to 2.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may

result. Observe a minimum preharvest interval of 60 days and apply no more than 5 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Aphids

imidacloprid (soil, foliar)--see label for rates and application methods
Lannate--1.5 pt LV/A (apply with ground equipment only) or OLF, or
malathion--1-2 pt 57EC/A or OLF

Cutworms

Sevin Bait--40 lb 5% bait/A

Flea Beetles, Harlequin Bugs

imidacloprid (soil, foliar)--see label for rates and application methods (flea beetle only), or
Sevin--0.63-1.25 lb 80S/A or OLF

Imported Cabbageworm

Bacillus thuringiensis--Consult label for rates and restrictions.

Leafhoppers

imidacloprid (soil, foliar)--see label for rates and application methods, or
Sevin--1.25-2.5 lb 80S/A or OLF

Note. Some species of leafhopper are known to transmit brittle-root disease of horseradish.

Thrips

Entrust--1-2 oz 80W/A, or
Lannate--1.5 pt LV/A (apply with ground equipment only) or OLF, or
Radiant--6-8 fl oz SC/A, or
SpinTor--4.5-6 fl oz 2SC/A

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
<i>Bacillus thuringiensis</i>	G	4	0
Entrust	G	4	3
imidacloprid (soil/foliar)	G	12	21/7
Lannate	R	48	65
malathion	G	12	7
Radiant	G	4	3
Sevin/Sevin Bait	G	12	7
SpinTor	G	4	3
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	12	0

See Table D-6.

¹G = general, R = restricted

Disease Control

Damping-Off (caused by *Pythium* and *Phytophthora*)

Apply the following preplant incorporated or as a soil-surface spray after planting.

Ridomil Gold--1-2 pt 4EC/A

Bacterial Leaf Spot

Rotate to allow 2 years between horseradish plantings. Avoid cultivation or other activity when foliage is wet to minimize spread of the disease.

Cercospora Leafspot, Downy Mildew, Ramularia Leafspot, and White Rust

Practice crop rotation with crops other than crucifers. When conditions favor disease development, apply the following and repeat every 7 to 14 days. Do not make more than two applications.

Quadris--6.2-15.4 fl oz 2.1F/A), or
Cabrio--8-16oz 20EG/A (white rust only)

LEEKs

Varieties

Varieties¹

Arkansas	These varieties are recommended in areas of DE, MD, NJ, PA, VA, WV where climatic conditions are favorable for leek production.
Carina	
Leefall	
Leekool	
Leekwik	
Otina	
Winora	

¹ Varieties listed alphabetically.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Leeks	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre	Pounds P ₂ O ₅ per Acre	Pounds P ₂ O ₅ per Acre	Pounds K ₂ O per Acre	Pounds K ₂ O per Acre	Pounds K ₂ O per Acre
	100-125 ¹	200 ¹	150 ¹	100 ¹	200 ¹	150 ¹	100 ¹
	50-75 ²	200 ²	150 ²	100 ²	200 ²	150 ²	100 ²
	25-50 ³	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress 3-4 weeks after planting if needed

Apply 3 - 4 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Transplants

Southern transplants are used for early spring plantings. For summer planting, sow in seedbeds from early April to mid-May. 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 12 to 16 weeks before field setting. Plants will be ready to set in early August.

Field Spacing

Rows: 20 to 30 inches apart; plants: 4 to 6 inches apart in the row. Set plants in trenches 3 to 4 inches deep using celery-type planter.

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.

Harvesting and Storage

Spring-transplanted leeks are ready for harvest in July. August-planted leeks are ready for harvest by November or can be wintered over. Half-mature leeks of the hardy varieties will stand winter freezing with some protection such as salt hay or straw. They will be ready early in the spring.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within recommended size and/or leaf stage.

Postemergence

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Onion Maggot

diazinon--2-4 qt AG500/A preplant or 1 qt AG500/A in-furrow at planting
malathion--2.24-4.0 pt 57EC/A (flies only)
Mustang MAX--2.24-4 fl oz/A (flies only)

Thrips, Aphids

Entrust (suppression only)--1-2 oz 80W/A (thrips only), or Mustang MAX--2.88-4.0 fl oz/A, or malathion--1.5-3 pt 57EC/A, or Radiant--6-10 fl oz SC/A, or Spintor (suppression only)--4-8 fl oz 2SC/A (thrips only)

Armyworms, Cutworms, Cabbageworm, Loopers

Bacillus thuringiensis--Consult label for rates and restrictions., or Entrust--1-2 oz 80W (armyworms and loopers only), or Mustang MAX--2.24-4.0 fl oz/A, or Spintor--3-6 fl oz 2SC/A (armyworms and loopers only)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
<i>Bacillus thuringiensis</i>	G	4	0
diazinon	R	24	-
Entrust	G	4	1
Mustang MAX	R	12	7
malathion	G	12	3
Radiant	G	4	1
Spintor	G	4	1
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	7
chlorothalonil (Group M5)	G	12	14
Endura (Group 7)	G	12	7
Forum (Group 40)	G	12	0
Pristine (Groups 11 + 7)	G	12	7
Quadris (Group 11)	G	4	0

See Table D-6.

¹ G = general, R = restricted

²Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Disease Control

Purple Blotch and Downy Mildew

Begin in fall as soon as transplants are set out. Alternate the following at 10-day intervals as long as night temperatures are warm.

Alternate:

Forum--6 fl oz 4.18SC/A (for downy mildew only; must be tank mixed with another fungicide effective for downy mildew) or chlorothalonil--1.5-3 pt 6F/A or OLF; (do not apply chlorothalonil more than three times per season)

With one of the following fungicides:

Quadris--6.2-12.3 fl oz 2.08F/A for purple blotch, or Quadris--9.2-15.4 fl oz 2.08F/A for downy mildew, or Cabrio--8-12 oz 20EG/A, (use 12 oz/A for downy mildew), or Pristine--10.5-18.5 oz 38WP/A (for purple blotch) or 18.5 oz 38WP/A for downy mildew suppression, or Endura--6.8 oz 70WG/A (for purple blotch only)

Materials with different modes of action (FRAC code) should always be alternated

White Rot

This disease is severe only on overwintered leeks. Practice crop rotation and use preplant soil fumigation with one of the materials listed in the "Soil Fumigation" section.

LETTUCE, ENDIVE, AND ESCAROLE

Lettuce and endive are cool-season crops. Properly hardened lettuce transplants can tolerate temperatures as low as 20° to 25°F (-6.67° to -3.89°C). Temperatures above 85°F (29.4°C) for several days will cause seedstalk formation and bolting in lettuce. Temperatures below 70°F (21.1°C) during the seedling stage promote premature seedstalk formation in endive and escarole.

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Lettuce: Bibb, Boston and Butterhead Types					
Ermosa (DMR,LMV,TBR)			N	P	V
Buttercrunch	D		N	P	V
Odyssey (TBR)				P	
Esmeralda	D	M	N	P	
Optima			N	P	
Bennett				P	
Harmony (DMR,TBR)				P	
Summer Bibb	D		N	P	V
Lettuce: Iceberg Types					
Summer Time				P	
Ithaca (spring)	D	M	N		
Ithaca (fall)	D	M	N	P	
Maverick II (spring and fall)			N	P	
Mesa 659 (fall)	D	M	N	P	
Lettuce: Leaf Types					
Grand Rapids (TBR)	D	M	N	P	V
Royal Green (TBR)	D	M	N	P	V
New Redfire			N	P	V
Red Sails (Direct Market)					
Salad Bowl (Direct Market)	D	M		P	
Royal Oakleaf				P	
Waldmann's Green	D		N	P	
Tropicana				P	
Lettuce: Leaf Types (continued)					
Two Star			N	P	V
Red Express (trial)				P	
Lettuce: Romaine (COS) Types					
Ideal Cos (spring,fall)(TBR)			N	P	V
Green Forest (CRR,TBR)	D		N	P	V
Coastal Star (CRR)				P	
Rouge de Hiver (red)(fall)				P	
Capistrano (TBR)				P	
Pyramid Cos			N	P	
Lettuce: Batavia Types					
Magenta (red)				P	
Nevada				P	

(table continued)

Varieties (continued)

Varieties ¹	DE	MD	NJ	PA	VA
Endive					
Green Curled	D		N	P	V
Salad King	D		N	P	
Escarole					
Florida Deep Heart	D		N	P	
Full Heart Batavian	D		N	P	V

¹ Varieties listed by maturity, earliest first.

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Crop	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre	Pounds P ₂ O ₅ per Acre	Pounds P ₂ O ₅ per Acre	Pounds K ₂ O per Acre	Pounds K ₂ O per Acre	Pounds K ₂ O per Acre
Leaf Lettuce	100-125 ¹	200 ¹	150 ¹	100 ¹	200 ¹	150 ¹	100 ¹
Endive,	50-75 ²	200 ²	150 ²	100 ²	200 ²	150 ²	100 ²
Escarole	25-50 ³	0	0	0	0	0	0
Iceberg Lettuce	60-80 ¹	200 ¹	150 ¹	100 ¹	200 ¹	150 ¹	100 ¹
	25-50 ²	200 ²	150 ²	100 ²	200 ²	150 ²	100 ²
	25-30 ³	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress 3-5 weeks after planting

Seed Treatment

Dust seed with thiram 65WP at the rate of 1 level teaspoon per pound of seed (3 ounces per 100 pounds).

Seeding and Transplanting

Spring crop. The early endive crop is usually grown from transplants shipped into the state. Lettuce transplants are started in frames or greenhouses. Seed for the lettuce crop is sown in frames in November, in unheated greenhouses in December, and in heated greenhouses in January and February at the rate of 4 to 6 ounces of seed for 1 acre of plants. Plants are ready for field planting early in March.

Direct-seeded lettuce is sown in prepared beds as early in the spring as the ground can be worked. Seed should be sown shallow-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 [26.7°C]) until germination occurs. The spring lettuce crop can be field-seeded through May. In Maryland, field-seeding in May results in seed stalk formation. Only leaf lettuce should be seeded as late as May. Successive plantings of endive can be made through the middle of August.

Fall lettuce crop. Seed in the field July 25 to August 10 in Pennsylvania and other cool areas, and August 5 to 20 in warmer areas.

Spacing

Lettuce. Head lettuce is planted in rows 2 feet apart with plants 12 to 15 inches apart in the row. Leaf and Boston 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.

Endive. 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.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within recommended size and/or leaf stage.

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Pronamide--1-2 lb/A. Apply 2 to 4 pounds per acre Kerb 50W to seeded or transplanted lettuce. Labeled for all types of lettuce plus endive and escarole. Irrigation (1 to 2 inches) should follow application. Primarily controls annual grasses and certain broadleaf weeds. Unlabeled crops should not be planted for 3 to 12 months, depending on herbicide rate used and crop. See label. Labeled crops include artichokes, lettuce, endive, and escarole

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For

best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days (head types) or 15 days (leaf types) and apply no more than 3 pints per acre in one season. Labeled for head and leaf-type lettuces.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Note: Not all pesticides are labeled for each crop in this section. Refer to Days to Harvest Table at the end of this section to determine which pesticides are labeled on specific crops.

Cutworms (Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Baythroid XL--0.8-1.6 fl oz /A, or
Lannate--1.5 pt LV/A or OLF, or
Mustang MAX--2.24-4.0 fl oz/A, or
permethrin--4-8 fl oz 3.2EC/A or OLF, or
Renounce--1-2 oz 20WP or OLF, or
Sevin Bait--20-40 lb 5% bait/A

Thrips

Several species of thrips spread Tomato Spotted Wilt Virus. Scout for thrips and begin treatments when observed. Do not produce vegetable transplants with bedding plants in the same greenhouse. **Note.** Use of lambda-cyhalothrin (Warrior;generics available) for other pests will reduce the thrips population.

Baythroid XL--0.8-1.6 fl oz /A, or
Lannate--1.5-3 pt LV/A or OLF, or
Mustang MAX--3.2-4.0 fl oz/A, or
Radiant--6-10 fl oz SC/A, or
Renounce--1-2 oz 20WP or OLF

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 four to five times at 5-day intervals.

acephate (Orthene, generics)--0.5-1.0 lb 97S/A, or
Actara--1.5-3 oz 25WDG/A, or
Baythroid XL--0.8-1.6 fl oz/A, or
bifenthrin--2.1-6.4 fl oz 2EC/A, or
dimethoate--0.5 pt 4EC/A or OLF, or
imidacloprid (soil, foliar)--see label for rates and application methods, or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or

Lannate--1.5 pt LV/A or OLF, or
 Mustang MAX--2.24-4.0 fl oz 1.5EW/A, or
 permethrin--4-8 fl oz 3.2EC/A or OLF, or
 Proaxis--2.56-3.84 fl oz/A, or
 Renounce--1-2 oz 20WP or OLF, or
 Venom--5-6 oz (soil); 1-3 oz(foliar) 70 SG/A

Aphid

On fall crop, seedling protection from aphids is important. Spray if the aphid population reaches 1 aphid/plant during the seedling stage of plant development, or >4 aphids/plant beyond the seedling stage.

acephate (Orthene, generics)--0.5-1.0 lb 97S/A, or OLF, or
 Actara--1.5-3 oz 25WDG/A, or
 Assail--2-4 oz 30SG/A, or
 Beleaf--50 SG (see label for rates), or
 diazinon--0.5-1 pt 4EC/A, or
 dimethoate--0.5 pt 4EC/A or OLF, or
 Fulfill--2.75 oz 50 WDG/A, or
 imidacloprid (soil, foliar)--see label for rates and application methods, or
 Lannate--1.5 pt LV/A or OLF, or
 Metasystox-R--1.5-2 pt 2SC/A, or
 Venom--5-6 oz (soil); 1-3 oz(foliar) 70 SG/A

Leafminer

abamectin (Agri-mek;generics available)--8-16 fl oz 1.5EC/A, or
 dimethoate--0.5 pt 4EC/A, or
 permethrin--4-8 fl oz 3.2EC/A or OLF, or
 SpinTor--6-10 fl oz 2SC/A, or
 Trigard--2.66 oz 75WSP/A, or
 Venom--5-6 oz (soil); 1-3 oz(foliar) 70 SG/A

Cabbage Looper

acephate (Orthene, generics)--1.0 lb 97S/A or OLF, or
 Avaunt--2.5-3.5 oz 30WDG/A, or
 Confirm--8 fl oz 2F/A, or
Bacillus thuringiensis--Consult label for rates and restrictions, or
 Baythroid XL--1.6-2.4 fl oz /A, or
 bifenthrin--2.1-6.4 fl oz 2EC/A, or
 Entrust--1-2 oz 80W, or
 Intrepid--4-8 fl oz 2F/A (early season), 8-10 fl oz 2F/A (late season), or
 lambda-cyhalothrin--1.92-3.2 fl oz/A or OLF, or
 Larvin--24-30 fl oz 3.2F/A, or
 Mustang MAX--3.2-4.0 fl oz/A, or
 permethrin--2-8 fl oz 3.2EC/A, or OLF, or
 Proaxis--1.92-3.2 fl oz/A, or
 Proclaim--3.2-4.8 oz 5SG/A, or
 Radiant--5-10 fl oz SC/A, or
 Renounce--2-3 oz 20WP or OLF, or
 SpinTor--4-8 fl oz 2SC/A

Beet Armyworm

This insect can cause serious damage to the fall crop.

Avaunt--3.5 oz 30WDG/A, or
 Confirm--8 fl oz 2F/A, or
 Entrust--1.25-2.5 oz 80W/A, or
 Intrepid--4-8 fl oz 2F/A (early season), 8-10 fl oz 2F/A (late season), or
 Lannate--1.5-3 pt LV/A or OLF, or

Larvin--16-30 fl oz 3.2F/A, or
 Proclaim--2.4-4.8 oz 5SG/A, or
 Radiant--5-10 fl oz SC/A, or
 SpinTor--4-8 fl oz 2SC/A

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). Apply Lannate every 2 to 5 days or permethrin every 5 to 10 days according to CEW moth populations and pest management alerts.

Avaunt--3.5 oz 30WDG/A, or
 Baythroid XL--2.4-3.2 fl oz /A or
 bifenthrin--2.1-6.4 fl oz 2EC/A, or
 lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
 Lannate--1.5-3 pt LV/A or OLF, or
 Larvin--16-30 fl oz 3.2F/A, or
 Mustang MAX--2.24-4.0 fl oz /A, or
 permethrin--4-8 fl oz 3.2EC/A, or OLF, or
 Proaxis--2.56-3.84 fl oz/A, or
 Proclaim--2.4-4.8 oz 5SG/A, or
 Radiant--5-10 fl oz SC/A, or
 Renounce--3-3.5 oz 20WP or OLF

Tarnished Plant Bug

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

Baythroid XL--2.4-3.2 fl oz/A, or
 bifenthrin--5.12-6.4 fl oz 2EC/A, or
 lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
 Mustang MAX--3.2-4.0 fl oz /A, or
 Proaxis--2.56-3.84 fl oz/A, or
 Renounce--3-3.5 oz 20WP or OLF, or
 Sevin--1.25-2.5 lb 80S/A or OLF (may cause leaf burn)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest			
			Head Let.	Leaf Let.	En-dive	Esca-role
INSECTICIDE						
abamectin(Agri-mek)	R	12	7	-	-	-
Actara	G	12	7	7	7	-
Assail	G	12	7	7	7	-
Avaunt	G	12	3	3	-	-
<i>Bacillus thuringiensis</i>						
<i>thuringiensis</i>	G	4	0	0	0	0
Baythroid XL	R	12	0	0	0	0
Beleaf	G	12	0	0	0	0
bifenthrin	R	12	7	-	-	-
Confirm	G	4	7	7	7	7
diazinon	R	24	10	10	10	10
dimethoate	R	48	7	14	14	14
Entrust	G	4	1	1	1	1
Fulfill	G	12	7	7	7	-
imidacloprid (soil)	G	12	21	21	21	21
imidacloprid (foliar)	G	12	7	7	-	-
Intrepid	G	4	1	1	1	1
lambda-cyhalothrin	R	24	1	1	-	-
Lannate	R	48	10	-	-	-
Larvin	G	12	14	14	14	-
Metasystox-R	R	24	28	-	-	-
Mustang MAX	R	24	5	-	-	-

(table continued next page)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest			
			Head Let.	Leaf Let.	En-Scalve	Escarole
INSECTICIDE (continued)						
Orthene	G	24	21	-	-	-
permethrin	R	12	1	1	1	-
Proaxis	R	24	1	1	-	-
Proclaim	R	48	7	-	-	-
Radiant	G	4	1	1	1	1
Renounce	R	12	0	0	-	-
Sevin/Sevin Bait	G	12	3	14	14	14
SpinTor	G	4	1	1	1	1
Thimet	R	48	-At plant application only-			
Trigard	G	12	7	7	7	-
Venom (soil)	G	12	21	21	21	21
Venom (foliar)	G	12	7	7	7	7
FUNGICIDE (FRAC code)						
Aliette (Group 33)	G	12,24	3	3	3	3
Botran (Group 14)	G	12	14	14	14	14
Contans WG (biological)	G	4	0	0	0	0
Endura (Group 7)	G	12	14	14	--	--
Forum (Group 40)	G	12	0	0	0	--
iprodione (Group 2)	G	12	14	14	14	14
maneb (Group M3)	G	12	10	10	10	10
Previcur Flex (Group 28)	G	12	2	2	2	2
Quadris (Group 11)	G	4	0	0	0	0
Ridomil Gold (Group 4)	G	12	-At plant application only-			
Tanos (Groups 11 + 27)	G	12	3	--	--	--
Ultra Flourish (Group 4)	G	48	-At plant application			

See Table D-6.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Dash (-) in table indicates pesticide is **not** labeled for that crop.

Disease Control

Damping-Off and Other Seedling Diseases

(See the "Disease Control in Plantbeds" section in this publication.) Apply the following in a 7-inch band after seeding or transplanting. Use formula given in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold or Ultra Flourish needed per acre.

mefenoxam--1-2 pt Ridomil Gold 4EC/A or 2-4 pt Ultra Flourish 2E/A

Big-Vein

The disease is favored by cool temperatures (<60°F) and high soil moisture conditions. Produce the crop on raised beds and avoid planting in fields with low-lying areas. Soil fumigation is helpful. Refer to the "Soil Fumigation" section for details on application.

Corky Root

Development of the disease is favored by continual cropping and by high soil moisture conditions. Cultural practices that reduce soil compaction, such as the use of a rye

cover crop, use of high beds, limiting irrigation between transplanting or thinning and the rosette stage of growth to encourage a deep root system, should be adopted to reduce disease incidence.

Downy Mildew

An application of mefenoxam (Ridomil Gold 4EC or Ultra Flourish 2E) for damping-off will assist in control of downy mildew. See "Damping-Off and Other Seedling Diseases" above for use pattern. Use one of the following during periods of high moisture and moderate temperatures.

Alternate:

Forum--6.0 fl oz 4.18SC/A (must be tank mixed with another fungicide registered on lettuce for downy mildew), or

Aliette--3 lb 80WDG/A (14-day schedule), or maneb--1.5-2 lb 75DF/A (7- to 10-day schedule) or OLF, or Previcur Flex--2.0 pt 6F/A

With one of the following FRAC code 11 fungicides:

Quadris--12.3-15.4 fl oz 2.08F/A, or

Tanos--8 oz 50W/A plus maneb

Leaf Spots

When conditions favor disease development, alternate the following and repeat every 7 to 14 days.

Quadris--6.2-15.4 fl oz 2.08F/A, or

maneb--1.5-2 lb 75DF/A or OLF

Bottom Rot (*Rhizoctonia*),

A midsummer application of a soil fumigant will be beneficial for the fall crop (Refer to "Soil Fumigation" section for details on materials and application techniques). For the spring and fall crop, all fields should receive the following fungicide application one week after transplanting or thinning and 10 and 20 days later.

Endura--8-11 oz 70W/A, or

iprodione (Rovral)--1.5-2 lb 50WP/A or OLF

Lettuce Drop (*Sclerotinia*)

Preplant: The following biological fungicide has been tested in some states; however, limited information is available on effectiveness in the Mid-Atlantic region. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches but do not plow before seeding or transplanting lettuce to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.

Contans--2-4 lb 5.3WG/A

Use one of the following at seeding, transplanting and/or thinning (see labels for restrictions):

iprodione (Rovral)--1.5-2 lb 50WP/A or OLF, or

Endura--8-11 oz 70WG/A, or

Botran--2-5.5 lb 75WP/A

Gray Mold (*Botrytis*)

Most troublesome in plant bed where air drainage is poor. Avoid crowding of plants and watering late in the day. Use one of the following as a foliar spray:

Botran--3 tbs 75WP/gal, or

iprodione (Rovral)--2 tbs 50WP/gal or OLF

Yellows

Control leafhopper vectors with insecticides. Refer to the preceding "Leafhopper" section under Insect Control.

Viruses

LMV (lettuce mosaic virus): Use virus-free or MT lettuce seed.

TuMV (turnip mosaic virus): Troublesome in late summer and early fall plantings. Control weed hosts around risers and areas bordering fields.

Tomato Spotted Wilt Virus (TSWV)

TSWV is spread from flowering ornamental plants (flowers) to lettuce by thrips. Do not grow any ornamental bedding plants in the same greenhouse as lettuce transplants. Scout and monitor for greenhouse thrips regularly and begin an insecticide control program once observed.

MUSKMELONS

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Aphrodite* (PMR1,2, FR 0,1,2)	D	M	N	P	V
Athena* (FR 0,1,2; PMR)	D	M	N	P	V
Eclipse* (PMR,FR 2)	D	M	N	P	V
Specialty Melons					
Earli-Dew*	D	M	N	P	V
Marygold (casaba type)(FR 2,PMR)	D	M		P	V
Sweet Dream* (green flesh)				P	
Tennerife (canary-type)	D	M		P	V

¹ Varieties listed by maturity, earliest first.

* Indicates hybrid varieties.

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Muskmelons	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
	75-100 ¹	150 ¹	100 ¹	50 ¹	150 ¹	150 ¹	100 ¹
	25-50 ²	125 ²	75 ²	25 ²	175 ²	125 ²	75 ²
	25 ³	25 ³	25 ³	25 ³	25 ³	25 ³	25 ³
	25-50 ⁴	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Suggested method of application broadcast and disk-in

³ Band-place with planter

⁴ Sidedress when vines start to run

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Note: If crop is to be mulched with plastic but not drip/trickle fertilized, broadcast 100 - 150 pounds of nitrogen (N) per acre with recommended P₂O₅ and K₂O and disk-in or incorporate prior to

laying mulch.

Drip/Trickle Fertilization: see below for drip/trickle fertilization guides.

Seed Treatment

Check with seedsman to determine if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 75WP (½ teaspoon per pound or 3 ounces per 100 pounds) and an approved commercially available insecticide

Plant Production

Transplants should be grown in pots or cells that provide a space of *at least* 2 inches by 2 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 muskmelon seed contains 950 to 1,250 seeds.

The required amount of seed can then be estimated using Table R-2 and knowing how many seeds make up an ounce of the desired variety. See also Table R-1 (Vegetable Seed Sizes).

Planting and Spacing

Transplant container-grown plants through plastic mulch when daily mean temperatures have reached 60°F (15.6°C). Temperatures below 45°F can stunt plant growth. Planting dates vary from May 1 in southern regions to June 5 in northern areas. Early plantings should be protected from winds with hot caps, tents, row covers, or rye strips.

The recommended spacing for muskmelons is 5 to 6 feet between rows and 2 to 3 feet between plants in the row.

Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5, apply enough farm-grade fertilizer to supply 50 pounds per acre of N, P₂O₅ and K₂O, and thoroughly incorporate into the soil.

After mulching and installing the trickle irrigation system, apply completely soluble fertilizer to supply 50 pounds (5 to 15 pounds in Pennsylvania) of N, P₂O₅ and K₂O per fertilized-mulched acre during each application. (A description of a **fertilized-mulched acre** may be found in the "Irrigation" section of this publication.) On soils testing low and low to medium in boron and that have not received any preplant boron fertilizer, include 0.5 pound of actual boron per fertilized-mulched acre in each soluble fertilizer application. **For convenience, rates of fertilizer nutrients can be converted from a mulched acre to linear foot basis. See Table C-8.**

The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting the melons. The same rate of soluble fertilizer should be applied again when the first fruit set. The third application should be applied about 2 weeks before the first harvest.

Heavier, late yields have been achieved by applying another application at the same rate of soluble fertilizer in between the first and second soluble fertilizer applications or about 2 weeks after the first soluble fertilizer application. In Pennsylvania, do not exceed 80 pounds of nitrogen per acre per season.

Mulching

Fumigated soil aids in the control of weeds and soil-borne diseases. Clear, plastic mulch laid before field plantings conserves moisture, increases soil temperature, and increases early and total yields. Plastic and fumigant--Vapam HL (30 to 37 gallons per acre)--should be applied on well-prepared planting beds 30 days before field planting. Plastic should be 4 feet wide (4,000-foot rolls) and laid on 5- or 6-foot centers 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 muskmelons may not provide satisfactory weed control when used under clear plastic mulch on nonfumigated soil. Consult your county agent for latest recommendations. Black plastic or paper can be used without a herbicide. Fertilizer must be applied during bed preparation. At least 50 percent of the nitrogen (N) should be in the nitrate (NO₃) form.

Fumigation will be necessary when there is a history of soil-borne diseases in the field.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in melons.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. See "Mulching" section above for further information on weed control under clear plastic mulch.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tube left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious under clear plastic. Bury the trickle tube several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E

preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Halosulfuron--0.023-0.047 lb/A. **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but not labeled on muskmelons.** Apply 0.5 to 1.0 dry ounce Sandea 75WG under plastic mulch to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Condensation that forms on the underside of the mulch will activate the herbicide. Delay transplanting for seven days after application. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied under plastic mulch.**

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.

Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Clomazone--0.094-0.188 lb/A. Apply 4 to 8 fluid ounces per acre Command 3ME as a banded directed shielded spray preemergence to the weeds to control annual grasses and many broadleaf weeds including common lambsquarter, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use, or use Strategy, the jug-mix that contains clomazone (Command) and ethalfluralin (Curbit).

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfluralin--0.38-0.75 lb/A. Apply 1 to 2 pints per acre Curbit 3E as a banded directed shielded spray preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarter, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin plus Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC as a banded directed shielded spray preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a jug-mix of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart below to determine the amount of each herbicide at commonly used rates:

Curbit and Command Active Ingredients (ai) in Commonly Used Strategy Rates

Strategy pints/A	Ethalfluralin (Curbit) lb ai/A	Clomazone (Command) lb ai/A
1.5	0.3	0.094
2	0.4	0.125
3	0.6	0.188
4	0.8	0.25
5	1.0	0.312
6	1.2	0.375

Labeled for use in all the mid-Atlantic states. Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

Halosulfuron--0.023-0.047 lb/A. **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but not labeled on muskmelons.** Apply 0.5 to 1.0 dry ounces of Sandea 75WG to suppress or control broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse textured soils low in organic matter and higher rates on fine textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally slight stunting may be observed following Sandea use early in the season, before the vines begin to run. When observed, recovery is rapid, with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with his mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 lb/A, equal to 1.0 dry ounce of Sandea, applied preemergence DO NOT exceed total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 lb/A, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.**

Postemergence

Halosulfuron--0.023-0.031 lb/A. **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but not labeled on muskmelons.** Apply 0.5 to 0.66 dry ounce Sandea 75WG as a banded directed shielded spray to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms

within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. . DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle.**

DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied preemergence and postemergence to multiple crops in one year.

Naptalam--1 lb/A. Apply 2 quarts per acre Alanap 2SC as a banded directed shielded spray when the crop is ready to vine to extend residual weed control and to suppress or control smooth pigweed. Do not use Alanap early in the season when growing conditions may be cold or wet. Do not apply if rainfall is expected within 6 hours. Do not mix with liquid fertilizer.

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a banded directed shielded spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and

before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

For Seeding Into Soil Without Plastic Mulch (Broadcast Applicators)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Seeding into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preplant Incorporated

Naptalam--2 lb/A. Apply 1 gallon per acre Alanap 2SC as a preplant incorporated (2 inches) treatment before seeding or transplanting. Weed control may not be satisfactory on sandy soils with less than 1 percent organic matter.

Bensulide *plus* naptalam--4-6 lb/A *plus* 2 lb/A. Apply 1 to 1.5 gallons of Prefar 4EC *plus* 1 gallon Alanap 2SC as a preplant incorporated (2 inches or less) treatment before seeding or transplanting. Tank mix is approved.

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Preemergence

Clomazone--0.094-0.188 lb/A. Apply 4 to 8 fluid ounces per acre Command 3ME preemergence to a direct-seeded crop to control annual grasses and many broadleaf weeds including common lambsquarter, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfuralin--0.38-0.75 lb/A. Apply 1 to 2 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarter, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfuralin *plus* Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfuralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart under

Ethalfuralin *plus* clomazone (jug-mix) in the section **For Soil Strips between Rows of Plastic Mulch** to determine the amount of each herbicide at commonly used rates.

Read and follow all the recommendations and warnings (above) for ethalfuralin (Curbit) and clomazone (Command).

Halosulfuron--0.023-0.047 lb/A. **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but not labeled on muskmelons.** Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. DO NOT exceed total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.**

Postemergence

Halosulfuron--0.023-0.031 lb/A. **Labeled for use on cantaloupes, honeydew melons, and Crenshaw melons, but not labeled on muskmelons.** Apply 0.5 to 0.66 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of

resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. . DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed total of 0.078 pounds per acre, equal to 1.66 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied preemergence and postemergence to multiple crops in one year.**

Naptalam--1 lb/A. Apply 2 quarts per acre Alanap 2SC when the crop is ready to vine to extend residual weed control and to suppress or control smooth pigweed. Do not use Alanap early in the season when growing conditions may be cold or wet. Do not apply if rainfall is expected within 6 hours. Do not mix with liquid fertilizer.

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Max 3SC or Gramoxone Inteon 2SC postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 1.5 pints per acre Gramoxone Max 3SC or 2.4 pints per acre Gramoxone Inteon 2SC as a directed spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray

solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

Postharvest With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for proper set and pollination. 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 and/or Table D-6 for relative toxicity of various pesticides for hazard to bees.

Insect Control

Seed Corn Maggot

To prevent maggot damage to transplants, a banded application of a soil-incorporated insecticide may be needed. Also see the preceding "Maggots" section in Soil Pests--Their Detection and Control. **Note:** The use of Admire (generics available) 2F at planting may help to reduce seed corn maggot populations.

Cucumber Beetle

Cucumber beetles transmit bacterial wilt, and most varieties of muskmelons are highly susceptible to this disease. Also, adult beetles can cause direct feeding injury to young plants. Insecticides should be used to control adult beetles before they feed extensively on the cotyledons and first true leaves. If foliar insecticides are used, begin spraying shortly after plant emergence and repeat applications at weekly intervals if new beetles continue to invade fields. Treatments may be required until vines begin to run. An alternative control option is the use of Furadan 4F applied at planting (see below).

MUSKMELONS

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--2.4-2.8 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Furadan--A Special Local-Needs Label 24(c) is in effect for use of liquid Furadan at 3.8 fl oz 4F/1,000 ft of row at planting. Consult your local county Extension office for current restrictions. **Note.** Use of Furadan at planting frequently leads to spider mite outbreaks later in the season, or
imidacloprid--see label for rates and application methods, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2 EC/A or OLF, or
Platinum--5-8 oz 2SG/A.
Sevin--1.25 lb 80S/A or OLF, or
Thionex--0.67-1.33 qts 3EC/A or OLF

Squash Vine Borer

When vines begin to run, apply to bases of plants four times at 7-day intervals.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
Thionex--0.67-1.33 qts 3EC/A or OLF

Cutworms (Also see "Cutworms" section in Soil Pests--Their Detection and Control.)

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--0.8-1.6 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2 EC/A or OLF

Pickleworm (PW), Melonworm (MW)

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

Asana XL--5.8-9.6 fl oz 0.66EC/A (PW only), or
Avaunt--2.5-6 oz 30WDG/A, or
Baythroid XL--1.6-2.4 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-10 fl oz 2F/A, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2 EC/A (PW only) or OLF, or
Radiant--5-10 fl oz SC/A, or
Sevin--1.25 lb 80S/A or OLF, or
SpinTor--4-8 fl oz 2SC/A, or
Thionex--0.67-1.33 qts 3EC/A or OLF

Aphids

Note. Aphids transmit mosaic virus. Thorough spray coverage beneath leaves is important. Reflective mulches will slow aphid colonization until canopy closure.

Actara--1.5-3.0 oz 25WDG/A, or
Beleaf--50 SG (see label for rate), or
Fulfill--2.75 oz 50WP/A, or
imidacloprid--see label for rates and application methods, or
Metasystox-R--1.5-2 pt 2SC/A (GPA only), or
Platinum--5-8 oz 2SG/A, or

Thionex--0.67-1.33 qts 3EC/A or OLF
Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A
Lannate--1.5-3 pt LV/A or OLF (Melon aphid only)

Squash Bug

Begin treatments if greater than one egg mass per plant is present. Sprays should target nymphal stages. Treat every 7-10 days, or as needed.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
permethrin--8 fl oz 3.2 EC/A or OLF, or
Sevin--1.25 lb 80S/A or OLF

Leafhoppers

High levels of leafhoppers cause leaf yellowing (chlorosis) known as hopper burn which will result in yield loss.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--0.8-1.6 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
dimethoate--1 pt 4EC/A or OLF, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A or OLF
Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A

Leafminers

abamectin(Agri-mek;generics available)--8-16 fl oz 0.15EC/A, or
dimethoate--1 pt 4EC/A or OLF, or
Entrust--2-2.5 oz 80W/A, or
permethrin--8 fl oz 3.2 EC/A or OLF, or
SpinTor--6-8 fl oz 2SC/A, or
Venom--1-4 oz (foliar); 5-6 oz (soil) 70SG/A, or
Vydate L--2-4 pt 2L/A

Rindworms (Cucumber beetle larvae)

Damage to the rinds may result from any one or a complex of insects including cucumber beetle, wireworms, and a number of "worm species, including but not limited to beet armyworm. Management of adult cucumber beetles early in the season may help reduce damage. See cucumber beetle and beet armyworm sections for labeled products.

Beet Armyworm

Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-10 fl oz 2F/A, or
Radiant--5-10 fl oz SC/A, or
Spintor--4-8 fl oz 2SC/A

Cabbage Looper

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Bacillus thuringiensis--Consult label for rates and restrictions, or
Baythroid XL--1.6-2.4 fl oz/A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-10 fl oz 2F/A, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
Radiant--5-10 80W/A, or
SpinTor--4-8 fl oz 2SC

Mites

Mite infestations generally begin around field margins and grassy areas. **CAUTION: DO NOT** mow or maintain these

areas after midsummer since this forces mites into the crop. Localized infestations can be spot treated. Begin treatment when 10 to 15 percent of the crown leaves are infested early in the season, or when 50 percent of the terminal leaves are infested later in the season.

Note. Continuous use of Furadan, Sevin, or the pyrethroids may result in mite outbreaks.

Acramite--0.75-1.0 lb 50WS/A, or
 abamectin (Agri-mek; generics available)--8-16 fl oz
 0.15EC/A, or
 bifenthrin--5.12-6.4 fl oz 2EC/A or OLF, or
 Danitol--10.66-16 fl oz 2.4EC/A, or
 Oberon--7.0-8.5 fl oz 2SC/A

Note: Use of dimethoate for leafminer control will reduce the mite population.

Thrips

Entrust--2-2.5 oz 80W/A, or
 lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
 SpinTor--6-8 oz 25C/A, or,
 Venom--5-6 fl oz (soil); 4 fl oz (foliar) 70SG/A, or
 Vydate--2-4 pt. L/A

Whiteflies

Actara--3-5.5 oz 25WDG/A, or
 bifenthrin--5.12-6.4 fl oz 2EC/A or OLF, or
 Danitol--10.66-16 fl oz 2.4EC/A, or
 imidacloprid--see label for rates and application methods, or
 Knack--8-10 fl oz/A, or
 Oberon--7-8.5 fl oz 2SC/A, or
 Platinum--5-8 oz 2SG/A, or
 Thionex--1.33 qt 3EC/A or OLF, or
 Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Acramite	G	12	3
Actara	G	12	0
abamectin(Agri-mek)	R	12	7
Ambush	R	24	1
Asana XL	R	12	3
Avaunt	G	12	3
<i>Bacillus thuringiensis</i>	G	4	0
Baythroid XL	R	12	0
Beleaf	G	12	0
bifenthrin	R	12	3
Danitol	R	24	7
dimethoate	R	48	3
Entrust	G	4	3
Fulfill	G	12	0
Furadan	R	48	At plant
Imidacloprid (soil/foliar)	G	12	21/0
Intrepid	G	4	3
Knack	G	12	7
lambda-cyhalothrin	R	24	1
Lannate	R	48	3
Metasystox-R	R	48	14
Oberon	G	12	7
Platinum	G	12	30
permethrin	R	12	0
Radiant	G	4	3

(table continued)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE (cont'd)			
Sevin	G	12	3
SpinTor	G	4	3
Thionex	R	24	2
Venom(soil/foliar)	G	12	21/1
Vydate L	R	48	1
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Forum (Group 40)	G	12	0
Gavel (Groups 22 + M3)	G	48	5
mancozeb (Group M3)	G	12,24	5
Nova (Group 3)	G	24	0
Previcur Flex (Group 28)	G	12	2
Pristine (Groups 11 + 7)	G	12	0
Procure (Group 3)	G	12	0
Quadris (Group 11)	G	4	1
Quintec (Group 13)	G	12	3
Ranman (Group 21)	G	12	0
Reason (Group 11)	G	12	14
Ridomil Gold (Group 4)	G	48	4
Tanos (Groups 11 + 27)	G	12	3
Ultra Flourish (Group 4)	G	48	0

See Table D-6.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL

Nematode Control

See "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section, or Vydate L--1-2 gal 2L/A. Incorporate into the top 2 to 4 inches of soil or 2 to 4 pints 2L per acre applied 2 weeks after planting and repeat 2 to 3 weeks later.

Disease Control

Damping-Off

Apply the following in a 7-inch band after seeding. Use formula given in the "Calibration for Changing from Broadcast to Band Application" section of calibrating

mefenoxam--1-2 pt Ridomil Gold 4EC/A or 2-4 pt Ultra Flourish 2E/A

Viruses (CMV, WMV2, PRSV, and ZYMV)

Plant fields as far away from existing cucurbit plantings as possible to help reduce the chances of aphid transmission of viruses from existing fields to new fields.

Bacterial Wilt

Controlling striped and spotted cucumber beetles is essential for preventing wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage through the season. Therefore, additional foliar insecticide applications may be necessary.

Fusarium Wilt

Rotate to allow 5 years between muskmelon plantings. Use resistant cultivars when possible. The cultivars ‘Athena’ and ‘Aphrodite’ have resistance to Race 0, 1, and 2 (predominant races present in the area). Cultivars ‘Eclipse’ and ‘Superstar’ have resistance to Race 2 only.

Phytophthora Fruit Rot

To minimize the occurrence of phytophthora, rotate away from susceptible crops (cucurbits, peppers, lima beans and snap beans, eggplants, and tomatoes) for as long as possible. Fields should be adequately drained to ensure that water does not accumulate around plants. Apply the following when conditions are favorable for disease development and always tank mix with a fixed copper.

These materials provide suppression only.

Forum--6.0 fl oz 4.18SC/A, or
Gavel--1.5-2 lb 75DF/A, or
Tanos--8-10 oz 50DF/A, or
Ranman--2.75 fl oz 400 SC/A (plus an adjuvant, see label for details)

Powdery Mildew

The fungus that causes cucurbit powdery mildew can develop resistance to several different groups of fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern US, therefore proper fungicide resistance management should be followed.

Powdery mildew generally occurs from mid-July until the end of the season. Excellent resistance is available in most recommended muskmelon varieties. Scout fields for the presence of powdery mildew. If one lesion is found on the underside of 45 old leaves, begin the following fungicide program:

Alternate one of the following tank mixes:

Nova--5 oz 40WP/A *plus* chlorothalonil--2-3 pt 6F/A, or
Procure--4-8 oz 50WS/A *plus* chlorothalonil--2-3 pt 6F/A

With:

Quintec--6oz 2.08F/A *plus* chlorothalonil--2-3 pt 6F/A, or
Pristine--12.5-18.5 oz 38WG/A *plus* chlorothalonil--2-3 pt 6F/A

Downy Mildew

Scout fields for disease incidence beginning in early summer. Begin sprays when vines run or if disease is predicted for the region. Refer to the Cucurbit Downy Mildew Forecasting website (www.ces.ncsu.edu/depts/pp/cucurbit/) for current status of the disease. Preventative applications are much more effective than applications made after downy mildew is detected. The following are the most effective materials (tank mix these products with a protectant such as chlorothalonil (1.5-2 pt 6F/A or OLF) and rotate between different FRAC codes:

Ranman--2.1-2.75 fl. oz. 400SC/A, or
Previcur Flex--1.2 pt 6F/A, or
Curzate--3.2 oz 60DF/A, or
Tanos--8 oz 50WDG/A, or
Gavel--1.5-2 lb 75DF/A Gavel contains mancozeb, which is a protectant fungicide and therefore does not need a tank mix partner.

Note: Some muskmelon varieties are sensitive to Gavel.

Always alternate between materials from different FRAC codes to reduce chances for fungicide resistance development.

Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced if label allows.

Alternaria Leaf Blight

Rotate muskmelons with unrelated crops. Begin sprays when vines begin to run, or earlier if symptoms are detected.

Alternate one of the following:

chlorothalonil--2-3 pt 6F/A, or
mancozeb--2-3 lb 75DF/A, (Muskmelon varieties, ‘Harvest Queen’, ‘Gold Star’, ‘Super Star’, ‘Sweet and Early’, and ‘Saticoy’ are sensitive to mancozeb.)

With:

Pristine--12.5-18.5 oz 38WG/A, or

a tank mix containing chlorothalonil *plus*:

Quadris--11.0-15.4 fl oz 2.08F/A (Do not apply near apples, see label for details), or
Cabrio--12-16 oz 20EG/A, or
Reason--5.5 fl oz 500SC/A

Scab

Disease occurs during cool periods. Begin sprays as true leaves form. Repeat every 5 to 7 days.

chlorothalonil--2-3 pt 6F/A or OLF

Gummy Stem Blight

Gummy stem blight occurs primarily in the late summer. Fungicides with a high-risk for resistance development such as FRAC code 11 fungicides (Cabrio, Pristine and Quadris) should be tank-mixed with a protectant fungicide. When tank-mixing use the minimum labeled rate of each fungicide in the tank mix. Do not apply FRAC code 11 fungicides more than 4 times total per season. If resistance to FRAC code 11 fungicides exists in the area, do not apply them. Use fungicides from a different FRAC code.

Begin sprays when vines begin to run, apply the following:

Under low disease pressure:

Apply chlorothalonil every 7 days at 2-3 pt/A, or

Under high disease pressure:**Alternate:**

chlorothalonil--2-3 pt 6F/A or OLF (Use low rate early in season)

With:

A tank mix containing a protectant fungicide (such as chlorothalonil or mancozeb) *plus*
Pristine--12.5-18.5 oz 38W/A

Manganese Toxicity

This disorder occurs in acid soils (pH less than 5.8). Maintain soil pH at 6.5 to avoid toxicity.

Harvesting and Storage

Muskmelon hybrids should be harvested no sooner than half-slip and preferably at full-slip for optimum fruit quality. High-quality melons depend on maintaining the vines and

leaves until melons are mature. Harvest daily or twice daily in hot weather.

OKRA

Okra is a tropical annual with a wide range of adaptation. It is, however, very sensitive to frost and cold temperatures and should not be planted until soil has warmed in the spring.

Varieties

Varieties¹

Annie Oakley II*	These varieties are recommended in areas of DE, MD, NJ, PA, VA, WV where climatic conditions are favorable for okra production.
Clemson Spineless	
Cajun Delight*	
North and South*	

¹Varieties listed by maturity, earliest first.

* Indicates hybrid varieties.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Okra	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med 150 ¹ 150 ² 0 0	Opt. 100 ¹ 100 ² 0 0	Low Pounds K ₂ O per Acre	Med 150 ¹ 150 ² 0 0	Opt. 100 ¹ 100 ² 0 0
	125-150 ¹	250 ¹	150 ¹	100 ¹	250 ¹	150 ¹	100 ¹
	50-100 ²	250 ²	150 ²	100 ²	250 ²	150 ²	100 ²
	25-50 ³	0	0	0	0	0	0
	25-50 ⁴	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress 3-4 weeks after planting

⁴ Sidedress 6-8 weeks after planting

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Note: If crop is to be mulched with plastic but not drip/trickle fertilized, broadcast 225 pounds of nitrogen (N) per acre with recommended P₂O₅ and K₂O and disk-in or incorporate prior to laying mulch.

Drip/Trickle Fertilization: see below under drip/trickle fertilization guides.

Seed Treatment

Use thiram 75WP at 3 to 4 ounces per 100 pounds (2/3 teaspoon per pound) plus Apron XL LS (0.32 to 0.64 fluid ounce) per 100 pounds of seed for improved germination and stand.

Seeding and Spacing

Usual field seeding date is May 20 to June 1. Generally only one planting is made. For Pennsylvania, seed in the greenhouse in cells on May 5 and transplant to the field on June 5 to 10 through black plastic mulch on raised beds with drip irrigation. Okra also responds to the application of trellises and row covers or high tunnels.

For dwarf varieties, space the rows about 3½ feet apart; for medium and tall varieties, 4 to 4½ feet apart. Drill seeds ¼ to ½ inch deep, 3 or 4 per foot of row (5 to 7 pounds per acre). Thin the plants when they are 5 inches high. Dwarf varieties should be about 12 to 15 inches apart in the row; plants of tall varieties should be 18 to 24 inches apart.

Harvesting

An okra pod usually reaches harvesting maturity 4 to 6 days after the flower opens. The pods are 3 to 3½ inches long at this stage and are tender and free of fiber. Pick pods at least every second day. Large and undesirable pods should be removed to permit the plant to continue to bear over a long period. Okra should be kept at temperatures between 50° to 55°F (10° to 12.8°C) and relative humidity of 85 to 90 percent. Okra pods are subject to chilling injury below 50°F (10°C).

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

There has been no research on this crop in this area. The following are suggestions taken from company labels:

Preplant Incorporated

Trifluralin--0.5-1 lb/A. Apply 1 to 2 pints per acre Treflan 4E. Incorporate 2 to 3 inches deep within 8 hours of application by disking twice with blades set 4 to 6 inches deep.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Insect Control

Aphids

imidacloprid--see label for rates and application methods, or malathion--1.5 pt 57EC/A

Corn Earworm

Avaunt--3.5 oz 30WDG/A, or *Bacillus thuringiensis*--Consult label for rates and restrictions, or Entrust--1-2 oz/A or, Intrepid--10-16 fl oz 2F/A, or Radiant--5-10 fl oz SC/A, or Sevin--1.25-2.5 lb 80S/A or OLF, or SpinTor--3-6 fl oz 2SC/A

Japanese Beetle

malathion--1.5 pt 57EC/A

Stink bugs

Sevin--1.25-2.5 lb 80S/A or OLF

Whiteflies

imidacloprid--see label for rates and application methods, or Knack--8-10 fl oz/A

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
INSECTICIDE			
Avaunt	G	12	3
Entrust	G	4	1
Intrepid	G	4	1
imidacloprid	G	12	21
Knack	G	12	14
malathion	G	12	1
Radiant	G	4	1
Sevin	G	12	3
SpinTor	G	4	1
FUNGICIDE (FRAC code)			
Quadris (Group 11)	G	4	0

See Table D-6.

¹ G = general

Nematode Control

Nematode control is very important in the production of this commodity. See "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section.

Disease Control

Damping-Off

Use seed treated with thiram *plus* Apron XL LS (0.32 to 0.64 fl oz) per 100 pounds of seed.

Seedling Root Rot and Basal Stem Rot (Rhizoctonia)

Quadris--0.40-0.80 fl oz 2.08F/1000 row ft

Fusarium and Verticillium Wilts

Avoid planting in fields where either disease is present. Rotate with non-solanaceous crops. Disease control rates of soil fumigants will aid in control of Verticillium wilt.

Fruit Rot

Choanephora is a soil-borne fungal disease which attacks senescent blossoms and fruit. There are no fungicides labeled for Choanephora control. Improving air circulation is the only effective means of reducing the chances for Choanephora development. In extreme cases, some growers remove the lower juvenile leaves to improve air circulation.

ONIONS

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Bulb Types: Sets (Yellow)					
Early Yellow Globe	D	M		P	
Ebenezer	D	M		P	V
Candy* (Sweet Spanish type)				P	V
Bulb Types: Sets (Red)					
Southport Red Globe				P	

(table continued)

Varieties (continued)

Varieties ¹	DE	MD	NJ	PA	VA
Bulb Types: Seed (Yellow)					
Fortress (PRR)				P	
Sweet Spanish types	D		N		V
Candy* (Sweet Spanish type)				P	V
Bulb Types: Transplants Intermediate Day					
Mars* (red)				P	
Super Star* (white, Sweet Spanish type)			P	V	
Mercury* (red)				P	
Candy* (Sweet Spanish type)				P	V
Condor* (FT,PRT) (Sweet Spanish type)				P	
Expression* (Sweet Spanish type)				P	V
Exacta (trial)			N	P	V
Sweet Spanish types	D	M	N	P	V
Green or Bunching					
Beltville Bunching	D	M	N	P	
Evergreen Bunching (overwinter)	D	M	N	P	
Kincho (summer)	D		N	P	
Southport White Globe (overwinter or early spring harvest only)	D	M	N	P	
Tokyo Bunching (summer)	D	M	N		
White Sweet Spanish	D	M		P	

¹ Varieties listed alphabetically

* Indicates hybrid varieties

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Crop	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre	Pounds P ₂ O ₅ per Acre	Pounds P ₂ O ₅ per Acre	Pounds K ₂ O per Acre	Pounds K ₂ O per Acre	Pounds K ₂ O per Acre
Bulb onions	75-100 ¹	200 ¹	100 ¹	50 ¹	200 ¹	100 ¹	50 ¹
	50-75 ²	200 ²	100 ²	50 ²	200 ²	100 ²	50 ²
	25-50 ³	0	0	0	0	0	0
Green onions	150-200 ¹	200 ¹	100 ¹	50 ¹	200 ¹	100 ¹	50 ¹
	50-75 ²	200 ²	100 ²	50 ²	200 ²	100 ²	50 ²
	50 ³	0	0	0	0	0	0
	50 ⁴	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Suggested method of application broadcast and disk-in

³ Sidedress 4-5 weeks after planting

⁴ Sidedress 3-4 weeks before harvest

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Seed Treatment

In areas where smut is a problem, use seed that has been treated with 10.67 ounces of either captan 50WP or thiram 75WP for every 10 pounds of seed. Where smut is not a problem, use either material at the rate of 0.67 teaspoon per pound for damping-off (4 ounces per 100 pounds).

Transplant Production

Produce onion transplants in cell trays. The maximum cell size recommended for Sweet Spanish transplants is 338 cells per tray. Grow transplants 10-12 weeks and maintain a plant height of 4 inches.

Planting and Seeding Dates

For dry bulb onions, sets and seed can be planted as soon as soil conditions are favorable in the spring. Transplants for bulb onions can be planted March 20 to April 1.

Seed for bunching onions can be planted as soon as soil conditions are favorable in the spring. Successive plantings can be made through the summer.

Spacing

For dry bulb onions, space rows 24 inches apart. Space eight to nine sets per foot (24 bushels per acre). For large Spanish onions, space sets 4 to 5 inches apart and seeds ½ to 2 inches in row (2 pounds per acre using split shoe). For bunching onions, space rows 12 to 16 inches apart; space seed ½ to 1½ inches apart (7 to 10 pounds per acre). Depth to seed ½ to ¾ inch except ½ to 1 inch on muck. Place sets 1 to 1½ inches deep.

For seedling transplants, grow 4 rows on a raised bed with plastic mulch. Space rows 6 inches apart and space plants 6 inches apart in each row (approximately 50,000-60,000 plants/A). Use one drip tape line between each two rows of onions on the raised beds for optimum growth and water management.

Cultivation

For bunching onions, hill 1 to 2 inches to ensure white base.

Drying

When at least 50% of onion tops have fallen over, start harvesting onion bulbs. Pull bulbs through the plastic mulch and lay on mulch surface for 3 days if there is no rain predicted. If rain is predicted within 24 hours, cut tops from onion bulbs (leaving 1.5 inch neck) and place bulbs in potato burlap bags or bulk bins and bring into shelter. If bulbs are placed in burlap bags, they can be placed in a greenhouse or high tunnel for 5 to 7 days to dry. Place sheet of row cover over burlap bags of onions to reduce/eliminate sunburn. If using bulk bins for drying onions, place in room with high air flow and a controlled heat source (drying temperature for onions should never exceed 90°F). Keep in dryer with moderate heat and high air flow for at least 48 hours. Before removing bulk bins from dryer, randomly check onion necks to insure they are paper dry. If storing onion bulbs for short period of time (up to 2 months) maintain cool temperature 38°F to 45°F and low relative humidity (75-85%) with active air movement.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Preemergence

DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre

Dacthal 6F at time of seeding or immediately after planting sets. A second application may be needed for longer season seed onions.

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 45 days and apply no more than 32 fluid ounces per acre in one season. Labeled for dry bulb onions only.

Fluzifop--0.125-0.188 lb/A. Apply 0.5 to 0.75 pints per acre Fusilade DX 2E with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge, wild onion, or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 45 days and apply no more than 6 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application. Labeled for dry bulb onions only.

S-metolachlor--0.64-1.27 lb/A. A **Special Local-Needs 24(c) label has been approved for the use of Dual Magnum in dry bulb onions and green bunching onions in New Jersey, and in dry bulb onions in Virginia.** Apply 0.67 to 1.33 pints per acre after the onions have reached the two true leaf stage of growth. Use lower rate on lighter coarse-textured sandy soils and the higher rate on heavier fine-textured soils. Follow with overhead irrigation if rainfall does not occur. On soils with an organic matter content greater than 5 percent, one additional treatment may be applied 3 to 4 weeks after the first treatment. Primarily

controls annual grass and certain broadleaf weeds, including galinsoga preemergence. Use other methods to control emerged weeds prior to application. Observe a 60-day preharvest interval. DO NOT exceed a total of 2.65 pints per acre per season. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.** For use on dry bulb onions only.

Oxyfluorfen--0.025-0.05 lb/A. Apply 1.6 to 3.2 fluid ounces per acre Goal 2XL postemergence when onions have a minimum of three true leaves to control seedling broadleaf weeds with four true leaves or less. Repeat the application but do not exceed a total of 0.5 pound per acre (32 fluid ounces per acre) and do not apply within 60 days of harvest.

Goal may cause injury to onion foliage. The injury will appear as necrotic spots on leaves and/or twisted leaves. Heed the following precautions to avoid or minimize injury: Use flat fan nozzles, 20 to 40 psi and 20 to 40 gallons of water per acre. DO NOT tank-mix with any other pesticide. DO NOT use surfactant, oil concentrates, or any other additive. DO NOT apply during extended periods of cool, wet, cloudy weather. DO NOT exceed 0.05 pound per acre (3.2 fluid ounces) per application. DO NOT apply to onions with less than three true leaves (do not count the flag leaf).

Bromoxynil--0.125-0.188 lb/A. Apply 4 to 6 fluid ounces Buctril 4EC to dry bulb onions with a minimum of 3 true leaves (do not count the flag leaf) to suppress or control many seedling broadleaf weeds with 4 true leaves or less in 50 to 70 gallons of water per acre. Water volume is important. Concentrated spray solutions kill onions. Repeat applications can be made, but do not apply more than 12 fluid ounces in a single growing season. Buctril may cause injury to onions. The injury will appear as necrotic spots on the leaves. To minimize the risk of injury, heed the following warnings. DO NOT tank-mix with any other pesticides or apply within 3 days of any other pesticide. DO NOT add surfactants, oil concentrates, or other additives. DO NOT treat onions injured by sand, insects, or disease. DO NOT treat onions growing during periods of cloudy weather with high humidity or other low light intensity conditions that could result in "soft" foliage with a thinner-than-normal waxy layer on the leaf surface. DO NOT treat onions with less than 3 true leaves. DO NOT count the flag leaf.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Onion Maggot

Continuous planting of onions on the same ground will increase onion maggot problems. Flies migrate up to one-half mile. Rotation is extremely important to reduce onion maggot damage. Avoid mechanical injury to bulbs in the field or during harvesting. Damaged plants encourage maggot infestation. Bury cull piles.

Seed Treatment

Onion seed commercially-treated with Trigard is available (pelleted). Growers must purchase seed treated by seed company.

In-Furrow Planting Treatment

Note. In-furrow planting treatments may be more effective than postplanting treatments for onion maggot control. diazinon--2-4 qt AG500/A preplant or 1 qt AG500/A in-furrow at planting, or Lorsban (dry bulb only)--3.7 oz 15G/1,000 ft of row on 18-inch row spacing or 1.1 fl oz 4EC/1,000 ft of row on 18-inch row spacing as an in-furrow drench. Follow label instructions.

Postplanting Spray Treatment

First-brood adult flies first appear in early to mid-May. Second brood occurs in July, and third brood occurs in August to September. The fall maggots are most important, because maggots may end up in stored onions, causing onion rot.

Crushed onions or culls attract onion maggot flies. Rotate fields if possible and eliminate culls. Foliar applications of insecticides are not likely to control maggot flies. Flies spend most of their time outside onion fields and must be contacted with the insecticide during application for control to occur. If a spray is applied, apply directly over the row. Soak soil around base of seedlings. **Note:** Permethrin also has a repellent effect.

permethrin--4-8 fl oz 3.2 EC/A or OLF, or diazinon--1 pt 4EC/A or OLF, or Mustang MAX--2.24-4.0 fl oz/A, or malathion--3.0 pt 57EC/A, or Proaxis--1.92-3.2 fl oz/A

Cutworms

(Also see "Cutworms" section in Soil Pests--Their Detection and Control.)

lambda-cyhalothrin--1.92-3.2 fl oz/A (bulb only) or OLF, or Lannate--3 pt LV/A or OLF, or Mustang MAX--2.24-4.0 fl oz/A, or Proaxis--1.92-3.2 fl oz/A (bulb only)

Leafminers

Entrust--1-2 oz 80W, or

Spintor--3-6 fl oz 2SC/A, or
Trigard--2.66 oz/A

Thrips

Frequently, thrips populations increase following adjacent alfalfa or grain harvest.

diazinon--1 pt 4EC/A or OLF, or
lambda-cyhalothrin--2.56-3.84 fl oz/A (bulb only) or OLF, or
Lannate--1.5 pt LV/A or OLF, or
Mustang MAX--2.88-4.0 fl oz/A, or
Pennacp-M--2 pt 2FM/A, or
permethrin--6-12 fl oz 3.2EC/A or OLF, or
Radiant--6-10 fl oz SC/A

Note: use of Entrust/Spintor for leafminer control will suppress thrips population.

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
diazinon 4EC	R	24	10
Entrust	G	4	1
lambda-cyhalothrin	R	24	14
Lannate, dry onions	R	48	7
Lannate, green onions	R	48	7
Lorsban	R	24	At plant
malathion	G	12	3
Mustang MAX	R	12	7
Pennacp-M	R	48	15
permethrin	R	12	1
Proaxis	R	24	14
Radiant	G	4	1
Spintor	G	4	1
Trigard	G	12	60(At plant) 7(foliar)
FUNGICIDE (FRAC code)			
chlorothalonil, dry onions (Group M5)	G	12	7
chlorothalonil, green onions (Group M5)	G	12	14
copper, fixed (group M1)	G	24	0
Endura (Group 7)	G	12	7
Forum (Group 40)	G	12	0
iprodione (Group 2)	G	24	7
mancozeb (Group M3)	G	12, 24	7
Maneb (Group M3)	G	24	7
Pristine (Groups 11 + 7)	G	12	7
Quadris (Group 11)	G	4	0
Quadris Opti (Groups 11 + M5)	G	12	14
Ridomil Gold (Group 4)	G	48	0
Ridomil Gold Bravo, dry onions (Groups 4 + M5)	G	48	7
Ridomil Gold Bravo, green onions (Groups 4 + M5)	G	48	21
Ridomil Gold MZ (Groups 4 + M3)	G	48	7
Switch (Group 9 + 12)	G	12	7

See Table D-6.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Disease Control

Damping-Off

Apply Ridomil Gold 4E at 0.5 to 1 pint per acre broadcast or banded immediately after seeding in the field.

Downy Mildew

The pathogen can survive as oospores in the soil, or as mold on bulbs, sets and seed. Downy mildew development is promoted by cool, moist conditions. Control begins with planting disease-free seed or sets and crop rotations of at least 3 years without related crops. Apply the following fungicides accordingly:

mancozeb or maneb--3 lb 75DF/A, applied at 7-day intervals, or alternated with:

Ridomil Gold Bravo--2 lb 81WP/A, applied at 14 day intervals, or

Ridomil Gold MZ--2.5 lb 68WG/A, applied at 14-day intervals, or

Quadris Opti--2.4-3.6 pt 5.5SC/A, apply in alternation with a fungicide that has a different mode-of-action on 5 to 7 day intervals

If purple blotch and Botrytis blight are present, use the higher rate of Quadris Opti, and if Botrytis blight is severe, also consider tank mixing with iprodione (Rovral-1.5 pt 4F/A or OLF).

Forum--6 oz 4.18SC/A (must be tank mixed with a product that is effective on downy mildew and has a different mode-of-action)

Purple Blotch (Alternaria)

The pathogen overwinters as mold in plant residue from onion-related plants. Purple blotch development is promoted by warm, moist conditions. Grow onions in well drained soil and rotate with non-related crops. Sweet Spanish types are especially susceptible to purple blotch.

Several of the most effective fungicides and mixtures of fungicides for purple blotch are listed below. Applications may be needed every 7 days for proper control. Rotate fungicides in different FRAC codes to slow the development of fungicide resistance (**NOTE:** iprodione applied at the high rate, and Pristine are labeled for use at 14-day intervals)..

Quadris--6.2-12.3 fl oz + mancozeb, 3 lb 75DF/A + fixed copper at labeled rates at 7 to 10 day intervals, or

chlorothalonil--1.5-3 pt 6F/A or OLF + mancozeb, 3 lb 75DF/A + fixed copper at labeled rates at 7 to 10 day intervals (14-day preharvest interval for green bunching onions), or

chlorothalonil--1.5-3 pt 6F/A or OLF + mancozeb, 3 lb 75DF/A + Rovral, 1 pt 4F/A at 7 to 10 day intervals (14-day preharvest interval for green bunching onions), or

Endura--6.8 oz 70WG/A, or

Pristine--10.5-18.5 oz 38W/A at 14-day intervals (also will provide suppression of downy mildew), or

Quadris Opti--1.6-3.2 pt 5.5SC/A, or

iprodione (Rovral)--1.5 pt 4F/A or OLF at 14-day intervals (for dry bulb onions only), or

Switch--11-14 oz 62.5WG/A at 7 to 10 day intervals, or

Switch--11-14 oz 62.5WG/A + mancozeb, 3 lb 75DF/A + fixed copper at labeled rates at 7 to 10 day intervals.

Botrytis Leaf Blight

The pathogen overwinters in cull piles, on onion debris

in the soil, and as sclerotia where related crops were recently grown. Botrytis leaf blight is promoted by moist, cool to mild conditions. Eliminate sources of inoculum and rotate 2 or 3 years between onion-related crops. Fungicide applications can be delayed until there is an average of 1 lesion on 10 leaves.

Apply and alternate between the following:

chlorothalonil--2-3 pt 6F/A or OLF *plus* fixed copper at labeled rates 7- to 10-day intervals (14-day preharvest interval for green bunching onions), or Quadris Opti (azoxystrobin + chlorothalonil)--1.6-3.2 pt 5.5SC/A, or Endura--6.8 oz 70WG/A, or Pristine--14.5-18.5 oz 38WG/A, or iprodione (Rovral)--1.5 pt 4F/A or OLF at 14-day intervals (for dry bulb onions only)

Always alternate between materials from different FRAC codes to reduce chances for fungicide resistance development.

White Rot

Use one of the following as a preplant soil fumigant and allow a 2- to 3-week waiting period after fumigation before seeding the fall crop.

Telone C-35--13-20.5 gal/A, or Vapam HL--50-75 gal/A

Neck Rot

Windrow plants to ensure dry tops before topping operation. iprodione (Rovral)--1.5 pt 4F/A or OLF at 14-day intervals (for dry bulb onions only)

PARSLEY

Varieties

Varieties¹

Varieties ¹	
Flat Leaf	These varieties are recommended for DE, MD, NJ, PA, VA, WV
Dark Green Italian (celery leaf)	
Single (overwinter)	
Curly	These varieties are recommended for DE, MD, NJ, PA, VA, WV
Banquet (overwinter)	
Forest Green	
Triple Moss Curled	

¹ Varieties listed alphabetically.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Parsley	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
150-175 ¹	200 ¹	150 ¹	100 ¹	200 ¹	150 ¹	100 ¹	
50-75 ²	200 ²	150 ²	100 ²	200 ²	150 ²	100 ²	
25-50 ³	0	0	0	0	0	0	
25-50 ⁴	0	0	0	0	0	0	

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress after first cutting

⁴ Sidedress after each additional cutting

Seeding and Spacing

Seed is sown 1/3 inch deep in a well-prepared seedbed beginning April 5. Later plantings can be seeded through July 10. Spacing between rows is 15 to 18 inches. Usual seeding rate is 20 to 40 pounds per acre. Seed is slow to germinate. If seed is more than 1 year old, have germination checked and adjust seeding rate accordingly.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in parsley.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Preemergence

Linuron--0.5-1 lb/A. Apply 1 to 2 pounds per acre Lorox 50DF or 1 to 2 pints Lorox 4L immediately after seeding. Follow with irrigation if rainfall does not occur. Primarily controls broadleaf weeds. Annual grasses may only be suppressed.

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses

may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more **than 3 pints per acre in one season**. Labeled for use in Parsley and Cilantro.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Aphids

Assail--2-4 oz 30SG/A, or
 Beleaf--50 SG (see label for rates), or
 Fulfill--2.75 oz 50WDG/A, or
 imidacloprid (soil, foliar)--see label for rates and application methods, or
 malathion--1-2 pt 8EC/A or OLF
 Venom--5-6 oz (soil); 1-3 foz (foliar) 70SG/A

Armyworms

Avaunt--3.5-6 oz WDG/A, or
Bacillus thuringiensis--Consult label for rates and restrictions., or
 Confirm--8 fl oz 2F/A, or
 Entrust--1.25-2.5 oz 80W/A, or
 Intrepid--4-8 fl oz 2F/A (early season) or 8-10 fl oz 2F/A (late season), or
 Larvin--16-30 fl oz 3.2F/A, or
 Proclaim--2.4-4.8 oz 5SG/A, or
 Radiant--5-10 fl oz SC/A, or
 SpinTor--4-8 fl oz 2SC/A

Flea Beetles, Leafhoppers, Tarnished Plant Bugs

imidacloprid (soil, foliar)--see label for rates and application methods (FB, LH only), or
 Baythroid XL--2.4-3.2 fl oz/A, or
 permethrin--2-8 fl oz 3.2EC/A (leafhoppers only) or OLF, or
 Sevin--1.25 lb 80S/A or OLF
 Venom--5-6 oz (soil); 1-3 oz (foliar) - leafhopper only

Carrot Weevil

Guthion--A Special Local-Needs Label 24(c) is in effect in New Jersey for the use of 1 lb 50WP. DO NOT exceed three applications.

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
INSECTICIDE			
Assail	G	12	7
Avaunt	G	12	3
Baythroid XL	R	12	0
Beleaf	G	12	0
Confirm	G	4	7
Entrust	G	4	1
Fulfill	G	12	7
Guthion	R	5 days	21
imidacloprid (soil/foliar)	G	12	21/7
Intrepid	G	4	1
Larvin	G	12	14
malathion	G	12	21
Mustang MAX	R	24	1
permethrin	R	12	1
Proclaim	R	48	7
Radiant	G	4	1
Sevin	G	12	14
SpinTor	G	4	1
Venom (soil/foliar)	G	12	21/7
FUNGICIDE (FRAC code)			
copper, fixed (Group M1)	G	24	0
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	48	21
Ultra Flourish (Group 4)	G	48	--

See Table D-6.

¹ G = general, R - restricted

Nematode Control

Nematode control is essential for satisfactory parsley production. See "Nematodes" section of Soil Pests-Their Detection and Control. Before planting, soil should be fumigated with metam-sodium (Busan or Vapam HL) according to directions in the "Soil Fumigation" section.

Disease Control

Damping-off

Apply the following as a soil surface spray immediately after seeding:

mefenoxam--1-2 pt Ridomil Gold 4EC/A or 2-4 pt Ultra Flourish 2E/A

Bacterial and Fungal Leaf Spots (*Septoria leaf spot*)

To help reduce disease pressure from bacterial and fungal diseases do not plant parsley continually in the same field. Rotate with non-related crops for at least 2 years. Space successive plantings in the same year as far apart as possible. Heavy winds and rain may damage leaves and predispose plant to bacterial infections.

Bacterial leaf spots: Avoid working in the fields while the foliage is wet to help reduce spread. Prevention is key to reducing spread of the pathogen. Scout fields on a regular

basis for early symptoms, apply the following and repeat every 7 days.

copper, fixed at labeled rates.

Fungal leaf spots: Early detection and prevention is key to controlling septoria leaf spot. Severe losses will occur if not controlled properly. Scout daily, if leaf spots are detected, alternate the following every 7 days.

Alternate:

Quadris--6.2-15.4 fl oz 2.08F/A (Do not make more than 4 applications per growing season)

With:

copper, fixed--at labeled rates.

PARSNIPS

Varieties

Varieties¹

All America	These varieties
Javelin*	are recommended for
Harris Model	DE, MD, NJ, PA, VA, WV

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Parsnips	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
	50-75 ¹	150 ¹	100 ¹	50 ¹	150 ¹	100 ¹	50 ¹
	25-50 ²	150 ²	100 ²	50 ²	150 ²	100 ²	50 ²
	25-50 ³	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress 4-5 weeks after planting

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Seeding and Spacing

Seed in March and April. The seeds germinate slowly. Never use seed that is more than 1 year old.

Seed 3 to 5 pounds per acre at a depth of 1/4 to 3/8 inch in rows 18 to 30 inches apart. Adjust seeder to give 8 to 10 plants per foot of row. Thin seedlings to 2 to 4 inches in the row.

Harvesting and Storage

Parsnips may be dug, topped, and stored at 32°F (0°C) at 90 to 95 percent 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.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Preemergence

Linuron--0.75-1.5 lb/A. Apply 1.5 to 3 pounds per acre Lorox 50DF or 1.5 to 3 pints per acre of Lorox 4L right after seeding. Plant seed at least 1/2 inch deep.

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Aphids

diazinon--0.5-1 pt 4EC/A or OLF, or imidacloprid (soil, foliar)--see label for rates and application methods, or malathion--1.5-2 pt 57EC/A

Leafhoppers

Baythroid XL--1.6-2.8 fl oz/A, or imidacloprid (soil, foliar)--see label for rates and application methods, or Sevin--1.25 lb 80S/A or OLF

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Baythroid XL	R	12	0
diazinon 4EC	R	24	10
imidacloprid (soil/foliar)	G	12	21/7
malathion	G	12	7
Sevin	G	12	3

(table continued next page)

(continued)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	10
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	48	0

See Table D-6.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Disease Control

Damping-Off

Apply the following preplant incorporated or as a soil-surface spray after planting.

Ridomil Gold--1-2 pt 4EC/A

Leaf Spots, Canker, and Mildew

Rotate to allow 2 years between parsnip plantings. Plant in well-drained soils with a pH of 7.0. Ridge soil over shoulders to prevent infection. Begin sprays at the first sign of disease. Repeat no more than three times at 10-day intervals.

Alternate:

chlorothalonil--1.5-2 pt 6F/A or OLF

With one of the following FRAC code 11 fungicides:

Quadris--9.2-15.4 fl oz 2.08F/A, or

Cabrio--8-12 oz 20EG/A

Do not make more than one consecutive application of Quadris or Cabrio.

PEAS

Peas thrive in cool weather and tolerate frost. Planting for processing is based on the heat-unit theory. First plantings can be made as soon as soil can be tilled in the spring. Do not attempt plantings after April 30. Inoculation of seed enhances early nodule formation.

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Processing					
Early Freezer 680	D	M	N	P	
Bolero	D	M	N	P	
Market					
Olympia (BV-2,EVR,FR,PMR)		M		P	
Progress No. 9	D	M	N		V
Knight		M	N	P	V
Nordic	D				
Novella II (FR)				P	
Green Arrow		M		P	V
Mayfair		M			

(table continued)

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Edible Pod: Flat					
Dwarf Gray Sugar (FR)				P	
Oregon Sugar Pod #2		M		P	V
Edible Pod: Round					
Sugar Ann				P	V
Sugar Snap (trellis type)(FR)	D	M	N	P	
Super Sugar Snap (trellis type)	D	M	N	P	

¹ Varieties listed by maturity within types, earliest first.

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Peas	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med	Opt.	Low Pounds K ₂ O per Acre	Med	Opt.
	40-80 ¹	120 ¹	80 ¹	40 ¹	120 ¹	80 ¹	40 ¹

¹ Broadcast and disk-in before seeding.

Seed Treatment

Use seed already treated with an approved seed treatment, or treat seed with a slurry or dust that contains an approved commercial fungicide-insecticide mixture. For disease control, use seed treated with Maxim 4FS (0.08-0.16 fl oz/100 lb seed) for Rhizoctonia & Fusarium control and Apron XL LS (0.16-0.64 fl.oz/100 lb seed) for Pythium control.

Seeding and Spacing

Peas can be planted between February 25 and April 30 when soil conditions are favorable. For processing peas, drill 250 to 275 pounds of seed per acre in rows 6 to 8 inches apart. For market peas, seed 80 to 120 pounds per acre in 30-inch rows. Seed at a depth of no more than 1 inch unless soil is dry. Use press wheel drill or seeder to firm seed into soil.

Harvest

Processing peas are ready between May 20 and June 30.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Preplant Incorporated or Preemergence

Imazethapyr--0.024-0.032 lb/A. Apply 1.5 to 2.0 fluid ounces per acre Pursuit 2SC. Shallow, thorough incorporation improves consistency of performance when dry weather follows

application. Primarily controls broadleaf weeds. Use in combination with another herbicide to control annual grasses. Pursuit residues persist in the soil after harvest and may affect following crops. Incorporation may increase the persistence of soil residues. Do not make more than one application of Pursuit per acre per year. Follow label instructions pertaining to following crops.

Preemergence

Clomazone--0.188-0.38 lb/A. Apply 8 to 16 fluid ounces Command 3ME preemergence to control annual grasses and many annual broadleaf weeds, except pigweed sp. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Some temporary injury, seen as a partial whitening of leaf and/or stem of the crop, may be observed after seedling emergence. Complete recovery from early injury will occur without affecting yield or delaying maturity.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. DO NOT apply when wind or weather conditions favor spray drift. Avoid preemergence applications when fields are adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from off-site Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in peas. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command has been used for weed control in peas.

S-metolachlor—0.48-96 lb/A. Apply 0.5 to 1.0 pints per acre Dual Magnum 7.64E (or OLF). Primarily controls annual grasses, suppresses yellow nutsedge, and suppresses or controls certain annual broadleaf weeds including pigweed species and nightshade species. Common lambsquarter and common ragweed will NOT be controlled. Recommended rates may be lower than the labeled rate to reduce the risk of crop injury. The use of less than 1 pint of Dual Magnum may reduce the duration or level of control of some weeds. Cold wet weather after application increases the risk of crop injury, which may delay maturity. Use the minimum recommended rate, or choose another herbicide when cold wet weather is anticipated after planting. Do NOT use Dual Magnum on peas in the New England states, New York, or Pennsylvania. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Postemergence

Bentazon--0.75-1 lb/A. Apply 1.5 to 2 pints per acre Basagran 4SC after peas have more than three pairs of leaves. Do not add oil concentrate. Ground application in a minimum of 20 gallons per acre is preferred. For broadleaf weed control only. See label for weed size for effective control.

Clethodim--0.094-0.125 lb/A. Apply 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. Control may be reduced if

grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 21 days.

Quizalofop-P-ethyl--0.04-0.08 lb/A. Apply 6 to 12 fluid ounces Assure II/Targa 0.88EC per acre postemergence to control most annual and perennial grasses. Add with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Do not tank-mix with other pesticides unless labeled, as the risk of crop injury may be increased or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 14 fluid ounces per acre in one season.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within one week before or after Basagran or any other pesticide unless labeled. The risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 4 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Seed Maggots

Seed Applied Treatments:

Lorsban 50W --2 fl oz per 100 pounds of seed by applying as a slurry treatment prior to planting, *plus* Apron XL LS (0.32 to 0.64 fluid ounce) per 100 pounds of seed
Cruiser 5FS - 1.28 fl oz/100 lbs of seed

Cutworms

See the "Cutworms" section in Soil Pests--Their Detection and Control and Table 32.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Mustang MAX--1.28-4.0 fl oz/A, or
lambda-cyhalothrin--1.92-3.20 fl oz/A or OLF, or
Lannate--1.5 pt LV/A (succulent peas only) or OLF, or
Sevin Bait--30 lb 5% bait/A

Pea Aphid

Treat when there are 5 to 10 aphids per plant or 50 or more aphids per sweep in a 15-inch sweep net.

dimethoate--0.5 pt 2.67 EC/A or OLF, or
imidacloprid (soil, foliar)--see label for rates and application methods, or

Lannate--1.5-3 pt LV/A or OLF, or
malathion--1.5 pt 57EC/A, or
Thionex--0.67-1.33 qt 3EC/A or OLF

Armyworm

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
Entrust--1.25-2 oz 80W/A, or
Lannate--1.5 pt LV/A or OLF, or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Mustang MAX--3.2-4.0 fl oz/A, or
Proaxis--2.56-3.84 fl oz/A, or
Radiant--4-8 fl oz SC/A, or
Sevin--1.25-1.88 lb 80S/A or OLF, or
SpinTor--4-6 fl oz 2SC/A

Alfalfa Looper, Alfalfa Caterpillar

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
Entrust--1.25-2 oz 80W/A, or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
Mustang MAX--2.72-4.0 fl oz/A, or
Proaxis--2.56-3.84 fl oz/A, or
Radiant (looper only)--4-8 fl oz SC/A, or
SpinTor--4-6 fl oz 2SC/A (loopers only), or
Thionex--0.67-1.33 qt 3EC/A (loopers only) or OLF

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
INSECTICIDE			
Asana XL	R	12	3
bifenthrin	R	12	3
dimethoate	R	48	0
Entrust	G	4	3
imidacloprid (soil/foliar)	G	12	21/7
lambda-cyhalothrin	R	24	7
Lannate	R	48	1
malathion	G	12	3
Mustang MAX	R	12	1
Proaxis	R	24	7
Radiant	G	4	3
Sevin/Sevin Bait	G	12	3
SpinTor	G	4	3
Thionex	R	24	5

(table continued)

Pesticide (continued)	Use Category ¹	Hours to Reentry	Days to Harvest
FUNGICIDE (FRAC code)			
Contans WG (biological)	G	4	0
Headline (Group 11)	G	12	7
Quadris (Group 11)	G	12	0
Ridomil Gold (Group 4)	G	48	--

See Table D-6.

¹ G = general, R = restricted

² 9 days = fresh, 24 hrs = processing

Disease Control

Downy mildew (*Peronospora viciae*)

Plant resistant varieties. Downy mildew development is favored by prolonged cool, wet weather conditions. Control strategies include crop rotations of 3 years or more. Avoid planting next to the previous years pea fields because the disease can overwinter on old debris. Downy mildew is also seed-borne and using seed treatments that are effective for downy mildew such as Allegiance FL or Apron XL can prevent primary systemic infections.

White Mold

Preplant. The following biological fungicide has been tested in some states; however, limited information is available on effectiveness in the Mid-Atlantic region. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches but **do not plow** before seeding beans to avoid untreated sclerotia in lower soil layers from infesting the upper soil layer.

Contans--2-4 lb 5.3WG/A

Fusarium Wilt

Use resistant varieties.

Damping-Off and Root Rot

Rotate and allow 4 to 5 years between pea plantings. Do not double crop with bean of any type. For damping-off and root rot caused by *Pythium*, apply the following as a broadcast treatment at seeding.

Ridomil Gold--0.5-1 pt 4E/A (*Pythium* only), or
Quadris--0.40-0.80 fl oz 2.08F/1000 ft row

Viruses

Use resistant varieties when possible and control aphids.

Bacterial Blight

Plant clean seed. Avoid walking through fields when vines are wet.

Ascochyta Blight

Plant fungicide treated seed. Follow a crop rotation that provides at least 2 years between pea plantings. If *Ascochyta* blight has been identified in a field, rotations should be extended to 4-5 years. Deeply incorporate crop debris immediately after harvest before the fungus can be dispersed by wind or rain. In fields with a history of blight apply one of the following FRAC code 11 fungicides preventatively:

Quadris--6.2-15.4 fl oz 2.08F/A, or
Headline--6-9 fl oz 2.1EC/A

PEPPERS

Peppers are a warm-season crop that makes its best growth at temperatures of 70° to 75°F (21.1° to 23.9°C). This crop is sensitive to temperature extremes. Poor fruit set and blossom drop can be expected when night temperatures drop below 60° (15.6°C) or day temperatures rise above 85°F (29.4°C).

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Bell Types					
Lantern*	D		N	P	
Alliance* (trial)					V
Aristotle* (PT,BLSR 1,2,3)	D	M	N	P	V
Lafayette* (yellow)				P	V
Vidi* (PVY,TEV,TMV) (long fruit)	D	M	N	P	
Paladin* (PR)	D	M	N	P	V
Revolution* (PT, BLSR,1,2,3,5, CMV)			N	P	
X3R Wizard* (BLSR 1,2,3;TMV)	D	M	N	P	
X3R Aladin* (yellow)					V
Admiral* (TMV,PVY,BLSR 1,2) (green/yellow)	D	M	N	P	
Zavory (mild Habanero, trial)				P	
Cherry Types					
Cherry Bomb*(hot)	D		N	P	
Large Red Cherry		M	N	P	V
Sweet Cherry			N	P	
Local strains	D	M	N	P	V
Sweet Frying Types					
Key Largo*	D	M	N	P	V
Aruba* (PR)	D		N	P	V
Navarone* (trial)				P	
X3R Key West (BLSR 1,2,3)	D		N		V
Biscayne*	D		N	P	
Giant Marconi*				P	
Cubanelle	D	M	N	P	V
Hot Types					
Volcano* (yellow)	D		N	P	
Surefire* (yellow)	D	M	N	P	V
Hot Portugal (red) (for plant sales)	D	M	N	P	V
Hungarian Wax (yellow)	D	M	N		V
Super Chili*				P	
Long Slim Cayenne		M		P	V
Tam Mild Chile-2 (PVY,TEV,TMV)		M		P	V
Tam Mild Jalapeno #1			N	P	V
Jalapeno M		M		P	V
Hot Types (continued)					
Elrey* (BLSR)					V
Eljete* (BLSR)					V
Cheese and Pimento Types					
Lipstick (pimento)				P	
Local strains			N	P	

¹ Varieties listed by maturity within each type, earliest first.

* Indicates hybrid variety.

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Peppers	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds	P ₂ O ₅	per	Pounds	K ₂ O	per
		Acre			Acre		
	100-130 ¹	200 ¹	150 ¹	100 ¹	200 ¹	150 ¹	100 ¹
	50 ²	200 ²	150 ²	100 ²	200 ²	150 ²	100 ²
	50 ³	0	0	0	0	0	0
	25-30 ⁴	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-ind

³ Sidedress after first fruit set

⁴ Sidedress later in season if needed.

Note: If crop is to be mulched with plastic but not drip/trickle fertilized, broadcast 150 pounds of nitrogen (N) per acre with recommended P205 and K20 and disk-in or incorporate prior to laying mulch. Apply 1 pound of boron (B) per acre if soil test for B is low.

Drip/Trickle Fertilization: see below for drip/trickle fertilization guides.

Seed Treatment

To minimize the occurrence of bacterial leaf spot, dip seed in a solution containing 1 quart of Clorox and 4 quarts of water plus ½ teaspoon of surfactant for 1 minute. 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. Dust or slurry with 1 teaspoon of thiram 75WP per pound of seed.

Planting and Spacing

Transplant into the field May 1 to May 30 for summer harvest. In Virginia and warm areas, transplant July 25 to August 1 for fall harvest.

Space rows 4 to 5 feet apart. Set plants 12 to 18 inches apart in the row. Select fields with good drainage. Plant on raised, dome-shaped beds to aid in disease control. To minimize sunscald when growing peppers on sandy soils and on plastic mulch without drip irrigation, plant varieties that have excellent fruit cover.

Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5 and then apply enough farm-grade fertilizer to supply 50 pounds (40 pounds in Pennsylvania) per acre of N, P₂O₅, and K₂O and then thoroughly incorporate into the soil. If the soil tests medium or less in soil potassium, apply a fertilizer with a ratio of 1-1-2 or 1-1-3 carrying 50 pounds of nitrogen per acre.

After mulching and installing the trickle irrigation system, apply completely soluble fertilizers to supply 30 pounds (15 pounds in Pennsylvania) of N, P₂O₅, and K₂O per fertilized-

mulched acre during each application. (A description of a fertilized-mulched acre may be found in the "Irrigation" section of this publication.) In Pennsylvania, do not exceed 80 to 90 pounds of N per acre per season. On soils testing low and low to medium in boron, also include 0.25 pound of actual boron per fertilized-mulched acre in each soluble fertilizer application. **For convenience, rates of fertilizer can be converted from a mulched acre to linear foot basis. See Table C-8.**

The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting peppers. The same rate of soluble fertilizer should be applied about every 3 weeks during the growing season for a total of 6 applications through the trickle irrigation system. The soluble fertilizer may be delivered in 12 equally timed applications through the growing season, provided the soluble nutrients are applied at half the above suggested rates per application so that the total seasonal rates of N, P₂O₅, and K₂O and B are the same. The number of fertilizer applications can be reduced for late plantings and in areas where the growing season is short. These rates were developed on sandy loam soils with a cation exchange capacity (CEC) of 3 to 5. If your soil has a lower CEC, you may wish to increase the total seasonal soluble fertilizer nutrient rates by at least one-third. On very coarse, very low CEC soils, it may be profitable to increase the total seasonal soluble fertilizer nutrient rates two-thirds over the first suggestion. On the heavier textured soils with CEC above 3 to 5, you may wish to decrease the total seasonal soluble fertilizer nutrients by one-half to three-quarters. If you are farming very heavy soils with high CEC, you may wish to apply all the total seasonal plant nutrient requirements (according to soil test) preplant before mulching and installing the trickle irrigation system and then just apply water through the trickle irrigation through the growing season.

Mulching

The use of black plastic mulch with drip irrigation and double rows can greatly increase yields and percentage of No. 1 sized peppers. Use opaque, white plastic when planting in the summer for fall harvest. Plant on raised, dome-shaped beds to aid in disease control. Plant double rows 12 to 15 inches apart with plants staggered 12 to 18 inches apart in each of the double rows. Use 5-foot wide plastic for double rows and 4-foot wide plastic for single row peppers. Do not use plastic mulch without trickle irrigation on sandy soils.

Staking

Staking peppers helps protect fruit from sunburn by holding the plants in an upright position. Use 2- to 2½-foot long by 1¼ x 1½-inch Honduran pine stakes (half length tomato stakes). Drive stakes 6 to 8 inches into the soil every 4 to 5 feet in the plant row. Tie plants with polyethylene string that is used for staked tomatoes. Tie the first string 7 to 9 inches above the soil when plants are 10 to 12 inches tall or at first fruit set. For single row peppers, run the string on one side of the row, looping and tightening string around each stake for about 100 feet. Then run the string back on the opposite side of the plant row using the same procedure. Allow 3- to 4-foot untied breaks every 100 feet to make harvesting easier. For double rows of peppers, use one row of stakes in each row of peppers. Tie each row separately as described above for single row peppers.

A second tie should be made at 6 to 8 inches above the

first string and before peppers enlarge and fall over the first string. Use the same procedure described above. An alternate method for applying the second string in single and double rows is to run a single string in the center of the plant canopy of each row, allowing the branches to grow up through the string and be caught and supported by the string. Consider the cost of staking versus reduction in losses and increases in quality and price received when making a decision about staking peppers. The higher price offered for red peppers increases the potential for profit when staking for the red compared to the green market.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tube left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tube several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Transplants

S-metolachlor--0.63-0.95 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in transplanted bell peppers in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability provided by the local growers association has been signed by the grower, all fees have been paid, and a label has been provided by the association.** Apply 0.67 to 1 pints per acre Dual Magnum 7.62E to control annual grasses, yellow nutsedge, galinsoga, and certain other broadleaf weeds. Use as a surface-applied

pretransplant spray before laying the plastic mulch, or as a directed basal spray after establishment. DO NOT preplant incorporate Dual Magnum. Make only one application during the growing season. DO NOT apply within 65 days of harvest. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for use in transplanted bell peppers only in DE, NJ, and PA! Labeled for use in bell, chili, Cubanelle, and tabasco peppers in Delaware, Maryland, and New Jersey.**

Seeded and Transplants

Clomazone--0.25-0.5 lb/A. Apply 0.66 to 1.33 pints per acre Command 3ME pretransplant before laying plastic mulch. Use the lower rate on fields with coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops or a winter crop. Use higher rates on fields with fine-textured soils and those with high organic matter, or to improve control of certain weeds, including common cocklebur. Command is an excellent broad-spectrum herbicide that will control annual grasses and most broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge. Combine with Devrinol or Dual Magnum (transplants only) to improve the control of carpetweed and pigweed sp. Labeled for use on all varieties including bell, hot, pimento, and sweet (except banana). See WARNING below.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Immediate incorporation will reduce or eliminate vapor drift. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used preplant incorporated for weed control in peppers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used for weed control in peppers.

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation

(optional) before herbicide application between the rows.

2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preplant (surface applied)

Transplants

Pendimethalin—0.48 – 1.42 lb/A. Apply 1 to 3 pints per acre Prowl H₂O as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use the lower rate on coarse-textured or sandy soils. **Do NOT apply “over the top” of the crop, or severe injury may occur. Observe a 70 day PHI (PreHarvest Interval). Labeled for use on bell pepper, chili pepper, cooking pepper, pimento, and sweet pepper.**

S-metolachlor--0.63-0.95 lb/A. A **Special Local-Needs Label 24(c)** has been approved for the use of Dual Magnum 7.62E to control weeds in transplanted bell peppers in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia. The use of this product is legal **ONLY** if a waiver of liability provided by the local growers association has been signed by the grower, all fees have been paid, and a label has been provided by the association. Apply 0.67 to 1 pints per acre Dual Magnum 7.62E to control annual grasses, yellow nutsedge, galinsoga, and certain other broadleaf weeds. Use as a surface-applied banded directed shielded spray, preemergence to the weeds. Posttransplant banded directed shielded sprays should be applied to weed-free soil. Dual Magnum will not control emerged weeds. Control emerged weeds with Gramoxone added to the shielded and directed banded herbicide spray. Make only one application during the growing season. DO NOT apply within 65 days of harvest. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for use in transplanted bell peppers only in DE, NJ, and PA! Labeled for use in bell, chili, Cubanelle, and tabasco peppers in Delaware, Maryland, and New Jersey.**

Seeded and Transplants

Clomazone--0.25-0.75 lb/A. Apply 0.66 to 2 pints per acre Command 3ME pretransplant as a banded directed

shielded spray. Use the lower rate on fields with coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops or a winter crop. Use higher rates on fields with fine-textured soils and those with high organic matter, or to improve control of certain weeds, including common cocklebur. Command is an excellent broad-spectrum herbicide that will control annual grasses and most broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge. Combine with Devrinol or Treflan (transplants only) to improve the control of carpetweed and pigweed sp. Labeled for use on all varieties including bell, hot, pimiento, and sweet (except banana). See WARNING below.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Immediate incorporation will reduce or eliminate vapor drift. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used preplant incorporated for weed control. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used for weed control in peppers.

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use the lower rate on coarse-textured or sandy soils. May reduce stand of and yield of fall grains. Mold-board plowing will reduce the risk of injury.

Postemergence

DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre Dacthal 6F 4 to 6 weeks after transplanting for preemergence weed control. Emerged weeds will not be controlled. Dacthal will not injure crop foliage. Spray broadcast when crop is grown without plastic mulch or band between the rows when plastic mulch is used. Controls late season annual grasses, common purslane, and other broadleaf weeds.

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a banded directed shielded spray to the soil strips of peppers grown on plastic mulch ONLY to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). DO NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and

up to a month for the weed to die. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. . DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied in one year.

Pendimethalin--0.48 – 1.42 lb/A. Apply 1 to 3 pints per acre Prowl H₂O as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds preemergence. Tank-mix with paraquat to control emerged weeds. Use the lower rate on coarse-textured or sandy soils. **Do NOT apply “over the top” of the crop, or severe injury may occur. Observe a 70 day PHI (PreHarvest Interval). Labeled for use on bell pepper, chili pepper, cooking pepper, pimiento, and sweet pepper.**

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone Inteon 2SC as a banded directed shielded spray between the rows ONLY, to control emerged grass and broadleaf weed seedlings. Do not allow spray to contact plants as injury or residues may result. Use shields to prevent spray contact with crop plants. Do not exceed a spray pressure of 30 psi. Add wetting agent as per label.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control

annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

For Transplanting Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Planting into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preplant Incorporated

Transplants

Trifluralin--0.5-1 lb/A. Apply 1 to 2 pints per acre Treflan 4E. Incorporate into 2 to 3 inches of soil within 8 hours after application. Slight stunting may result if weather is cool and damp.

Seeded and Transplants

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators to control most annual grasses and certain broadleaf weeds. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

Trifluralin--0.5-1 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Trilin in Maryland.** Apply 1 to 2 pints per acre Trilin prior to transplanting. Incorporate to a depth of 3 inches. Use the lower rate on coarse-textured soils low in organic matter, and the higher rate on fine-textured soils with high organic matter. Avoid planting during periods of cold, wet weather to reduce the risk of temporary stunting.

Preplant (soil surface applied)

Transplants

S-metolachlor--0.63-0.95 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in transplanted bell peppers in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability provided by the local growers association has been signed by the grower, all fees have been paid, and a label has been provided by the association.** Apply 0.67 to 1 pints per acre Dual Magnum 7.62E to control annual grasses, yellow nutsedge, galinsoga, and certain other broadleaf weeds. Use as a surface-applied pretransplant spray, or as a directed basal spray after establishment. DO NOT preplant incorporate Dual Magnum. Posttransplant directed sprays should be applied to weed-free soil. Dual Magnum will not control emerged weeds. Cultivate and/or hoe to control emerged weeds before treatment. Make only one application during the growing season. DO NOT apply within 65 days of harvest. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop. Labeled for use in transplanted bell peppers only in DE, NJ, and PA! Labeled for use in bell, chili, Cubanelle, and tabasco peppers in Delaware, Maryland, and New Jersey.**

Seeded and Transplants

Clomazone--0.25-0.75 lb/A. Apply 0.66 to 2 pints per acre Command 3ME pretransplant. Use the lower rate on fields with coarse-textured soils low in organic matter, when weed pressure is light, or to minimize herbicide carryover that could affect subsequent crops or a winter crop. Use higher rates on fields with fine-textured soils and those with high organic matter, or to improve control of certain weeds, including common cocklebur. Command is an excellent broad-spectrum herbicide that will control annual grasses and most broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge. Combine with Devrinol or Treflan (transplants only) to improve the control of carpetweed and pigweed sp. Labeled for use on all varieties including bell, hot, pimento, and sweet (except banana). See WARNING below.

WARNING: Command spray *or* vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Immediate incorporation will reduce or eliminate vapor drift. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, **fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.**

Herbicide residues may limit subsequent cropping options when Command is used preplant incorporated for weed control in peppers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used for weed control in peppers.

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF prior to transplanting or seeding. Incorporate with one-half inch of sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use the lower rate on coarse-textured or

sandy soils. May reduce stand of and yield of fall grains. Mold-board plowing will reduce the risk of injury.

Postemergence

DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre Dacthal 6F 4 to 6 weeks after transplanting for preemergence weed control. Emerged weeds will not be controlled. Dacthal will not injure crop foliage. Controls late season annual grasses, common purslane, and other broadleaf weeds.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

Postharvest

With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Insect Control

Cutworms

(Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Preplanting Field Treatment

Just before transplanting, broadcast the following on soil surface:

Granules can be used in place of spray. Work treatment into top 4 inches of soil.

Postplanting Treatment

Confirm--6-8 fl oz 2F/A (early season) or 8-16 fl oz/A (late season), or
lambda-cyhalothrin--1.92-3.2 fl oz/A or OLF, or
Lannate--1.5 pt LV/A or OLF, or
Mustang MAX--2.24-4.0 fl oz/A, or
Proaxis--1.92-3.2 fl oz/A, or
Sevin Bait--40 lb 5% bait/A

Flea Beetle

Actara--2-3 oz 25WDG/A, or
Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--2.8 fl oz /A or
imidacloprid (soil)--see label for rates and application methods, or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Mustang MAX--2.24-4.0 fl oz /A or
permethrin--4-8 fl oz 3.2 EC/A, or OLF, or
Platinum--5-8 fl oz 2SC/A, or
Proaxis--2.56-3.84 fl oz/A, or
Renounce--2-3 oz 20WP or OLF
Sevin--1.25 lb 80S/A or OLF, or
Thionex--1-2lb 50 WP/A or OLF, or
Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A

Green Peach Aphid

Note. For best green peach aphid control during periods of drought, apply insecticide 2 to 3 days after irrigation. Thorough spray coverage beneath leaves is important when foliar sprays are used.

Actara--2-3 oz 25WDG/A, or
Assail--2-4 oz 30SG/A, or
Beleaf--1.7-2.8 oz 50SG/A, or
Fulfill--2.75 oz 50WDG/A, or
imidacloprid (soil, foliar)--see label for rates and application methods, or
Lannate--1.5-3 pt LV/A or OLF, or
Metasystox-R--2 pt 2SC/A, or
Orthene--0.5-1.0 lb 97S/A (Bell Peppers); 0.5 lb 97S/A(non-bells), or OLF, or
Platinum--5-8 fl oz 2SC/A, or
Thionex--1-2 lb 50WP/A or OLF, or
Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A

Pepper Maggot

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

dimethoate--0.5-0.67 pt 4EC/A or OLF, or
Mustang MAX--2.24-4.0 fl oz/A, or
Thionex--1-2 lb 50WP/A

Note. Use of Orthene for borer control will reduce pepper maggot infestations.

Pepper Weevil (PW)

PW is a pest occasionally imported on older transplants or transplants with flowers or fruit.

Actara--3-4 oz 25 WDG/A (see label for additional instructions), or
Assail--4 oz 30SG/A, or
bifenthrin--2.1-6.4 fl oz 2E/A or OLF, or
Kryocide--10-12 lb 96W/A, or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Mustang MAX--2.24-4.0 fl oz/A or
permethrin--4-8 fl oz 3.2EC/A or OLF, or
Proaxis--2.56-3.84 fl oz/A, or
Vydate--2-4 pt 2L/A

European Corn Borer (ECB)

Note. Begin treatments when fruit are ¼ to ½ inch in diameter or larger and ECB moths are being caught in either local pheromone or blacklight traps. Consult your county Extension agent or integrated pest management reports for additional information about trap catches, phenology predictions, and proper timing of sprays for ECB.

Asana XL--5.8-9.6 fl oz 0.66EC/A. Treat every 5 to 7 days, or
Avaunt--3.5 oz 30 WDG/A (Bell Pepper only), or
Baythroid XL--1.6-2.8 fl oz /A, or
bifenthrin--2.1-6.4 fl oz 2E/A or OLF, or
Confirm--8-16 fl oz 2F/A, or
Entrust--1.0-2.0 oz 80W/A, or
Intrepid--4-8 fl oz 2F/A (early season), 8-16 fl oz/A (late season), or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Lannate--3 pt LV/A or OLF. Treat every 5 to 7 days, or
Orthene--0.75-1.0 lb 97S/A (Bell Pepper only), or OLF, or
Mustang MAX--2.24-4.0 fl oz/A, or
permethrin (sweet, bell-type only)--8 fl oz 3.2EC/A, or OLF.
Treat every 5 to 7 days, or
Proaxis--2.56-3.84 fl oz/A, or
Radiant--5-10 fl oz SC/A, or
Renounce--2-3.5 oz 20WP or OLF
SpinTor--3-6 fl oz /A

Leafminers

abamectin (Agri-mek;generics available)--8-16 fl oz 0.15EC/A, or
Entrust--2.0-2.5 oz 80W/A, or
permethrin (sweet, bell type only)--4-8 fl oz 3.2EC/A or OLF, or
SpinTor--6-8 fl oz 2SC/A, or
Trigard--2.66 oz 75WSP (one packet)/A, or
Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A, or
Vydate--2-4 pt 2L/A

Corn Earworm (CEW), Hornworms(HW)

Control CEW and hornworms beginning in mid-July

Asana XL--5.8-9.6 fl oz 0.66EC/A (CEW only), or
Baythroid XL--1.6-2.8 fl oz /A, or
bifenthrin--2.1-6.4 fl oz 2E/A (CEW only) or OLF, or
Entrust--1-2 oz 80W, or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or

Mustang MAX--2.24-4.0 fl oz/A, or
Proaxis--2.56-3.84 fl oz/A, or
Proclaim--2.4-4.8 oz 5 SG/A, or
Radiant--5-10 fl oz SC/A, or
Renounce--2-3.5 oz 20WP (CEW only) or OLF, or
Sevin--1.5-2.5 lb 80S/A or OLF, or
SpinTor--3-6 fl oz 2SC/A, or
Thionex--1.33-2.67 pt 3EC/A (HW only)

Beet Armyworm

Avaunt--3.5 oz 30WDG/A, or
Confirm--8-16 fl oz 2F/A, or
Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-8 fl oz 2F/A (early season), 8-16 fl oz/A (late season), or
Lannate--1.5 pt LV/A or OLF, or
Proclaim--2.4-4.8 oz 5 SG/A, or
Radiant--5-10 fl oz SC/A, or
SpinTor--4-8 fl oz 2SC/A

Fall Armyworm

Avaunt--3.5 oz 30WDG/A, or
Confirm--8-16 fl oz 2F/A, or
Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-8 fl oz 2F/A (early season), 8-16 fl oz/A (late season), or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Lannate--1.5-3.0 pt LV/A or OLF, or
Mustang MAX--3.2-4.0 fl oz/A, or
Proaxis--2.56-3.84 fl oz/A, or
Proclaim--2.4-4.8 oz 5SG/A, or
Radiant--5-10 fl oz SC/A, or
SpinTor--4-8 fl oz 2SC/A

Cabbage Looper

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Avaunt--2.5-3.5 oz 30WDG/A, or
Baythroid XL--2.1-2.8 fl oz/A, or
Confirm--8-16 fl oz 2F/A, or
Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-8 fl oz 2F/A (early season), 8-16 fl oz 2F/A (late season), or
lambda-cyhalothrin--1.92-3.2 fl oz/A or OLF, or
Lannate--1.5-3.0 pt LV/A or OLF, or
Orthene--0.5-1.0 lb 97S/A, or OLF, or
permethrin (sweet, bell-type only)--4-8 fl oz 3.2EC/A or OLF, or
Proaxis--1.92-3.2 fl oz/A, or
Proclaim--2.4-4.8 oz 5 SG/A, or
Radiant--5-10 fl oz SC/A, or
Renounce--2.6-3.5 oz 20WP or OLF
SpinTor--4-8 fl oz 2SC/A

Thrips

Diseased plants should be rogued out. After spraying for thrips, place diseased plants in a plastic bag and remove from the field. Several species of thrips spread Tomato Spotted Wilt Virus. Scout for thrips and begin treatments when observed. Do not produce vegetable transplants with bedding plants in the same greenhouse.

abamectin (Agri-mek;generics available)--8-16 fl oz 0.15 EC/A, or
Assail--4 oz 30SG/A
Baythroid XL--2.1-2.8 fl oz /A, or

bifenthrin--2.1-6.4 fl oz 2E/A or OLF, or
 Entrust--1.25-2.5 oz 80W/A, or
 lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
 Proaxis--2.56-3.84 fl oz/A, or
 Radiant--6-10 fl oz SC/A, or
 Renounce--2.6-3.5 oz 20WP or OLF
 SpinTor--4-8 fl oz 2SC/A, or
 Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A, or
 Vydate--2-4 pt 2L/A

Note. Use of Orthene for aphid or ECB control will reduce thrips population.

Stink bugs

Actara--3-4 oz 25WDG/A, or
 Baythroid XL--1.6-2.8 fl oz /A, or
 lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
 Mustang MAX--3.2-4.0 fl oz/A, or
 Proaxis--2.56-3.84 fl oz/A, or
 Renounce--2-3.5 oz 20WP or OLF

Mites

Acramite--0.75-1.0 oz 50 WS/A, or
 abamectin (Agri-mek;generics available)--8-16 fl oz
 0.15EC/A, or
 bifenthrin--5.12-6.4 fl oz 2E/A or OLF, or
 Oberon--7.0-8.5 fl oz 2SC/A

Nematode Control

See "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or use Vydate L for control. Consult label before use.

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Acramite	G	12	3
Actara	G	12	0
abamectin (Agri-mek)	R	12	7
Asana XL	R	12	7
Assail	G	12	7
Avaunt	G	12	3
Baythroid XL	R	12	7
Beleaf	G	12	0
bifenthrin	R	12	7
Confirm	G	4	7
Entrust	G	4	1
Fulfill	G	12	0
imidacloprid (soil/foliar)	G	12	21/0
Intrepid	G	4	1
Kryocide	G	12	14
lambda-cyhalothrin	R	24	5
Lannate	R	48	3
Metasystox-R	R	48	3
Mustang MAX	R	12	1
Oberon	G	12	7
Orthene	G	24	7
Platinum	G	12	30
permethrin	R	12	3
Proaxis	R	24	5
Proclaim	R	48	7
Radiant	G	4	1
Renounce	R	12	7
Sevin/Sevin Bait	G	12	3

(table continued)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE (continued)			
SpinTor	G	4	1
Thionex	R	24	4
Trigard	G	12	0
Venom(soil/foliar)	G	12	21/1
Vydate	R	48	7
FUNGICIDE (FRAC code)			
Agri-Mycin/Agri-Strep (Group 25)	G	12	AP
Cabrio (Group 11)	G	12	0
copper, fixed (Group M1)	G	24	0
Flint (Group 11)	G	12	3
Forum (Group 40)	G	12	4
maneb (Group M3)	G	24	7
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	12	7
Ridomil Gold Copper (Groups 4 + M1)	G	48	7
Tanos (Groups 11 +27)	G	12	3
Terraclor (Group 14)	G	12	--
Ultra Flourish (Group 4)	G	12	7

See Table D-6.

¹ G = general, R = restricted; AP=At Plant

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

³ See restrictions.

Disease Control

Damping-Off

Use the disease-free planting mix described in Tables A-2 and A-3. Consideration should be given to using soilless mixes containing microorganisms that suppress damping-off fungi. Use of the following will assist in control:

SoilGard 12G--1-1.5 lb/cu yd of soilless mix

SoilGard is a naturally occurring soil fungus that is an antagonist to plant pathogenic fungi. Uniformly add SoilGard 12G when soilless mixes are being blended by mechanical devices. After one day of incubation (keep at room temperature), seed or transplants can be added to the treated mix.

Where planting mix is not used, pretreat seedbeds with metam-sodium (Vapam HL) at 0.75 quart per 100 square feet.

Bacterial Leaf Spot

Plant cultivars (X3R Aladin, Aristotle, Revolution, X3R Wizard, and X3R Key West) that have resistance to all three races of the pathogen that occur in the region. When producing transplants, be sure to use the Clorox seed treatment described under the preceding "Seed Treatment" section. Use disease-free seeds and a 2-year rotation in the seedbed and field. Apply streptomycin (Agri-Mycin 17, Agri-Strep) sprays (1 pound per 100 gallons, 1¼ teaspoons per gallon) when first true leaves appear and continue every 4 to 5 days until transplanting. Streptomycin cannot be used on transplants after they are field-planted.

In some years, there can be a high risk of developing Bacterial leaf spot when using southern-produced transplants. Be sure to use only certified transplants.

Loss from bacterial spot may be reduced by maintaining a high level of fertility. Maintaining high fertility levels will stimulate additional leaf formation to replace those lost

from bacterial spot infections. However, sufficient restraint must be used to ensure that plants do not become overly vegetative, or fruit set may be severely reduced. Where disease is present or anticipated, do not work in fields when plant surfaces are wet. Disk field as soon as possible after the growing season. This will hasten breakdown of the crop debris that is harboring the bacteria and minimize overwintering of the bacteria in the field.

Field sprays to reduce spread: Applying fixed coppers (see Table E-8 for listing of available fixed copper fungicides) at labeled rates plus maneb at 1.5 lb 75DF/A, or fixed copper (at labeled rates) or maneb at 1.5 lb 75DF/A plus Tanos at 8 – 10 oz 50WDG/A are of value in suppressing the spread of the disease. Begin shortly after transplanting and repeat every 7 to 10 days.

Anthracnose Fruit Rot

Anthracnose fruit rot is increasing in the mid-Atlantic region. Excessive fertility programs may create thick, dense canopies which reduce chemical control and create microclimates conducive for fruit infection. Scout on a regular basis as fruit begin to develop. Remove infected fruit from field.

Beginning at flowering:

Alternate:

maneb--1.5-3 lb 75DF/A or OLF every 7-10 days

With one of the following FRAC code 11 fungicides:

Quadris--6.2–15.4 fl oz 2.08F/A, or

Cabrio--8-12 oz 20EG/A, or

Flint--3-4 oz 50WDG/A, or

Tanos--8–10 oz 50WDG/A

Do not make more than two consecutive applications of any FRAC code 11 fungicide.

Bacterial Soft Rot

During periods of humid weather, the stem ends of harvested peppers may turn brown due to bacterial soft rot. If necessary, pack peppers dry without washing to minimize soft rot losses. If peppers must be washed, maintain 25 ppm of chlorine (1 tablespoon of Clorox per 8 gallons of water) in the wash water. Avoid washing peppers with water more than 10°F (6°C) cooler than the fruit temperature to prevent movement of bacteria into the stem end of the fruit.

Phytophthora Blight

Plant loss can be severe in all pepper types. Phytophthora blight typically develops in low-lying areas of fields after rain and can spread quickly throughout the entire field. Planting on a ridge or raised, dome-shaped bed will help provide better soil drainage. Use at least a 3-year crop rotation with crops other than peppers, cucurbits, lima and snap beans, eggplants, or tomatoes. In fields with low-lying, wet areas, plant only Phytophthora-tolerant cultivars, such as ‘Paladin’, ‘Aristotle’, or ‘Revolution’. In heavily-infested fields with a known history of Phytophthora blight, plant only tolerant cultivars to help reduce plant losses. If mefenoxam-insensitivity is known to exist in a field/farm, plant only tolerant cultivars. Do not apply mefenoxam in fields where mefenoxam-insensitivity is known to exist.

For control of the crown rot phase of blight, apply:

mefenoxam--1 pt Ridomil Gold 4EC/A or 1 qt Ultra Flourish 2E/A. Apply broadcast prior to planting or in a 12- to 16-inch band over the row before or after transplanting.

Make two additional postplanting directed applications at 1 pint Ridomil Gold 4E or 1 qt Ultra Flourish 2E per acre to 6 to 10 inches of soil on either side of the plants at 30-day intervals. Use formula in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold needed per acre when band applications are made.

When using polyethylene mulch, apply Ridomil Gold 4E at the above rates and timing by injection through the trickle irrigation system. Dilute Ridomil Gold 4E prior to injecting to prevent damage to injector pump.

For prevention of the stem and fruit rot phase of blight, apply the following on a 7- to 10-day schedule:

copper, fixed--at labeled rates or OLF, or

Ridomil Gold Copper--2.5 lb 65WP/A. Make three to four applications at 10- to 14-day intervals. (Only apply Ridomil Gold 4E at planting and 30 days later. The third application of Ridomil Gold 4E cannot be made when Ridomil Gold Copper is applied.)

The following materials are labeled for Phytophthora control on peppers, but there is little information on efficacy in the Mid-Atlantic region. For best results tank mix with a copper containing fungicide.

Forum--6.0 oz 4.18SC/A, or

Tanos--8-10 oz 50WDG/A

Blossom End Rot

This physiological disorder is caused by reduced calcium uptake and calcium movement into the fruit when soil moisture is low. To control blossom end rot, maintain proper soil calcium and nutrient balance. Avoid root pruning and damage. The most effective control is to maintain uniform, favorable soil moisture. This is especially important when cropping in raised beds for Phytophthora control, because soil in raised beds will dry more quickly than in flat bed culture.

Sunscauld

To reduce sunscauld, select varieties with good foliage cover. Maintain vigorous vegetative growth by following recommended fertilizer (especially nitrogen) program and timely irrigation. Harvest carefully to avoid damaging stems, branches and foliage.

Southern Blight (Sclerotium)

High soil moisture and temperature favor disease development. Long crop rotations with corn and small grains help reduce disease incidence. Additionally, use the following in the transplant water.

Terraclor--3 lb 75WP/100 gal of water or OLF and apply 0.5 pint per plant.

Verticillium Wilt

The verticillium fungus can attack and reproduce on a number of plants (eggplants, tomatoes, peppers, potatoes, and strawberries), and can survive in the soil for many years. Therefore, a long, proper crop rotation is necessary to reduce

verticillium wilt. DO NOT grow tomato, potato, strawberries, or eggplant in rotation or consecutively in the same field and never plant other solanaceous crops, such as eggplants or tomatoes, between pepper plantings.

Viruses

Tobacco mosaic virus (TMV): TMV is transmitted mechanically. Use resistant varieties to control TMV.

Aphid-transmitted viruses (PVX, CMV, TEV, PVY, and AMV): These viruses of pepper cannot adequately be controlled with insecticide applications, but symptom expression can be delayed through their use. Since aphids transmit the virus, growers may wish to use yellow trap pans containing water to determine when mass flights of winged aphids occur. Repeated applications of a contact aphicide at those times are most beneficial.

Thrips-transmitted virus (Tomato Spotted Wilt Virus, TSWV, and Impatiens Necrotic Spot Virus, INSV): Resistant varieties are available. TSWV can be severe on peppers during both greenhouse transplant and field production of the crop. INSV causes similar symptoms on peppers as TSWV; however, the virus is not as severe and does not limit production to the same extent as TSWV. Both viruses are transmitted by a number of thrips (Western flower thrips most notably) in a persistent manner (ie. thrips can transmit the virus during their entire life cycle). During transplant production, thrips can transmit the virus from infected ornamental plants (flowers). DO NOT GROW any ornamental bedding plants in the same greenhouse as pepper transplants. **Monitor greenhouses and scout fields regularly for thrips populations.** Begin an insecticide program once thrips are observed. When thrips are observed in the field, treat with an insecticide and rogue out any plant showing TSWV symptoms.

PUMPKINS AND WINTER SQUASH

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Pumpkins (less than 1 pound)					
Apprentice*					
Munchkin					
Wee-B-Little*					
Baby Boo					
Pumpkins (1 to 5 pounds)					
Baby Pam					
Ironsides*					
Baby Bear*					
Touch of Autumn*					
Pik A Pie*					
Snackjack* (edible seeds)					
Cannonball* (FM)					
Iron Man *					
Pumpkins (5 to 10 pounds)					
Small Sugar (BRT)					
Casper (white)					
Mystic Plus* (PMT)					
Hybrid Pam*					

These pumpkins varieties are recommended for DE, MD, NJ, PA, VA, WV

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Pumpkins (10 to 20 pounds)					
Magic Lantern* (PMT)					
Sorcerer*					
Charisma* (PM)					
Magician* (PMR, ZYMV)					
Gold Boullion*					
Pumpkins (more than 20 pounds)					
Pro Gold 510					
Conestoga Giant (trial)					
Howden Biggie					
Gladiator* (PM)					
Atlantic Giant					
Prize Winner					
Aladdin (PM)					
Gold Medal					
Winter Squash (Acorn Type)					
Table Ace*					
Tay Belle* (semi bush, PM)					
Table Gold					
Table Queen					
Autumn Queen					
Royal Ace (bush PM)					
Winter Squash (Butternut Type)					
Puritan Butternut					
Nicklow's Delight Butternut					
Bugle* (bush, PMT)					
Waltham Butternut					
Early Butternut					
Harris Butternut					
Winter Squash (Buttercup Type)					
Sunshine* (trial)					
Ambercup*					
Buttercup					
Sweet Mama					
These winter squash varieties are recommended for DE, MD, NJ, PA, VA, WV					
Winter Squash (Delicious Type)					
Golden Delicious					
Winter Squash (Hubbard Type)					
Hubbard Types					
Boston Marrow					
Spaghetti Squash					
Orangetti					
Stripetti					
Vegetable Spaghetti					
These squash varieties are recommended for DE, MD, NJ, PA, VA, WV					
Processing					
Golden Delicious					
Neck Pumpkin Types					
Hercules & Other Butternut Types					

¹ Varieties are listed by maturity within each type, earliest first.

* Indicates hybrid varieties

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

(continued)

Crop	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
Pumpkins and	50-100 ¹	150 ¹	100 ¹	50 ¹	200 ¹	150 ¹	100 ¹
Squash	25-50 ²	150 ²	100 ²	50 ²	200 ²	150 ²	100 ²
(Winter)	25-50 ³	0	0	0	0	0	0

¹Total amount nutrient recommended

²Broadcast and disk-in

³Sidedress when vines start to run

Seed Treatment

Check with seedsmen to determine if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 75WP (½ teaspoon per pound or 3 ounces per 100 pounds) and an approved commercially available insecticide.

Seeding and Spacing

Seed in the field between June 15 and July 5 in cooler areas, and between June 15 and July 15 in warmer, southern areas.

Base plant spacing on vine habit and average fruit size of the variety. **Note.** Fruit size may be decreased at closer spacings.

Large vine with fruit over 30 pounds: Rows 10 to 12 feet apart with 5 to 6 feet between plants in the row.

Large vine with fruit 12 to 25 pounds: Rows 7.5 to 9 feet apart with 4 feet between plants in the row.

Large/medium vine with fruit 8 to 15 pounds: Rows 6 to 7.5 feet apart with 3 to 4 feet between plants in the row.

Small vine/bush with fruit less than 8 pounds: Rows 5 to 6 feet apart with 2 feet between plants in the row.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tube left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tube several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.

2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for cucumbers to treat **Soil**

1. **Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation Spray preemergence herbicide(s), registered and (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s) recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E as a banded directed shielded spray preemergence to the weeds and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Ethalfuralin--0.38-0.75 lb/A. Apply 1 to 2 pints per acre Curbit 3E as a banded directed shielded spray preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarter, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfuralin *plus* Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC as a banded directed shielded spray preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfuralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart below to determine the amount of each herbicide at commonly used rates:

Curbit and Command Active Ingredients (ai) in Commonly Used Strategy Rates

Strategy pints/A	Ethalfuralin (Curbit) lb ai/A	Clomazone (Command) lb ai/A
1.5	0.3	0.094
2	0.4	0.125
3	0.6	0.188
4	0.8	0.25
5	1.0	0.312
6	1.2	0.375

Labeled for use in all the mid-Atlantic states. Read and follow all the recommendations and warnings (above) for ethalfuralin (Curbit) and clomazone (Command).

Postemergence

Carfentrazone--0.008-0.031 lb/A. Apply 0.5 to 2 fluid ounces of Aim 2EC or Aim 1.9EW as a banded directed shielded spray between the rows of plastic mulch to suppress or control broadleaf weeds including morningglory species, pigweed species, common lambsquarter, and nightshade species when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Aim applied postemergence will not control annual or perennial grasses. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution), or oil concentrate or methylated seed oil to be 1 -2% percent of the spray solution (1-2 gallons per 100 gallons of spray solution). **The shielded (hooded) sprayer must be designed to prevent spray or drift from contacting the stems, leaves, flowers or fruit of the crop, or severe injury may occur.**

Halosulfuron--0.023-0.031 lb/A. Apply 0.5 to 0.66 dry ounce Sandea 75WG as a banded directed shielded spray between the rows of plastic mulch to suppress or control yellow nutsedge and broadleaf weeds including common

cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). Do NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. Do NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **Do NOT exceed total of 0.047 pounds per acre, equal to 1. dry ounce of Sandea, applied postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied to multiple crops in one year.**

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of or Gramoxone Inteon 2SC postemergence as a banded directed shielded spray between the rows of plastic mulch in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a banded directed shielded spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be

needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

For Seeding Into Soil Without Plastic Mulch (Broadcast Applicators)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Seeding into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preplant Incorporated

Clomazone--0.25-0.5 lb/A. **For pumpkins ONLY**, apply 0.5 to 1 pint per acre Command 4EC preplant. Incorporate immediately after application. For best results, use equipment that will provide shallow, thorough incorporation. Poor incorporation technique may result in excessive crop injury in streaks throughout the field. Use lower rates on fields with coarse-textured soils that are low in organic matter and when planting short-season varieties. Use higher rates when planting full-season varieties in fine-textured soils and those with high organic matter. Expect some temporary injury, seen as a partial whitening of leaf and/or stem of the crop, that becomes apparent after seedling emergence. Complete

recovery from early injury will occur without affecting yield or delaying maturity. Command is an excellent broad-spectrum herbicide that will control annual grasses and most broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Immediate incorporation will reduce or eliminate vapor drift. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used for weed control.

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Preemergence

Clomazone--0.25-0.5 lb/A. **For winter squash ONLY**, apply 0.66 to 1.3 pints per acre Command 3ME preemergence to control annual grasses and many annual broadleaf weeds, except pigweed sp., carpetweed, annual morningglory sp., and yellow nutsedge. Some temporary injury, seen as a partial whitening of leaf and/or stem of the crop, may be observed after seedling emergence. Complete recovery from early injury will occur without affecting yield or delaying maturity.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor spray drift. Preemergence applications are restricted to after June 15 in Maryland to reduce the risk of drift injury to rapidly growing sensitive spring foliage. Avoid preemergence applications when fields are adjacent to horticultural, in Maryland to reduce the risk of drift injury to rapidly growing sensitive spring foliage. Avoid preemergence applications when fields are adjacent to horticultural fruit, vegetable, or other sensitive crops (see label). Drift injury from off-site Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations. Follow all label restrictions that require buffer zones between treated fields and sensitive crops.

Herbicide residues may limit subsequent cropping options when Command is used for weed control. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command has been used.

Ethalfuralin--0.56-0.75 lb/A. **A Special Local Needs Label 24(c) has been approved for the use of Curbit 3E on winter squash and pumpkins in Delaware, Maryland, Pennsylvania, and Virginia.** Apply 1.5 to 2 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpet-weed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarter, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others, may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use on transplanted pumpkin or winter squash. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfuralin *plus* Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC reemergence to control annual grasses and many annual broadleaf weeds. Use the 2 pint rate on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfuralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart under Ethalfuralin *plus* clomazone (jug-mix) in the section **For Soil Strips Between Rows of Plastic Mulch** to determine the amount of each herbicide at commonly used rates.

Read and follow all the recommendations and warnings (above) for ethalfuralin (Curbit) and clomazone (Command).

Postemergence

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a directed spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not

tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Halosulfuron--0.023-0.031 lb/A. Apply 0.5 to 0.66 dry ounces of Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves, but has not yet begun to "run" or bloom. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution). Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant, and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated, but may require 2 to 3 weeks to become evident, and up to a month for the weed to die. Occasionally slight yellowing of the crop may be observed within a week Sandea application. When observed, recovery is rapid, with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. DO NOT exceed total of 0.047 pounds per acre, equal to 1.0 dry ounce of Sandea, applied postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied to multiple crops in one year.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

Postharvest With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

No-Till Pumpkins

Seeded or transplanted no-till pumpkins planted into small grain cover crop or stubble, hairy vetch, or fallow ground has produced commercially acceptable yields. A cover crop on the soil surface will reduce dirty pumpkins at harvest, provide some weed suppression, and minimize fruit rot by creating a barrier between pumpkins and the soil. Yellow nutsedge and certain "hard to control" broadleaf weeds may escape the preemergence residual herbicide applications. Since cultivation is usually not an option in no-till planting systems and post-emergence herbicides are not available to control escaped weeds, choose fields carefully for no-till pumpkin production. Avoid fields with heavy populations of yellow nutsedge or broadleaf weeds that may not be controlled by the residual herbicides available for use in pumpkins. Suggested cultural procedures are outlined below. **Not recommended in New Jersey.**

Cover Crop Establishment

Small grain stubble provides an ideal crop-mulch for pumpkins. Be sure the combine distributes straw uniformly. No other manipulation of the crop residue is required before planting pumpkins. An alternative crop-mulch is hairy vetch. Seed hairy vetch in the fall 3 to 4 weeks before the average frost date at the rate of 20 to 25 pounds per acre with a grain drill or broadcast spreader. On sloping ground, mix a winter-killed variety of spring oats (0.5 bushel per acre) with the vetch to decrease the time required for ground cover to reduce soil erosion. Adjust soil pH before the vetch is seeded because tillage will not be performed before pumpkin planting. Application of phosphorus and potassium before seeding vetch is optional, depending on soil test results.

Cover Crop and Weed Management

Soil Moisture. Soil moisture prior to planting is a critical factor for successful establishment of pumpkins. The living, hairy vetch cover crop may remove soil moisture and prevent pumpkin germination and growth. If irrigation is not available, kill the vetch 10 to 14 days prior to planting in order for rainfall to provide adequate soil moisture for seeding or transplanting. If rainfall is excessive, hairy vetch may remove water to facilitate timely planting. Irrigation will eliminate the concerns about soil moisture for pumpkin seeding and germination.

Contact Herbicides. To kill hairy vetch, apply Gramoxone Inteon 2SC (2.4 pints 2SC per acre) 10 to 14 days before planting followed by a second application after seeding but before seedlings emerge or before transplanting. For sequential applications of Gramoxone Max 3SC or

Gramoxone Inteon 2SC, the rates may be reduced slightly. Two applications, each at 1.1 pound of glyphosate acid equivalent per acre (3 pints per acre of Roundup Ultra, Glyphomax Plus, or Touchdown IQ, or 2.4 pints per acre of Roundup Ultra Max), are required for effective hairy vetch control. Glyphosate is required for control of some weeds such as horseweed and smartweed. **Caution:** glyphosate-resistant horseweed has been identified in numerous fields in Delaware, Maryland, and New Jersey. This weed may not be adequately controlled. Glyphosate has the potential to remain on foliage until washed off by rainfall or irrigation which could cause injury to germinating pumpkin seedlings or transplants. Allow at least 3 days between application and planting. Glyphosate or Gramoxone Max 3SC or Gramoxone Inteon 2SC may be applied singularly, sequentially, or alternately to control specific weeds and cover crops.

To kill standing small grains or weeds in small grain stubble, make one application of glyphosate. Glyphosate is preferred for the control of grasses. Gramoxone Max 3SC or Gramoxone Inteon 2SC is acceptable for small grasses and for morningglory control. (See glyphosate caution above.)

Residual Herbicides for Pumpkins. Prefar (bensulide), may be applied alone or in combination with the first application of either Gramoxone or glyphosate to control germinating weeds as the mulch cover dies. Curbit (**not labeled in all states; see Pumpkin Weed Control Sections above for details**) should not be applied until after seeding and it should not be used for transplanted pumpkins. Prefar can be applied to the soil surface before transplanting pumpkins.

Strategy (clomoxone *plus* ethalfluralin) or Curbit (ethalfluralin), may be used alone or in combinations with Prefar (bensulide). **Curbit is not labeled in all states (see Pumpkin Weed Control Sections above for details).** Strategy, Curbit and Prefar may allow late season grass escapes which can be controlled by Select (clethodim) or Poast (sethoxydim) postemergence. Certain broadleaf weeds and yellow nutsedge can be controlled with a postemergence application of Sandea (halosulfuron). Broadleaf weed escapes not controlled by preemergence or postemergence herbicides should be hand weeded before the canopy closes to reduce the weed seed load for following crops.

Pumpkin Planting

See the herbicide recommendations for pumpkins for further discussion.

Use no-till corn planters equipped with coulters to cut through straw or cover crop stems killed by contact herbicides. Planters with finger pickup or air/vacuum units function well for seeding pumpkins. Plate planters may damage seed and should be evaluated carefully before use. Cole plate planters are satisfactory. A disk coulters on the seeding unit is essential to cut through the vetch or straw stems. Mount a 3-inch wide waffle coulters ahead of pot-transplanters to provide for effective penetration of the cover crop and plant placement.

Fertility

Hairy vetch will normally supply all the nitrogen requirements for pumpkins. However, if nitrogen deficiency symptoms appear before fruit production, topdress with 20 to 30 pounds nitrogen per acre. Phosphorus and potassium

amendments can be applied (based on soil tests) to the soil surface before planting cover crop or before planting pumpkins. When planting pumpkins into nonlegume cover crops or grain stubble, apply the recommended nitrogen, phosphorus, and potassium (based on soil tests) before planting pumpkins.

Pollination

Honey bees squash bees, bumblebees and other wild bees are important for proper set and pollination. 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 and/or Table D-6 for relative toxicity of various pesticides for hazard to bees.

Insect Control

Seed Corn Maggot

imidacloprid (soil, foliar)--see label for rates and application methods, or

Lorsban 50W is approved as a seed treatment for pumpkins. Use 2 ounces per 100 pounds of seed as a slurry treatment prior to planting.

Also, see the "Maggots" section in Soil Pests--Their Detection and Control.) **Note.** The use of Admire (generics available) 2F at planting may reduce seed corn maggot populations.

Cucumber Beetle

Cucumber beetles cause direct damage to pumpkin and winter squash rinds. Fall treatments with foliar insecticides to prevent feeding damage may also reduce the incidence of black rot. When plants are young, they need to be protected from cucumber beetle feeding. An alternative control option is the use of Furadan 4F applied at planting (see below).

Note. Cucumber beetles cause direct damage to pumpkin rinds. Treatment to reduce feeding damage to rinds will prevent or reduce incidence of black rot.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--2.4-2.8 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Danitol--10.66-16 fl oz 2.4 EC/A, or

Furadan--A Special Local-Needs Label 24(c) is in effect for the use of liquid Furadan at 3.8 fl oz 4F/1,000 ft of row at planting. Consult your local county Extension office for current restrictions.

Note: Use of Furadan at planting frequently leads to spider mite outbreaks later in the season, or
imidacloprid (soil, foliar)--see label for rates and application methods, or

lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A, or
Platinum--5-8 oz 2SG/A,
Sevin--1.25 lb 80S/A or OLF, or
Thionex--0.67-1.33 qts 3EC/A or OLF

Squash Vine Borer

When vines begin to run, apply to bases of plants four times at 7-day intervals. Pheromone traps for squash vine borer are commercially available. These traps can be used to indicate when moth activity begins. **Note:** Use of SpinTor for looper control will reduce squash vine borer populations.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
Thionex--0.67-1.33 qts 3EC/A or OLF

Cutworms (Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--0.8-1.6 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A (pumpkins only) or OLF

Pickleworm, Melonworm

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

Asana XL--5.8-9.6 fl oz 0.66EC/A (pickleworm only), or
Avaunt--1.5-6 oz 30WDG/A, or
Baythroid XL--1.6-2.4 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-10 fl oz 2F/A, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A or OLF, or
Radiant--5-10 fl oz SC/A, or
Sevin--1.25 lb 80S/A or OLF, or
SpinTor--4-8 fl oz 2SC/A, or
Thionex--0.67-1.33 qts 3EC/A or OLF

Aphids

Note. Aphids transmit mosaic virus. Thorough spray coverage beneath leaves is important. Treat seedlings every 5 to 7 days or as needed. Also, mosaic-resistant winter squash cultivars are available.

Actara--2.5-3.0 oz 25WDG/A, or
Beleaf--50 SG (see label for rate), or
Fulfill--2.75 oz 50WDG/A, or
imidacloprid (soil, foliar)--see label for rates and application methods, or
Metasystox-R--1.5-2 pt 2SC/A, or
Platinum--5-8 oz 2SG/A, or
Thionex--0.67-1.33 qts 3EC/A or OLF, or
Venom--5-6 oz (soil); 1-4 oz(foliar) 70SG/A

Thrips

Entrust--2-2.5 oz 80W, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
SpinTor--6-8 fl. oz 2SC/A, or
Venom--5-6 oz (soil); 1-4 oz(foliar) 70SG/A, or
Vydate L--2-4 pt 2L/A

Squash Bug

Begin treatments if greater than one egg mass per plant is present. Sprays should target nymphal stages. For best squash bug control, under leaf spray coverage is essential. **Note:** Use of Metasystox-R for aphid control will reduce squash bug populations.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
azadirachtin (Azatin, Ecozin, Neemix)--11-21 fl oz EC/A.
Apply when pests first appear and are in their early nymphal stages, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or

PUMPKINS AND WINTER SQUASH

permethrin--8 fl oz 3.2EC/A or OLF, or
 Sevin--1.25 lb 80S/A or OLF, or
 Thionex--2/3-1 1/3 qt 3EC/A

Leafminers

abamectin (Agri-mek; generics available)--8-16 fl oz
 0.15EC/A, or
 Entrust--2-2.5 oz 80W, or
 permethrin--8 fl oz 3.2EC/A or OLF, or
 SpinTor--6-8 fl oz 2SC/A, or
 Trigard--2.66 oz 75WSP (one packet)/A, or
 Venom--5-6 oz (soil); 1-4 oz(foliar) 70SG/A, or
 Vydate L--2-4 pt 2L/A

Rindworms

Damage to the rinds may result from a complex of insect
 pests including cucumber beetle, wireworms, and a number
 of "worm species, (beet army worm, etc). Management of
 adult cucumber beetles early in the season may help reduce
 damage. See cucumber beetle section for labeled products.

Cabbage Looper

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Bacillus thuringiensis--Consult label for rates and
 restrictions, or
 Baythroid XL--1.6-2.4 fl oz /A, or
 bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
 Danitol--10.66-16 fl oz 2.4EC/A, or
 Entrust--1.25-2.5 oz 80W/A, or
 lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
 Radiant--5-10 80W/A, or
 SpinTor--4-8 fl oz 2SC/A

Mites

Mite infestations generally begin around field margins and
 grassy areas. CAUTION: DO NOT mow or maintain these
 areas after midsummer since this forces mites into the crop.
 Localized infestations can be spot-treated. Begin treatment
 when 10 to 15 percent of the crown leaves are infested early
 in the season, or when 50 percent of the terminal leaves are
 infested later in the season.

Note. Continuous use of Furadan, Sevin, or the pyre-
 throids may result in mite outbreaks.

Acramite--0.75-1.0 lb 50 WS/A, or
 abamectin (Agri-mek;generics available)--8-16 fl oz
 0.15EC/A (pumpkins only), or
 bifenthrin--5.12-6.4 fl oz 2EC/A or OLF, or
 Danitol--10.66-16 fl oz 2.4EC/A, or
 Oberon--7.0-8.5 fl oz 2SC/A

Note. The addition of crop oils or organosilicon spray
 additives will increase mite control.

Whiteflies

Actara--3-5.5 oz 25WDG/A, or
 bifenthrin--5.12-6.4 fl oz 2EC/A or OLF, or
 imidacloprid (soil)--see label for rates and application
 methods, or
 Oberon--7.0-8.5 fl oz 2SC/A, or
 Thionex--1.33 qts 3EC/A or OLF, or
 Venom--5-6 oz (soil); 1-4 oz(foliar) 70SG/A

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Acramite	G	12	3
abamectin(Agri-mek)	R	12	7
Actara	G	12	0
Asana XL	R	12	3
Avaunt	G	12	3
azadirachtin	G	4	0
<i>Bacillus thuringiensis</i>	G	4	0
Baythroid XL	R	12	0
Beleaf	G	12	0
bifenthrin	R	12	3
Danitol	R	24	7
Entrust	G	4	3
Fulfill	G	12	0
Furadan	R	48	AP
imidacloprid	G	12	21
Intrepid	G	4	3
lambda-cyhalothrin	R	24	1
Metasystox-R	R	48	14
Oberon	G	12	7
Platinum	G	12	30
permethrin	R	12	0
Radiant	G	4	3
Sevin	G	12	3
SpinTor	G	4	3
Thionex, squash	R	24	2
Thionex, pumpkins	R	24	1
Trigard	G	12	0
Venom(soil/foliar)	G	12	21/1
Vydate L	R	48	1
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Flint (Group 11)	G	12	3
Flouronil (Group 4 + M5)	G	48	14
Forum (Group 40)	G	12	0
maneb (Group M3)	G	24	5
MetaStar (Group 4)	G	48	AP
Nova (Group 3)	G	24	0
Quadris (Group 11)	G	4	1
Previcur Flex (Group 28)	G	12	2
Procure (Group 3)	G	12	0
Pristine (Groups 11 + 7)	G	12	0
Ranman (Group 21)	G	12	0
Ridomil Gold (Group 4)	G	48	0
Ridomil Gold Bravo (Groups 4 + M5)	G	48	0
Ridomil Gold Copper (Groups 4 + M1)	G	48	5
Sulfur Micronized Wettable (Group M2)	G	24	-
Tanos (Groups 11 and 27)	G	12	
Ultra Flourish (Group 4)	G	48	0

See Table D-6.

¹ G = general, R = restricted, AP=At Plant

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Nematode Control

See "Nematodes" section of Soil Pests--Their Detection
 and Control. Use fumigants listed in the "Soil Fumigation"
 section.

Vydate L--1-2 gal 2L/A. Incorporate into the top 2 to 4
 inches of soil or 2 to 4 pints 2L per acre applied 2 weeks
 after planting and repeat 2 to 3 weeks later.

Disease Control

Damping-Off

Apply the following in a 7-inch band after seeding. Use formula in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold or Ultra Flourish needed per acre.

mefenoxam--1-2 pt Ridomil Gold 4EC/A or 2-4 pt Ultra Flourish 2E/A
metalaxyl--4-8 pt MetaStar 2E

Viruses (CMV, WMV2, PRSV, ZYMV)

Use resistant varieties when possible. 'Magician' is resistant to ZYMV. Plant fields as far away from existing cucurbit plantings as possible to prevent aphid transmission of viruses from existing fields to new fields.

Angular Leaf Spot/Bacterial Leaf Spot

Both diseases can produce foliar symptoms that are often over-looked. Early detection is important, since control of the foliar phase can reduce infection in developing fruit. Both diseases are seedborne and can survive on infested debris for at least one year or until the debris decomposes. Apply the following when disease is first detected on the foliage and repeat every 7 to 10 days.

copper, fixed--at labeled rates or OLF

Bacterial Wilt

Controlling striped and spotted cucumber beetles are essential for preventing of wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at planting may not prevent beetle damage season long, therefore, additional foliar insecticide applications may be necessary.

Powdery Mildew

The fungus that causes cucurbit powdery mildew has developed resistance to several different groups of fungicides.

Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern U.S., therefore proper fungicide resistance management should be followed.

Powdery mildew generally occurs from mid-July until the end of the season. Plant tolerant varieties, when possible. Powdery mildew development on tolerant varieties will vary from year to year. Planting tolerant varieties will help delay the development of powdery mildew. Make first application when powdery mildew is observed in the area or is detected by scouting (one lesion on the underside of 45 old leaves).

Alternate:

Nova--5 oz 40WP/A plus chlorothalonil--2-3 pt 6F/A, or Procure--4-8 oz 50WS/A plus chlorothalonil--2-3 pt 6F/A,

With:

Micronized Wettable Sulfur--4 lb 80W/A, sulfur may injure plants especially at high temperatures. Certain varieties can be more sensitive. Consult label for precautions, or

With a tank mix containing:

chlorothalonil plus Pristine--12.5-18.5 oz 38WG/A

If Powdery mildew has become well established in the mid- to late part of the season, only apply protectant

fungicides such as chlorothalonil or sulfur.

Downy Mildew

Scout fields for disease incidence early in the growing season. Begin sprays when vines start to run or if downy mildew is predicted for the region. Refer to the Cucurbit Downy Mildew forecasting website (www.ces.ncsu.edu/depts/pp/cucurbit/) for current status of the disease. **Preventative applications are much more effective than applications made post infection.** The following are the most effective materials. Tank mix one of the following products with a protectant such as chlorothalonil--1.5-3 pt 6F/A or maneb (Manex)--1.2-1.6 pt 4F/A, or OLF and alternate between different modes of action (FRAC codes):

Ranman--2.1-2.75 fl. oz 400 SC/A, or Previcur Flex--1.2 pt 6F/A, or Curzate--3.2 oz 60DF/A, or Tanos--8 oz 50WDG/A

Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.

Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced if label allows.

Plectosporium Blight (*Microdochium blight*)

Research studies have shown that no-till pumpkin production may result in less disease development. Rotate with crops other than cucurbits. It is important to achieve maximum foliage coverage with each fungicide application. Scout fields on a regular basis. Once symptoms appear on petioles or as fruit begins to form, apply the following and repeat every 7-10 days:

chlorothalonil--2-3 pt 6F/A or OLF, or maneb (Manex)--1.2-1.6 pt 4F/A or OLF

A spray schedule that contains Cabrio, or Flint will also provide control.

Scab

Use resistant varieties when possible. Scab develops during cool periods. Begin sprays as true leaves form and repeat every 5 to 7 days.

chlorothalonil--2-3 pt 6F/A or OLF

Gummy Stem Blight (Black Rot) and Anthracnose

Rotate to provide at least 2 years between cucurbit plantings. Pumpkin cv. 'Small Sugar' appears to be the least affected by Black rot. Fungicides with a high-risk for resistance development such as FRAC code 11 fungicides (Cabrio, Pristine and Quadris) should be tank-mixed with a protectant fungicide. When tank-mixing use at least the minimum labeled rate of each fungicide in the tank mix. Do not apply FRAC code 11 fungicides more than 4 times total per season. If resistance to FRAC code 11 fungicides exists in the area, do not apply them. Use fungicides from a different FRAC code.

Begin the following fungicide program when fruit start to form:

Alternate:

chlorothalonil--2-3 pt 6F/A or OLF,
(use low rate early in season)

With:

a tank mix containing chlorothalonil *plus*
 Pristine--12.5-18.5 oz 38WG/A, or
 Quadris--11.0-15.4 fl oz 2.08F/A, or
 Cabrio--12-16 oz 20 WG/A

Maintain fungicide schedule until harvest. See the "Harvesting and Storage" section. Fungicide application for black rot control will help maintain "handles" on the fruit. Harvest carefully because wounding can negate benefits from a season-long fungicide program.

Phytophthora Blight

Rotate with crops other than peppers, eggplants, tomatoes, lima and snap beans, and other cucurbits. Fields should be adequately drained to ensure that soil water does not accumulate around the base of the plant. Mefenoxam (Ridomil Gold or Ultra Flourish) should be applied pre-plant for early season control. Once the canopy closes, subsoil between the rows to allow for faster drainage following rainfall. When conditions favor disease development, Apply one of the the following for suppression only and always tank mix with fixed copper:

Forum--6.0 fl oz 4.18SC/A (must be tank mixed with another fungicide active against Phytophthora blight on pumpkins and winter squash such as fixed copper), or
 Ranman--2.75 fl oz 400 SC/A (*plus* an adjuvant), or
 Tanos--8-10 oz 50 WDG/A

Harvesting and Storage

Begin with disease-free fruit by following a regular fungicide program during crop production. Harvest as soon as fruits are mature and prior to frost. Use care in handling fruit to prevent wounds. Wounding can negate benefits from a season-long fungicide program. Cure after harvest at temperatures between 80° to 85°F (26.7° to 29.40°C) with a relative humidity of 75 to 80 percent for 10 days.

Temperatures below 50°F (10°C) cause chilling injury. The hard-shelled varieties, such as Butternut, Delicious, and the Hubbard strains, can be stored. Store at 55°F (12.8°C) and 55 percent relative humidity.

RADISHES, RUTABAGAS, AND TURNIPS

Radishes. Radishes are a quick-growing, cool-season crop makes its best quality and root shape when grown at temperatures of 50° to 65°F (10° to 18.3°C) in moderate to short day lengths. Crop must be grown rapidly (23 to 28 days) and with an adequate moisture supply. When growth is checked, the radish becomes hot, tough, and pithy. Long days (15 hours) and warm temperatures induce seedstalk formation. Under medium to short day lengths, roots are generally well shaped and tops are small.

Rutabagas. A cool-season crop developing best at temperatures of 60° to 65°F (15.6° to 18.3°C). Usually considered a fall crop; it can be grown in the spring.

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Radishes: spring to fall					
Cherriette*				P	
Improved Red Prince	D	M	N	P	V
Champion	D	M	N	P	V
Radishes: winter					
China Rose				P	
Round Black Spanish				P	
Rutabagas					
Laurentian	D	M	N		
Improved American Purple Top	D	M	N	P	V
Purple Top Yellow Globe				P	
Turnips: white					
White Lady*				P	
Hakeuri			N		
Turnips: purple top					
Royal Globe II*			N		
Royal Crown*			N	P	
Purple Top White Globe (MR)	D	M	N	P	V
Just Right*				P	

¹ Varieties listed by maturity, earliest first.

* Indicates hybrid varieties.

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests
 Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Radishes, Rutabagas, & Turnips	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med	Opt.	Low Pounds K ₂ O per Acre	Med	Opt.
	50 ¹	150 ¹	100 ¹	50 ¹	150 ¹	100 ¹	50 ¹

¹ Broadcast and disk-in before seeding.

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Seed Treatment

Soak seed in hot water at 122°F (50°C). Soak rutabagas for 20 minutes and turnips for 25 minutes. Dry, then dust with captan 50WP or thiram 75WP at 1 level teaspoon per pound of seed.

Spacing and Seeding

Radishes. Seed as early in the spring as soil can be worked, then at 8 to 10 day intervals through September. Seed 10 to 15 pounds per acre. Space rows 8 to 15 inches apart with 12 to 15 plants per foot in the row.

Rutabagas. Seed in early spring for the early summer crop and at least 90 days before the early freeze date in the fall. Sow 1½ to 2 pounds of seed per acre at a depth of ¼ 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.

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, 1/8 to 1/4 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.

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 or shipping. Rutabagas can be stored 2 to 4 months at 32°F (0°C) and at a relative humidity of 90 to 95 percent.

Turnips. The crop is dug mechanically and either bunched or topped. Turnips can be stored over winter at 32° to 35°F (0° to 1.67°C) and at a relative humidity of 90 to 95 percent.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Use shallow cultivation as necessary to control seedling weeds.

Preemergence

Turnips. DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre Dacthal 6F immediately after seeding.

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days for radish and 30 days for Rutabagas and Turnips.

Clopyralid—0.047-0.188 lb/A. Turnips ONLY! (roots and tops) Apply 2 to 8 fluid ounces of Stinger 3A per acre in a single application to control certain annual and perennial broadleaf weeds. Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod

species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 8 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days for turnip roots and 15 days for turnip tops. Stinger is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Cabbage Root Maggots

Note. When yellow-rocket (mustard family) first blooms, cabbage maggot adults (flies) begin flying and laying eggs on roots or soil near roots.

For **radishes** use:

diazinon--10.5-14 lb 14G/A or 1.5-2 qt 4EC/A at planting or as a postemergence spray before edible parts form using high gallonage to thoroughly soak plants, or Lorsban--1 fl oz 4E/1000 ft of row or OLF. Apply in-furrow with the seed at planting

For **turnips** use:

diazinon--10.5-14 lb 14G/A or 1.5-2 qt 4EC/A or OLF. Apply in-furrow at planting or as a postemergence spray. Apply the spray after roots show above ground using high gallonage to thoroughly soak the soil around plants, or Lorsban--1.6-2.75 fl oz 4E/1,000 ft of row or OLF in-furrow at planting time.

Cutworms

Baythroid XL---1.6-2.8 fl oz 2E/A, or OLF, or Sevin--1.25 lb 80S/A or OLF

Flea Beetles

Asana XL--5.8-9.6 fl oz 0.66EC/A, or Baythroid XL--1.6-2.8 fl oz /A or diazinon--0.5-1 pt 4EC/A or OLF, or, imidacloprid (soil, foliar)--see label for rates and application methods, or Entrust--1-2 oz 80W/A, Sevin--0.75 lb 80S/A or OLF, or Spintor--3-6 fl oz 2SC/A

Aphids,

diazinon--1 pt 4EC/A or OLF, or dimethoate--0.5 pt 4EC/A or OLF, or imidacloprid (soil, foliar)--see label for rates and application methods, or

malathion--1.5-2 pt 5EC/A(radish and turnip); 1.5 pt 5EC/A (rutabagas) or OLF

Leafminers

diazinon--1 pt 4EC/A or OLF, or
Entrust--1-2 oz 80W/A, or
SpinTor--4.5-6 fl oz 2SC/A.

Cabbage Looper (CL), Imported Cabbageworm (ICW), Diamondback Larvae

Note: For best worm control, underleaf spray coverage is essential.

Bacillus thuringiensis--Consult label for rates and restrictions, or
Entrust--1-2 oz 80W/A(CL only), or
Intrepid (CL & ICW only)--4-8 fl oz 2F/A (early season), 8-10 fl oz 2F/A (late season), or
Radiant--6-8 fl oz SC/A (CL only), or
SpinTor--3-6 fl oz 2SC/A(CL only).

The following chart gives minimum days wait between last application of pesticide and harvest of root crucifers.

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest ³		
			Radish	Rutabagas	Turnip
INSECTICIDE					
Asana XL	R	12	7	-	-
<i>Bacillus thuringiensis</i>					
Baythroid XL	G	4	0	-	0
diazinon 4EC	R	24	10	-	10
Entrust	G	4	3	3	3
imidacloprid	G	12	21/7	21/7	21/7
Intrepid	G	4	-	-	1
Lorsban 15G,4E	R	24	AP	AP	AP
75WG	G	24	AP	AP	AP
malathion	G	12	7	3	7
Radiant	G	4	3	3	3
Sevin	G	12	7	7	7
SpinTor	G	4	3	3	3
FUNGICIDE (FRAC code)					
Cabrio (Group 11)	G	12	0	0	0
copper, fixed (Group M1)	G	24	0	-	0
Quadris (Group 11)	G	4	0	0	0
Ridomil Gold (Group 4)	G	AP	AP	AP	AP
Ridomil Gold Copper (Groups 4 + M1)	G	48	7	-	-

See Table D-6.

Dash (-) in table indicates pesticide is **not** labeled for that crop.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

³ AP = At planting time only

Disease Control

Damping-off (caused Pythium and Basal stem rot caused by Phytophthora)

Apply the following as a pre-plant incorporated or as a soil surface spray after planting:

Ridomil Gold--1-2 pt 4EC/A

Black Rot, Blackleg, Alternaria

Use hot water seed treatment. See the preceding "Seed Treatment" section.

Clubroot

Radishes are susceptible to clubroot, whereas turnips are resistant. Use of irrigation water containing spores of the fungus is the principal way that disease is spread to new fields. If clubroot occurs, take time to clean and disinfect any equipment to be used in other fields to prevent spread. Adjust soil pH with hydrated lime to as close to 7.0 as possible. Improve drainage in the field as much as possible and grow on raised beds.

Downy Mildew

Apply the following when the disease is first noticed and repeat every 7 to 10 days:

copper, fixed--at labeled rates

Leaf Spots

When the disease is first noticed, alternate one of the following FRAC code 11 fungicides every 7 to 10 days:

Quadris--6.2--15.4 oz 2.08F/A, or
Cabrio--8-12 oz 20WG/A

With:

copper, fixed--at labeled rates

Scab

This disease is more severe under dry soil conditions, high soil pH, and low level of magnesium. Heavy irrigation in the first 2 weeks after emergence and the application of sulfur to reduce soil pH will assist in disease control.

White Rust

At the first sign of disease in field; alternate one of the following FRAC code 11 fungicides every 7 days:

Alternate:

Quadris at 6.2 to 15.4 fl oz 2.08F/A, or
Cabrio--8-16 oz 20 WG/A

With

Ridomil Gold Copper--2 lb 70WP/A

SPINACH

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Fall Processing					
Seven R* (MMR)					
Hybrid No. 7*					
Melody* (MMR)					
Tyee* (DMR)					
Fidalgo* (WRT) (trial)					
Vancouver* (WRT) (not for overwinter)					
Fall Market					
Packer* (MR)	D	M	N	P	V
Olympia* (DMR)		M		P	
Melody* (MMR)	D	M	N	P	V
Bolero* (flat-leaved for bunching)				N	
Camano (DMR)				N	P
Tyee* (DMR)					P
Samish* (DMR,WRT)					P

(table continued next page)

Varieties

Varieties ¹	DE	MD	NJ	PA	VA
Spring Processing					
Seven R* (MMR) (early seeding)	D		N		
Hybrid No. 7*	D	M			V
Melody* (MMR)	D	M	N	P	V
Tyce* (DMR)	D			P	
Spinner* (DMR)				P	
Spring Market					
Vienna* (MMR)	D	M	N		
Marathon* (MMR)	D	M		P	
Kent* (MMR)				P	
Olympia* (DMR)				P	
Tyce* (DMR)	D			P	
Spinner* (DMR)				P	
Overwinter Market					
Vienna* (MMR)	D	M	N	P	

¹ Varieties listed by maturity within each group, earliest first.

* Indicates hybrid varieties.

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations: section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Crop	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med Pounds P ₂ O ₅ per Acre	Opt. Pounds P ₂ O ₅ per Acre	Low Pounds K ₂ O per Acre	Med Pounds K ₂ O per Acre	Opt. Pounds K ₂ O per Acre
Spinach	100-195 ¹	200 ¹	150 ¹	100 ¹	200 ¹	150 ¹	100 ¹
Spring or Fall	50-75 ²	200 ²	150 ²	100 ²	200 ²	150 ²	100 ²
	25-40 ³	0	0	0	0	0	0
	25-40 ⁴	0	0	0	0	0	0
Spinach	80-120 ⁵	0	0	0	0	0	0
Overwinter	50-80 ⁶						
	30-40 ⁷						

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Sidedress or topdress

⁴ Topdress after each cutting

⁵ Total Spring application for over-wintered crop

⁶ Topdress late February

⁷ Topdress in March

Seed Treatment

Use seed treated with Maxim 4FS (0.08-0.16 fl oz/100 lb. seed) for Rhizoctonia and Fusarium control and Apron XL LS (0.16-0.64 fl oz./100 lb. seed) for Pythium control.

Seeding

Seeding Dates. *Spring:* March 12 to April 20 (harvest May 20 to June 7). *Fall:* August 10 to August 31 (harvest September 25 to October 10). *Overwinter:* October 1 to 15 (harvest in the spring).

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 on 6- and 8-row beds.

Preharvest

FOR FALL HARVEST ONLY. Apply 6-8 grams (active ingredient) gibberellic acid per acre to improve harvesting efficiency of semi-upright varieties and to increase yield of spinach under cool growing conditions. For best response, apply when daytime temperatures are 40° to 70°F (4.4° to 21.1°C) and when early morning dew is present on the crop. Make one application in 20 to 50 gallons of water per acre by ground equipment 12 to 18 days before each harvest. When applying gibberellic acid to promote growth of a second or third cutting, wait until some regrowth has occurred before making application.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in spinach.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Preplant Incorporated

Cycloate--2.5-3 lb/A. Apply 3 to 4 pints per acre Ro-Neet. Apply before seeding and incorporate into soil 2 to 4 inches with disk. Delay of planting for 7 to 10 days may help reduce potential injury.

Preemergence

S-metolachlor--0.32-0.63 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Dual Magnum 7.62E to control weeds in spinach in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia. The use of this product is legal ONLY if a waiver of liability provided by the local growers association has been signed by the grower, all fees have been paid, and a label has been provided by the association.** Apply 0.33 to 0.67 pints per acre Dual Magnum 7.62E to control annual grasses, galinsoga, and certain other broadleaf weeds. Use as a surface-applied preemergence spray. DO NOT preplant incorporate Dual Magnum. Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. Apply Dual Magnum to spinach accurately with a well calibrated sprayer. The margin of crop safety for Dual Magnum on spinach is narrow; rates higher than recommended for the soil type may result in crop injury. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of

the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Clopyralid—0.047-0.188 lb/A. Apply 2 to 8 fluid ounces of Stinger 3A per acre in a single application to control certain annual and perennial broadleaf weeds. Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 8 fluid ounces to suppress or control perennial weeds. Spray additives are not needed or required by the label, and are not recommended. Application of higher recommended rates, 0.094 to 0.188 lb/A (4 to 8 fluid ounces), may cause a crop response that appears as a more upright leaf development. Yield and maturity are not affected. Observe a minimum preharvest interval (PHI) of 21 days. Stinger is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover.

Phenmedipham--0.33-0.67 lb/A. Apply 2 to 4 pints per acre Spin-aid 1.3E. For use on spinach for processing only. Controls seedling broadleaf weeds. Only chickweed less than three inches long or tall can be controlled consistently. Scout fields regularly and reapply if weeds germinate after the initial application, but do NOT exceed 6 pints per acre per year and maintain a 40-day preharvest interval. Apply only during the fall months to spinach with a minimum of four to six true leaves. Apply in a spray volume of 10 to 18 gallons of water per acre. The use of an 8002 flat fan nozzle or a comparable nozzle is suggested. See label for application restrictions, mixing instructions, and weather restrictions to prevent crop injury or herbicide failure.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. Choose Poast 1.5EC to control large

crabgrass. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Annual bluegrass, yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 15 days and apply no more than 3 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Seed Corn Maggot

To prevent damage to spring- and fall-seeded plants, use a broadcast application of a soil incorporated insecticide. Treatments must be applied immediately before planting and lightly incorporated to be effective. Also, see the "Maggots" section in Soil Pests--Their Detection and Control.

Cutworms (Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Lannate--1.5 pt LV/A or OLF, or
Mustang Max--2.24-4.0 oz/A, or
permethrin--4-8 fl oz 3.2EC/A or OLF

Flea Beetle

imidacloprid (soil, foliar)--see label for rates and application methods, or
Mustang Max--2.24-4.0 oz/A, or
Sevin--0.67-1.25 lb 80S/A or OLF

Aphids

Actara--1.5-3.0 oz 25WDG/A, or
Assail--2-4 oz 30SG/A, or
Beleaf--50 SG (see label for rates), or
Fulfill--2.75 oz 50 W/A, or
imidacloprid (soil, foliar)--see label for rates and application methods, or
Platinum--5-11 oz 2SG/A, or
Venom--5-6 oz(soil); 1-3 oz(foliar) 70SG

Leafminers

Agri-mek--8-16 fl oz 0.15 EC/A, or
Entrust--2.0-3.0 oz 80W/A, or
permethrin--4-8 fl oz 3.2EC/A or OLF, or
SpinTor--6-10 fl oz 2SC/A, or
Trigard--0.167 lb 75WSP (one packet)/A
Venom--5-6 oz(soil); 1-3 oz(foliar) 70SG/A

Note. Use of imidacloprid at planting for control of aphids will reduce the leafminer population.

Cabbage Looper (CL), Beet Armyworm (BAW)

Avaunt--2.5-3.5 oz (CL), 3.5-6.0 oz (BAW) 30WDG/A, or *Bacillus thuringiensis* (CL only)--Consult label for rates and restrictions, or

Confirm--8 fl oz 2F/A, or

Entrust--1.2-2.5 oz 80W/A, or

Intrepid--4-8 fl oz 2F/A (early season) 8-10 fl oz 2F/A (late season), or

Lannate--1.5-3 pt LV/A or OLF

Note. Continuous use of Lannate may result in leafminer outbreaks.

Do not apply Lannate when minimum daily temperature is 32°F (0°C) or lower. DO NOT apply to spinach seedlings less than 3 inches in diameter, or

Larvin--24-30 oz 3.2F/A, or

Proclaim--3.2-4.8 oz 5SG/A (CL); 2.4-4.8 oz 5SG/A (BAW), or

Radiant--5-10 oz SC/A, or

SpinTor--4-8 fl oz 2SC/A

Grasshoppers

Sevin--0.6-1.8 lb 80S/A or OLF

Note. The use of permethrin for worm control will reduce grasshopper populations.

Webworms

Sprays must be applied before webbing occurs.

Bacillus thuringiensis--Consult label for rates and restrictions, or

Confirm--8 fl oz 2E/A

Intrepid--4-8 fl oz 2F/A (early season) 8-10 fl oz 2F/A (late season)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Actara	G	12	7
Agri-Mek	R	12	7
Assail	G	12	7
Avaunt	G	12	3
<i>Bacillus thuringiensis</i>	G	4	0
Beleaf	G	12	0
Confirm	G	4	7
Entrust	G	4	1
Fulfill	G	12	7
imidacloprid (soil/foliar)	G	12	21/7
Intrepid	G	4	1
Lannate	R	48	7
Larvin	R	48	14
Mustang Max	R	12	1
Platinum	G	12	30
permethrin	R	12	1
Proclaim	R	48	7
Radiant	G	4	1
Sevin	G	12	14
SpinTor	G	4	1
Trigard	G	12	7
Venom(soil/foliar)	G	12	21/7

(table continued)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
FUNGICIDE (FRAC code)			
Actigard (Group P)	G	12	7
Aliette (Group 33)	G	12,24	3
Cabrio (Group 11)	G	12	0
coppers, fixed (Group M1)	G	24	0
Metastar	G	48	AP
Quadris (Group 11)	G	4	0
Ridomil Gold (Group 4)	G	48	21
Ridomil Gold Copper (Groups 4 + M1)	G	48	21
Ultra Flourish (Group 4)	G	12	21

See Table D-6.

¹ G = general, R = restricted AP = at planting

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Disease Control

Damping-Off

Apply the following preplant incorporated or as a soil surface spray after planting:

mefenoxam--1-2 pt Ridomil Gold 4E/A or 2-4 pt Ultra Flourish 2E/A, or metalaxyl--4-8 pt MetaStar 2E

Downy Mildew (Blue Mold) and White Rust

Rotate away from spinach for at least 2 years. Use resistant varieties where possible. Do not plant spring crop near overwintered fields. The use of mefenoxam or metalaxyl at planting for damping-off control will provide early season control. Beginning 2 to 3 weeks after emergence (prior to symptom development), apply the following on a 7- to 10-day schedule (do not use if temperature is 90°F [32.2°C] or above). Fungicides containing copper may cause some phytotoxicity.

Actigard--0.75 oz 50WG/A, or

Quadris--6.0-15.5 fl oz 2.08F/A (use 12.0-15.5 fl oz/A for downy mildew), or

Cabrio--12-16 oz 20EG/A (white rust only use 8-12 oz.), or

Aliette--3 lb 80WDG/A, or

Fixed copper, see labels for rates and details, or

Ridomil Gold Copper--2.5 lb 70WP/A (14-day schedule)

FRAC code 11 fungicides, such as Quadris and Cabrio should not be applied more than twice before switching to a fungicide with a different mode of action.

Leaf Spots and Anthracnose

These diseases can be prevalent in overwintered, second, and third cut fields. Apply the following as soon as symptoms appear in the spring or shortly after cutting and repeat every 7 to 10 days. If more than 2 applications are needed, apply a copper fungicide prior to making a third application.

Quadris--6.2-15.4 fl oz 2.08F/A, or

Cabrio--12-16 oz 20EG/A

FRAC code 11 fungicides, such as Quadris and Cabrio should not be applied more than twice before switching to a fungicide with a different mode of action

Cucumber Mosaic Virus

Use resistant (MR and MMR) varieties. See table.

STRAWBERRIES

For additional information, Maryland growers refer to Bulletin 242, Maryland Commercial Small Fruit Recommendations. New Jersey growers refer to Commercial Strawberry Recommendations and Fact Sheets 193, 194, 784, and E171. **“The Mid-Atlantic Commercial Berry Guide for Commercial Growers”**, a cooperative publication for Pennsylvania, Maryland, New Jersey, Delaware, West Virginia, and Virginia, contains additional information.

Annual Production System on Plastic Mulch

This system is recommended for Delaware, Maryland, New Jersey, Virginia, southeastern Pennsylvania, and for trial in other areas of Pennsylvania.

Varieties

Varieties	DE	MD	NJ	PA	VA
Early					
Sweet Charlie ¹ (trial)	D	M		P	V
Midseason					
Chandler	D	M	N	P	V
Camarosa ² (shipping only)	D	M	N	P	
Allstar (for northern areas) (trial)		M	N		V
DarSelect (trial)				P	V
Late					
Ovation (trial)		M	N		
Everbearer					
Seascape				P	

¹ Matures 7 to 10 days earlier than Chandler; recommended for trial in southern regions of Maryland. Plant only in areas with low risk of frost. May require overhead sprinkler for additional frost protection during bloom.

² Must be fully red-ripe for flavor development.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Strawberries Annual System	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds per Acre	Med P ₂ O ₅	Opt	Low Pounds K ₂ O	Med	Opt
Loamy sands	90-120 ¹	165 ¹	115 ¹	65 ¹	165 ¹	115 ¹	65 ¹
And sandy loams	60-75 ²	165 ²	115 ²	65 ²	165 ²	115 ²	65 ²
	15-25 ³	0	0	0	0	0	0
	15-25 ⁴	0	0	0	0	0	0
Loams and silt loams	70-90 ¹	150 ¹	100 ¹	50 ¹	150 ¹	100 ¹	50 ¹
	50-60 ²	150 ²	100 ²	50 ²	150 ²	100 ²	50 ²
	20-30 ³	0	0	0	0	0	0

(table continued)

¹ Total recommended

² Disc in before bedding

³ Inject through drip at first flowering in spring

⁴ Inject through drip at fruit enlargement (2 weeks after first flowering)

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Background

The annual strawberry production system has potential for increased profitability over conventional matted-row plantings. Establishment costs are higher, but production is earlier (when crop value is highest) and of higher quality. Start with small acreage and increase as knowledge and experience is gained with the system. This is an integrated system and all of the components are important for maximum production and efficiency. Omission of one or more of the following components could lead to failure.

Site Selection

Plan the field location of strawberries grown on plastic and matted rows carefully if you intend to harvest by Pick-Your-Own. Pick-Your-Own customers have a strong preference for berries grown on plastic and may not pick matted row strawberries located in adjacent fields. The annual system has given highest yields at locations with a long growing season. Select fields with good surface and internal drainage, a southern exposure, and protection from westerly winds.

Field Preparation

Have the soil tested to determine specific nutritional needs. Apply 60 to 75 pounds actual nitrogen plus P₂O₅ and K₂O at the rates recommended above and work into beds. Base additional phosphorus, potassium, and boron application rates on soil test results. Prepare raised beds (30 to 40 inches wide and 6 to 8 inches high) on 5- to 5½-foot row centers. Beds should be center-crowned and firm. Depending on soil type, plant vigor, and plant tissue test results, inject an additional 30 to 40 pounds of nitrogen per fertilized-mulched acre through the drip system in the spring. **For convenience, rates of fertilizer nutrients can be converted from a mulched acre to linear foot basis. See Table C-8.**

Weed Control.

Fumigation is essential to control weeds because labeled residual herbicides cannot be used over the top of the plastic to provide adequate weed control around the plant hole. Several weed control options are listed below to control troublesome winter annuals and other weeds that grow around plant holes.

Prepare soil, apply fertilizer, then apply fumigant. See the “Soil Fumigation” and “Nematodes” sections under Soil Pests--Their Detection and Control for materials, rates, and precautions. Wait 20 days to allow the fumigant to act and disperse. Then prepare raised beds as described above and apply 4 to 6 pounds per acre of Devrinol 50DF to the surface of the bed and the area between beds. Lay drip irrigation and plastic mulch.

OR

Apply fertilizer, prepare raised beds, and inject metam-sodium (Vapam HL) at 56 to 75 gallons per acre or 37 gallons per mulched acre. Immediately reshape beds (if

necessary to form a firm, crowned bed) and apply 4 to 6 pounds per acre of Devrinol 50DF to the surface of the bed and the area between beds, and lay drip irrigation and plastic mulch. Wait 20 days between fumigation and planting to allow the fumigant to act and to disperse.

OR

Apply fertilizer and prepare raised beds as described above. Apply 4 to 6 pounds per acre of Devrinol 50DF to the surface of the bed. Apply drip irrigation and plastic mulch. Inject metam-sodium (Vapam HL) through the drip system at 37 gallons per mulched acre. Wait 20 days between fumigation and planting to allow the fumigant to act and to disperse.

Weeds between the mulched beds can be controlled with standard strawberry weed control herbicides recommended for matted-row culture. Band the treatment between the strips of plastic. Grasses between the rows and around plant holes can be controlled by postemergence applications of Poast 1.5EC. See recommendations for Poast 1.5EC in the "Weed Control" section of Matted Row Culture.

Plants and Planting

The best current option is the use of transplant "plugs" propagated from actively growing runner tips. Plugs can be purchased directly or one can purchase tips and produce the plugs. To produce plugs, use a well-drained artificial mix containing 50% peatmoss and 50% horticultural vermiculite or 50% perlite. A poorly drained growing medium promotes root diseases. A list of nurseries that supply plugs and runner tips, and/or directions for propagating from tips, is available through your local county Extension office.

Plugs are easy to plant mechanically with a waterwheel-type planter. Be sure to place the crown of the transplant at the soil level when planting. Deep planting can promote decay of the plant and shallow planting allows the plant to desiccate. Space plants 12 inches apart in each of the double rows in a staggered pattern. Space double rows 12 to 18 inches apart on the bed. The 18-inch between-row spacing has produced high yields and requires a 36- to 40-inch wide bed.

Plant in late August to early September for highest first-year yields in southern New Jersey, Delaware, Maryland, and Virginia. In Pennsylvania and northern New Jersey plant in mid to late August. Mid-September is the latest recommended planting date.

Renovation

Strawberries grown on plasticulture can be renovated in July. For varieties (Sweet Charlie) and plantings with moderate vigor, mow tops with a rotary mower, leaving several leaves on the plant. For very vigorous varieties (Chandler) and plantings, cutting away a portion of the crown with an asparagus knife leaving 3 crowns or a combination of mowing followed by crown thinning, may be the most effective renovation technique. After renovation, maintain adequate soil moisture and good insect and disease control. In early September, apply 60 pounds of N, P₂O₅, and K₂O per mulched acre via drip irrigation and manage the renovated planting using the same cultural practices as for a new planting.

Renovation has improved berry size, however, size is usually smaller than in the first harvest season. Marketable yields of renovated strawberries have been equal to yields in

the first harvest season. Renovation is especially useful if the planting will be harvested as a Pick-Your-Own.

Row Covers

Floating row covers (FRC) are an essential part of the system to reduce the desiccating effects of winter winds, for frost and freeze protection, and early fruiting. Ultraviolet light resistant covers with a weight of 1 to 1.4 ounces per square yard and 60 to 70 percent light transmission have been effective. Apply FRC between October 15 and November 15, depending on location and planting date, for maximum fall growth and yields. FRC can be applied in early December for overwinter protection. Remove the FRC at the first signs of flower bud emergence. Leaving the covers on too long may reduce fruit size. Leave the covers at the edge of the field so plants can be quickly covered if there is a frost warning.

Irrigation

Overhead irrigation at planting is essential to cool plants and plastic in warm weather and improve establishment. Provide for irrigation in the fall to promote good plant growth before row covers are applied. Large fruit size is important for high crop value, and adequate moisture is critical for maintaining good fruit size. Drip irrigation is effective in increasing fruit size without wetting the fruit and causing increased fruit rots. Be prepared to irrigate frequently to maintain favorable soil moisture in the spring. Overhead mist irrigation may be required in the spring for frost and freeze protection.

Pest Control.

Use an effective disease control program. To control Phytophthora crown rot caused by *Phytophthora cactorum* on newly set transplants apply Ridomil Gold 4E--1pt/A through the trickle irrigation system after transplanting. Apply a fungicide to control leaf spots after plants are established. Apply a fungicide plus insecticides to control aphids and mites just before covering plants with the floating row in the fall. Insecticides and miticides should be applied during late summer or early fall to prevent aphids and mites from reaching damaging levels in the spring. Maintain a good pest control program after covers are removed in the spring.

Bloom sprays are important for control of Botrytis gray mold. See "Disease Control" and "Insect Control" sections for materials and rates.

Harvesting

The *Chandler* variety grown with the annual system ripens about 1 week earlier than standard varieties grown in matted rows. The duration of harvest is about 3 weeks. The tips of some *Chandler* berries may be light colored or white, but they will ripen after harvest. For local markets, harvest when tips have red color.

Matted Row Culture

Varieties					
Varieties ¹	DE	MD	NJ	PA	VA
Early					
Earliglow (RSR)	D	M	N	P	V
Annapolis (RSR)	D	M	N		
Midseason					
DarSelect				P	V
Allstar (VR,RSR)	D	M	N	P	V
Guardian (VR,RSR)	D	M	N		V
Honeye				P	
L'Amour (trial)				P	V
Redchief (VR,RSR)(PYO-NJ)	D	M	N	P	V
Late					
Ovation (trial)			N	P	V
Latestar (VR,RSR)	D	M	N		V
Jewel				P	V

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Strawberries Matted Row System	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med Pounds P ₂ O ₅ per Acre	Opt. Pounds P ₂ O ₅ per Acre	Low Pounds K ₂ O per Acre	Med Pounds K ₂ O per Acre	Opt. Pounds K ₂ O per Acre
<i>New Plantings</i>	110-150 ¹	165 ¹	115 ¹	65 ¹	165 ¹	115 ¹	65 ¹
Sandy loams,	30 ²	165 ²	115 ²	65 ²	165 ²	115 ²	65 ²
loamy sands,	20-30 ⁴	0	0	0	0	0	0
and sands	20-30 ⁵	0	0	0	0	0	0
	30-40 ⁶	0	0	0	0	0	0
	10-20 ⁷	0	0	0	0	0	0
<i>New plantings</i>	90-120 ¹	150 ¹	100 ¹	50 ¹	150 ¹	100 ¹	50 ¹
Loams and silt loams*	30 ³	150 ³	100 ³	50 ³	150 ³	100 ³	50 ³
	30-40 ⁵	0	0	0	0	0	0
	30-50 ⁶	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in deep

³ Broadcast and plow down or disk-in deep

⁴ Sidedress 2 weeks after planting

⁵ Sidedress when first runners start

⁶ Topdress in mid-August

⁷ Topdress in February or March

*Growers on clay or clayloam soils should reduce nitrogen rates to 25 percent.

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Strawberries Matted Row System	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med Pounds P ₂ O ₅ per Acre	Opt. Pounds P ₂ O ₅ per Acre	Low Pounds K ₂ O per Acre	Med Pounds K ₂ O per Acre	Opt. Pounds K ₂ O per Acre
<i>Established plantings</i>							
Sandy loams and silt loams**	50-60 ¹	165 ¹	115 ¹	65 ¹	165 ¹	115 ¹	65 ¹
<i>Established plantings</i>							
Loamy sands and sands	60-80 ¹	165 ¹	115 ¹	65 ¹	165 ¹	115 ¹	65 ¹
All soil types**	30 ²	0	0	0	0	0	0

¹ Topdress at renovation
² Topdress in February or early March
 **Growers on clay or clayloam soils should reduce nitrogen rates to 25 percent and reduce by half or eliminate spring nitrogen applications.

Plants

Use certified dormant plants packed dry in polyliners. These plants can be stored at 30°F (-1.11°C) for a longer period than fresh-dug plants packed in sphagnum moss.

Spacing

Plant virus-free plants as early in the spring as possible. Plant in 4-foot rows with plants 18 to 30 inches apart in row. Distance will depend on variety and soil type. The approximate number of plants needed per acre is between 5,400 and 8,700.

Renovation

Strawberry beds must be renovated annually (immediately after harvest) to thin the plants, retain vigor, and maintain berry size in subsequent years. Follow the steps below when renovating strawberry plantings:

1. Apply 2,4-D herbicide for broadleaf weed control. Wait 7 to 8 days for weeds to absorb the herbicide.
2. Mow off the leaves as close to the ground as possible without damaging the crowns.
3. Narrow row widths to 12 inches using a cultivator or rototiller. Allow 1 inch of soil to cover crown.
4. Apply topdressing with N, P, and K as indicated in Recommendations Based on Soil Tests above.
5. Apply preemergent herbicides.
6. Irrigate to incorporate fertilizer and herbicide.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

New Planting-Posttransplant

DCPA--6-9 lb/A. Apply 8 to 12 pints per acre Dacthal 6F. Apply preplant incorporated with shallow cultivation before transplanting, or apply anytime after transplanting to weed-

free soil. Primarily controls annual grasses and certain small-seeded broadleaf weeds.

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF to weed-free soil immediately after transplanting. Activate with one-half inch sprinkler irrigation within 24 hours after application. Napropamide left on the soil surface is broken down by sunlight. Irrigation moves the herbicide into the soil and prevents breakdown by the sun. Primarily controls annual grasses and suppresses or controls certain annual broadleaf weeds.

Terbacil--0.10-0.15 lb/A. Apply 2 to 3 dry ounces of Sinbar 80DF per acre after transplanting but before new runner plants start to root. Controls many annual broadleaf weeds, but may be weak on pigweed species. Do NOT add surfactant, oil concentrate, or any other spray additive, or tank-mix with any other pesticide unless the mixture is approved on the Sinbar 80DF label. If strawberry transplants are allowed to develop new foliage prior to application, the spray must be followed immediately by 0.5 to 1.0 inches of irrigation or rainfall to wash the Sinbar 80 DF off the strawberry foliage, or unacceptable crop injury may result. University data has shown that more consistent weed control and less crop injury occurs when 0.05 lb/A, 1 dry ounce of Sinbar 80 DF is applied at 3 week intervals. Begin applications 3 to 6 weeks after transplanting, when the strawberries have 3 new full size trifoliate leaves, but before weeds exceed 1 inch in height.

Certain varieties differ in their sensitivity to Sinbar. Determine varietal tolerance before spraying field. Do NOT apply Sinbar 80 DF to soils with less than 0.5% organic matter. Do NOT use more than 8 ounces of Sinbar per acre per year unless otherwise directed on the label.

New Planting- Postemergence (summer)

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 4 days.

Sethoxydim--0.2-0.4 lb/A. Apply 1 to 2 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions

prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 7 days and apply no more than 2.5 pints per acre in one season.

Terbacil--0.1-0.3 lb/A. Apply 2 to 6 dry ounces of Sinbar 80DF per acre in late summer or early fall to control winter annual broadleaf weeds. Use lower rates on coarse textured sandy soils low in organic matter, and higher rates on fine textured silt and clay soils high in organic matter. Do NOT add surfactant, oil concentrate, or any other spray additive, or tank-mix with any other pesticide unless the mixture is approved on the Sinbar 80DF label. If the crop is not dormant at the time of application, the spray must be followed immediately by 0.5 to 1.0 inches of irrigation or rainfall to wash the Sinbar 80 DF off the foliage, or unacceptable crop injury may result.

University data has shown that more consistent weed control and less crop injury occurs when 0.05 lb/A, 1 dry ounce of Sinbar 80 DF is applied at 3 week intervals. Begin applications 3 to 6 weeks after transplanting, when the strawberries have 3 new full size trifoliate leaves, but before weeds exceed 1 inch in height.

Certain varieties differ in their sensitivity to Sinbar. Determine varietal tolerance before spraying field. Do NOT apply Sinbar 80 DF to soils with less than 0.5% organic matter. Do NOT use more than 8 ounces of Sinbar per acre per year unless otherwise directed on the label.

New Planting-Late Fall Dormant

DCPA--6-9 lb/A. Apply 8 to 12 pints per acre Dacthal 6F. Apply to weed-free soil in the fall and repeat in early spring, but do not apply after bloom. Primarily controls annual grasses and certain broadleaf weeds.

Napropamide--2-3 lb/A. Apply 4 to 6 pounds per acre of Devrinol 50DF (or OLF). Apply in late fall through early winter (not on frozen ground) or in early spring. Do not apply from bloom through harvest. Rainfall or irrigation will increase effectiveness. Primarily controls annual grasses and certain broadleaf weeds, including chickweed spp.

Clethodim--0.094-0.125 lb/A. (See the preceding "Clethodim" paragraph.)

Sethoxydim--0.2-0.4 lb/A. (See the preceding "Sethoxydim" paragraph.)

Terbacil--0.1-0.2 lb/A. Apply 2 to 4 dry ounces of Sinbar 80DF per acre just prior to mulching in late fall to extend weed control through harvest the following spring. Controls many annual broadleaf weeds, but may be weak on pigweed species. Use lower rates on coarse textured sandy soils low in organic matter, and higher rates on fine textured silt and clay soils high in organic matter. Do NOT add surfactant, oil concentrate, or any other spray additive. Do NOT apply within 110 days of harvest.

Certain varieties differ in their sensitivity to Sinbar.

Determine varietal tolerance before spraying field. Do NOT apply Sinbar 80 DF to soils with less than 0.5% organic matter. Do NOT use more than 8 ounces of Sinbar per acre per year unless otherwise directed on the label.

Bearing Year-Late Winter or Early Spring

Clopyralid--0-.047-0.25 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Stinger 3A to control weeds in strawberries in New Jersey, Maryland, Pennsylvania, and Virginia. The legal use of this product may require a waiver of Liability that has been signed by the grower, and returned to Dow AgroSciences.** Apply 2 to 10.5 fluid ounces of Stinger 3A per acre in one or two applications during the spring to control certain annual and perennial broadleaf weeds. Observe a minimum preharvest interval (PHI) of 30 days. When two applications are used to control susceptible hard-to-kill perennial weeds, spray the first application in the spring at least 30 days before harvest and second application at renovation, after harvest. Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 10.5 fluid ounces, in one or split into two applications to suppress or control perennial weeds, but do not exceed 10.5 fluid ounces in one year. Spray additives are not needed or required by the label, and are not recommended. Do NOT tank-mix Stinger with other herbicides registered for use in strawberries. Observe a minimum preharvest interval (PHI) of 30 days. Stinger is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover.

DCPA--6-9 lb/A. Apply 8 to 12 pints per acre Dacthal 6F. Apply anytime to weed-free soil in the early spring. Do not apply after bloom. Primarily controls annual grasses and certain broadleaf weeds.

Flumioxazin—0.096 lb/A. Apply 3 dry ounces of Chateau 51WDG to established stands of matted row strawberries in late winter or early spring when strawberries are dormant, or as a hooded/shielded spray between the rows of strawberries on plastic mulch before fruit set. Controls many annual broadleaf weeds, and suppresses or controls wild pansy. Tank-mix with 2,4-D to improve the spectrum of weeds controlled when treating dormant matted row strawberries, or tank-mix with Gramoxone when applying a hooded/ shielded spray between the rows of strawberries grown on plastic mulch. Oil concentrate at 1% of the spray solution (1 gallon per 100 gallons of spray solution) or nonionic surfactant at 0.25% of the spray solution (1 quart per 100 gallons of spray solution) may be added to improve the control of emerged weeds, but may also increase the risk of crop injury.

Napropamide--2-3 lb/A. Apply 4 to 6 pounds per acre Devrinol 50DF (or OLF). Apply in late fall through early

winter (not on frozen ground) OR in early spring. Do not apply from bloom through harvest. Rainfall or irrigation will increase effectiveness. Primarily controls annual grasses and certain broadleaf weeds.

Clethodim--0.094-0.125 lb/A. (See the preceding "Clethodim" paragraph.)

Sethoxydim--0.2-0.4 lb/A. (See the preceding "Sethoxydim" paragraph.)

2,4-D--1-1.5 lb/A. Apply 1 to 1.5 quarts per acre amine form of 2,4-D (Formula 40) to established stands in late winter or early spring when the strawberries are dormant. Controls many broadleaf weeds. Do not apply unless possible injury to the crop is acceptable. Do not apply 2,4-D between mid-August and winter dormancy, as it may reduce flower bud formation.

Bearing Year Renovation-Summer

Clopyralid--0-.047-0.25 lb/A. **A Special Local-Needs Label 24(c) has been approved for the use of Stinger 3A to control weeds in strawberries in New Jersey, Maryland, Pennsylvania, and Virginia. The legal use of this product may require a waiver of Liability that has been signed by the grower, and returned to Dow AgroSciences.** Apply 2 to 10.5 fluid ounces of Stinger 3A per acre in one or two applications to control certain annual and perennial broadleaf weeds. When two applications are used to control susceptible hard-to-kill perennial weeds, spray the first application in the spring at least 30 days before harvest and second application at renovation, after harvest. Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 10.5 fluid ounces, in one or split into two applications to suppress or control perennial weeds, but do not exceed 10.5 fluid ounces in one year. Spray additives are not needed or required by the label, and are not recommended. Do NOT tank-mix Stinger with other herbicides registered for use in strawberries. Observe a minimum preharvest interval (PHI) of 30 days. Stinger is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover.

DCPA--6-9 lb/A. Apply 8 to 12 pints per acre Dacthal 6F. Apply anytime after harvest to weed-free soil. Primarily controls annual grasses and certain broadleaf weeds.

Paraquat—0.5 lb/A. Apply 2 pints per acre of Gramoxone Inteon 2SC as a directed shielded spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution). Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. Do not apply more than 3

times per season. See the label for additional information and warnings.

Terbacil--0.2-0.4 lb/A. Apply 4 to 8 ounces per acre Sinbar 80WP at postharvest renovation after old leaves have been removed but before new growth begins. Primarily controls broadleaf weeds but does NOT control pigweed species. Use Devrinol, Dacthal, or Poast 1.5 EC to control annual grasses. Use lower rates on coarse textured sandy soils low in organic matter, and higher rates on fine textured silt and clay soils high in organic matter. Do NOT add surfactant, oil concentrate, or any other spray additive. Certain varieties differ in their sensitivity to Sinbar. Determine varietal tolerance before spraying field. Do NOT apply Sinbar 80 DF to soils with less than 0.5% organic matter. Do NOT use more than 8 ounces of Sinbar per acre per year unless otherwise directed on the label.

Clethodim--0.094-0.125 lb/A. (See the preceding "Clethodim" paragraph.)

Sethoxydim--0.2-0.4 lb/A. (See the preceding "Sethoxydim" paragraph.)

2,4-D--1-1.5 lb/A. Apply 1 to 1.5 quarts per acre amine form of 2,4-D (Formula 40) to established stands immediately after the last picking. Controls many broadleaf weeds. Do not apply 2,4-D between mid-August and winter dormancy, as it may reduce flower bud formation.

Established Planting-Late Fall Dormant

DCPA--6-9 lb/A. Apply 8 to 12 pints per acre Dacthal 6F. Apply to weed-free soil in the fall and repeat in early spring, but do not apply after bloom. Primarily controls annual grasses and certain broadleaf weeds.

Napropamide--2-3 lb/A. Apply 4 to 6 pounds per acre Devrinol 50DF (or OLF). Apply in late fall through early winter (not on frozen ground) **OR** in early spring. Do not apply from bloom through harvest. Rainfall or irrigation will increase effectiveness. Primarily controls annual grasses and certain broadleaf weeds, including chickweed spp.

Clethodim--0.094-0.125 lb/A. (See the preceding "Clethodim" paragraph.)

Sethoxydim--0.2-0.4 lb/A. (See the preceding "Sethoxydim" paragraph.)

Terbacil--0.2-0.4 lb/A. Apply 4 to 8 dry ounces of Sinbar 80DF per acre just prior to mulching in late fall to extend weed control through harvest the following spring. Controls many annual broadleaf weeds, but may be weak on pigweed species. Use lower rates on coarse textured sandy soils low in organic matter, and higher rates on fine textured silt and clay soils high in organic matter. Do NOT add surfactant, oil concentrate, or any other spray additive. Do NOT apply within 110 days of harvest.

Certain varieties differ in their sensitivity to Sinbar. Determine varietal tolerance before spraying field. Do NOT apply Sinbar 80 DF to soils with less than 0.5% organic matter. Do NOT use more than 8 ounces of Sinbar per acre per year unless otherwise directed on the label.

Pollination

Honey bees are important for proper set and pollination. 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 and/or Table D-6 for relative toxicity of various pesticides for hazard to bees.

Insect Control

Aphids, Spittlebug

Apply 10 days after new growth begins.

Danitol--10.67 oz 2.4EC/A, or imidacloprid (foliar)--see label for rates and application methods, or

Lannate (Aphids only);--1.5-3 pt LV/A, or Thionex--1.33 qt 3EC/A or OLF (DO NOT reapply within 15 days or more than twice within a 35-day period when fruit is present.)

Leafroller

Apply one spray 10 days after full bloom.

Brigade--6.4-32 oz WSB/A, or diazinon--12.75 fl oz AG600 WBC/A or OLF, or Entrust--1.25-1.5 oz 80W/A, or Sevin--1.25-2.5 lb 80S/A, 1-2 qt XLR Plus/A or OLF, or Spintor--4-6 fl oz 2SC/A

Potato Leafhopper

malathion--1.5-2.5 pt 5EC/A

Root Weevils

Brigade--8-32 oz WSB/A. Apply at first sign of leaf injury; repeat at 7-10 day intervals, or Malathion--1-2 pt 8 Aquamul/A, or OLF, or Entomopathic nematodes (use *Heterorhabditis bacteriophora*). Apply 1-2 billion per acre during evening or early morning when soil temperatures are 60°F (15.6°C) or greater, then irrigate them into the soil.

Sap Beetles

Sap beetles are attracted to ripe, decaying fruit and bore into berries. They are a nuisance, especially in Pick-Your-Own fields where rotting, over-ripe berries abound.

Preventing the accumulation of decaying fruit on or between beds is one way of avoiding beetle buildup.

Brigade--6.4-32 oz WSB/A, or Danitol--16-21.3 fl oz 2.4 EC/A

Slugs

Slugs prefer a cool, wet, dark environment. Mulch, weeds, and other plant trash in beds during a wet spring provide the perfect setting for their development. Mulch removal and adequate weed control are two ways to reduce the slug population. Sevin Bait broadcast over the beds several days before first harvest may be useful.

Deadline--10-40 lb MPs/A, or Sevin Bait--40 lb 5% bait/A or OLF, or Trails End--40 lb LG/A

Strawberry Rootworm

Sevin, Guthion, or Thionex applied for other pests will aid in controlling strawberry rootworm.

Strawberry Weevil (Strawberry Clipper)

Apply after new growth starts and before fruit buds are visible. Repeat 10 days later.

Danitol--16-21.3 fl oz 2.4 EC/A, or
 Lorsban--1 qt 4E/A. Apply when buds first appear and again 10 to 14 days later. DO NOT apply when fruit sets or berries are present, or

Tarnished Plant Bug

Brigade--6.4-32 oz WSB/A, or
 Danitol--10.67 oz 2.4EC/A, or
 Thionex--1.33 qt 3EC/A

Thrips

Entrust--1.25-1.5 oz 80W/A, or
 Lannate--1.5-3 pt LV/A or OLF, or
 Spintor--4-6 fl oz 2SC/A

Two-Spotted Spider Mite (TSSM)

For best results, control TSSM early in the spring before eggs are laid. Thorough underleaf spray coverage is necessary. Alternate materials with different modes of action.

Acramite--0.75-1.0 lb 50 WS/A, or
 abamectin (Agri-mek;generics available)--16 fl oz 0.15EC/A, or
 Brigade--16-32 oz WSB/A, or
 Danitol--16-21.3oz 2.4EC/A, or
 Oberon--12-16 fl oz 2SC/A, or
 Savey--3-6 oz 50WP/A or OLF, or
 Vendex--1.5-2 lb 50WP/A or OLF, or
 Zeal--2-3 oz /A

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Acramite	G	12	1
abamectin	R	12	3
Brigade	R	24	0
Danitol	R	24	2
Deadline	G	12	0
diazinon 4EC	R(NJ),G	12,24	5
Entrust	G	4	1
imidacloprid	G	12	7
Lannate	R	48	3 fresh 10 processing Prebloom
Lorsban	R	24	3
malathion	G	12	3
Oberon	G	12	3
Savey	G	12	3
Sevin	G	12	7
Sevin Bait	G	12	1
Spintor	G	4	1
Thionex	R	24	4
Trails End	G	12	1
Vendex	G	48	1
Zeal	G	12	1
FUNGICIDE (FRAC code)			
Abound (Group 11)	G	4	0
Aliette (Group 33)	G	12,24	0
Cabrio (Group 11)	G	24	0
Captan (Group M4)	G	24	1
Captevate (Groups 17 + M4)	G	24	0

(table continued)

Pesticide (<i>continued</i>)	Use Category ¹	Hours to Reentry ²	Days to Harvest
FUNGICIDE (FRAC code)			
copper, fixed (Group M1)	G	24	0
Elevate (Group 17)	G	4	0
iprodione (Group 2)	G	12	0
Nova (Group 3)	G	24	1
Pristine (Groups 11 + 7)	G	12	0
Procure (Group 3)	G	12	1
Ridomil Gold (Group 4)	G	48	NA
Switch (Groups 9 +12)	G	12	0
Thiram (Group M3)	G	24	3
Topsin M (Group 1)	G	12	1

See Table D-6.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Nematode Control

See "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section.

Preplant

Nemacur 3SC--2.5-3.5 qt/A

Postplant

Nemacur 15G--12-18 lb/A, or

Nemacur 3SC--2.5-3.5 qt/A

(Note: Sale and distribution of Nemacur will be discontinued as of May 31, 2007)

Disease Control

Transplant Treatment

Rovral 50WP (iprodione) can be used as a preplant dip for gray mold control in the plants. Use 2 pounds of 50WP per 100 gallons of water.

Angular Leaf Spot

Begin applications when disease appears. Discontinue applications if plant injury occurs.

Copper, fixed--2-3 lb 40DF/A

Anthracoese Fruit Rot

Begin sprays no later than 10% bloom or prior to disease development and continue on a 7 to 10 day interval.

Use the higher rate and shorter intervals when disease pressure is high. **Do not make more than two (2) consecutive applications of either Pristine, Cabrio or Abound, before switching to another fungicide.**

Apply the following combinations:

Application #1:

captan--4 lb 50WP/A *plus* Pristine--18.5-23 oz 38 WG/A

Application #2:

captan--4 lb 50WP/A *plus* Abound--6.2-15.4 fl oz 2.08F/A, or Cabrio--12-14 oz 20EG/A

Application #3:

Captevate--3.5-5.25 lb 68WDG/A

For subsequent applications:

Alternate:

captan--4 lb 50WP/A *plus* Abound--6.2-15.4 fl oz 2.08F/A,
 or

Cabrio--12 to 14 oz 20EG/A, *plus* captan--4 lb 40WP/A, or
 Captevate--3.5-5.25 lb 68WDG/A.

Gray Mold (*Botrytis* Fruit Rot)

Apply at 5 to 10 percent bloom and every 10 days until harvest because 90% of fruit infections occur through the flower. During periods of excessive moisture, spray intervals of 5 to 7 days may be necessary. Tank mix and alternate different fungicides (ie. FRAC codes) to reduce the chances for fungicide resistance development.

Application #1:

captan--4 lb 50WP/A *plus* thiophanate-methyl--1 lb 70WP,
 or
 Switch--11-14 oz. 62.5WG/A

Application #2:

Elevate--1.1-1.5 lb 50WDG/A, or
 Pristine--18.5-23 oz 38 WG/A

Application #3:

captan--4 lb 50WP/A *plus* thiophanate-methyl--1 lb 70WP,
 or
 Switch--11-14 oz. 62.5WG/A

For subsequent applications:

Alternate:

captan--4 lb 50WP/A, or
 Captevate--3.5-5.25 lb 68WDG/A, or
 Switch--11-14 oz. 62.5WG/A, or
 Pristine--18.5-23 oz 38WG/A, or
 Thiram--4-5 lb 65WSB/A

Fungal Leaf Blight, Leaf Scorch and Spot

Apply one spray 10 to 14 days before full bloom. On susceptible varieties, fall sprays on a 3-week schedule may be necessary. Do not make more than 2 consecutive applications of either FRAC code 11 fungicide (Cabrio or Abound) before switching to another fungicide. Do not use Abound in propagation nurseries and do not apply more than 1.92 quarts per acre per season.

Abound--6.2-15.4 fl oz 2.08F/A or OLF, or
 Cabrio--14 oz. 20EG/A, or
 Nova--2.5-5 oz 40WP/A, or
 thiophanate-methy--1 lb 70WP/A

Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.

Powdery Mildew

Begin applications when the disease first appears and repeat at 14 to 21 day intervals.

Alternate:

Cabrio--14 oz 20EG/A, or
 Nova--2.5-5 oz 40WP/A, or
 Procure--4-8 oz 50WS/A

With the following fungicide:

thiophanate-methy--1 lb 70WP/A

Materials with different modes of action (FRAC codes) should always be alternated to reduce the chances for fungicide resistance development.

Virus Diseases

Use certified, virus-free plants.

Red Stele and *Phytophthora* Crown Rot

Where possible, prevent fungus transfer with cultivation equipment and surface runoff water. Planting on high, raised beds may offer some relief. Planting in well-drained soils may provide a measure of relief. In the case of red stele, control by crop rotation is of little value, because the red stele fungus persists many years in soil.

Use varieties resistant to strains of the red stele fungus if present. Allstar, Earliglow, Guardian, and Latestar, have resistance to several races. Resistance is not available to crown rot. Also, use disease-free plants when establishing planting.

For additional control, apply one of the following:

New Plantings

Aliette--2.5-5 lb 80WDG/A. Begin 14 to 21 days after planting and continue on a 30 to 60 day interval as long as favorable disease conditions occur, or

Ridomil Gold--1 pt 4EC/A. Make one application at transplanting plus an additional application at fruit set or 30 days before harvest.

Established Plantings

Aliette--2.5-5 lb 80WDG/A. Begin in spring when plants start active growth and repeat every 30 to 60 days, or

Ridomil Gold--1 pt 4EC/A. Apply in spring before first bloom and repeat once in the fall.

Verticillium Wilt

This disease is a serious problem with most varieties. However, Guardian and Latestar have good wilt resistance. Even resistant varieties will become infected if the soil is heavily infested with *Verticillium*. A 5-year rotation following tomato, potato, eggplant, or pepper is generally sufficient to permit the planting of susceptible varieties. Practice strict weed control during the rotation period, because a number of common weed species serve as alternate hosts for *Verticillium*.

For control, use one of the following:

methyl bromide *plus* chloropicrin (67% *plus* 33%)--250
 lb/A, or

Vapam HL--50-75 gal/A. Apply in the fall before planting.

Black Root Rot

This is a disease complex caused by many different fungi and by nematode feeding injury. The most prevalent fungi causing the disease are *Rhizoctonia* and *Pythium*.

Crop rotation of 4 to 5 years will reduce the incidence of black root rot. In fields with a high water table, the use of raised beds will provide some control.

Nematicides may provide additional control when combined with an adequate rotation period.

SUMMER SQUASH

Varieties

Varieties¹

Straightneck Type (yellow)

Seneca Prolific, GS³
Lemondrop L, GS

Zucchini Types

Zucchini Elite
Golden Dawn III (yellow)
Senator
Spineless Beauty
Seneca Zucchini
Gold Rush (yellow)

Spring or Summer Planting

Crookneck Type (yellow)

Prelude II (GMO²), GS, (CMV, WMV2, ZYMV) PM⁴

Straightneck Type (yellow)

XPHT1832 III, (GMO), PY³, (CMV, WMV2, ZYMV)
Patriot II, (GMO), GS, (WMV2, ZYMV)
Multipik, PY
Sunray, PY, PM
Fortune, PY
Cougar, PY (PRSV, ZYMV)
Lioness, GS (CMV, WMV2, ZYMV)
Superpik, PY
Conquerer III, (GMO), GS, (CMV, PRSV, WMV2, ZYMV)

Scallop Types

Peter Pan (light green)
White Ruffles
Starship (dark green)
Sunburst (golden)
Flying Saucer (yellow and green)

Specialty Types

Magda (short, light green, Mid-East type)
Zephyr (yellow, green blossom end)
Floridor (round yellow) (trial)
Eight Ball (round green) (trial)

Zucchini Types

Revenue (CMV, WMV2, ZYMV)
Justice III (GMO) (CMV, WMV2, ZYMV)
Independence II (GMO) (WMV2, ZYMV)
Payroll (WMV2, ZYMV) PM
Cashflow (ZYMV)
Judgement III (GMO), (CMV, WMV2, ZYMV) PM
Lynx (PRSV, WMV2, ZYMV)
Wildcat (PRSV, WMV2, ZYMV) PM
Dividend (CMV, WMV2, ZYMV)
Tigress (WMV2, ZYMV)

CMV=Cucumber Mosaic Virus, WMV2=Watermelon Mosaic Virus 2, PRSV=Papaya Ring Spot Virus, and ZYMV=Zucchini Yellow Mosaic Virus

¹ALL SUMMER SQUASH VARIETIES ARE HYBRIDS Varieties listed by maturity within each type, earliest first and are recommended for in DE, MD, NJ, PA, VA and WV.

²GMO, where denoted variety transformed with viral coat protein antisense for strong virus resistance. Varieties not denoted GMO have conventionally-breed resistance as indicated.

(table continued)

³In yellow-fruited summer squash the precocious yellow gene, (PY) confers tolerance to CMV and WMV2 as compared to the green stem (GS) counterpart.

⁴PM were denoted indicates varieties with intermediate resistance to powdery mildew.

Varieties with multiple resistance are available (see above table). Varieties expressing the precocious yellowing gene (PY) such as ‘Multipik’ will mask the greening of fruit caused by WMV and CMV, but will become bumpy and/or distorted when infected with either PRSV or ZYMV. **All 4 viruses may be detected at some level in squash fields in our region in any given year, therefore it is best to plant varieties with resistance to more than one virus, especially in later plantings when virus transmission by aphids increases.**

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Summer Squash	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med	Opt.	Low Pounds K ₂ O per Acre	Med	Opt.
	75-100 ¹	150 ¹	100 ¹	50 ¹	200 ¹	150 ¹	100 ¹
	25-50 ²	150 ²	100 ²	50 ²	200 ²	150 ²	100 ²
	50 ³	0	0	0	0	0	0
	25-30 ⁴	0	0	0	0	0	0

¹Total amount nutrient recommended

²Broadcast and disk-in

³Sidedress when vines start to run

⁴Apply through irrigation system

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations

Seed Treatment

Check with seedsman to determine if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 75WP (½ teaspoon per pound or 3 ounces per 100 pounds) and an approved commercially available insecticide.

Seeding, Transplanting, and Spacing

Seed April 15 through August 15 in warmer, southern regions and May 10 to August 1 in Pennsylvania and other cool areas. Use 4 to 6 pounds of seed per acre.

Container-grown plants are planted through the plastic when daily mean temperatures have reached 60°F (15.6°C). Planting dates vary from April 15 in southern regions to June 1 in northern areas. Early plantings should be protected from winds with hot caps, tents, or row covers.

Space rows 5 to 6 feet apart with plants 2 to 3 feet apart in the row.

Mulching

Fumigated soil aids in the control of weeds and soil-borne diseases. Clear, plastic mulch laid before field planting conserves moisture, increases soil temperature, and increases early and total yield. Plastic and fumigant--Vapam HL (30 to 37 gallons per acre)—should be applied on well-prepared

planting beds 30 days before field planting. Plastic should be 4 feet wide (4,000-foot rolls) and laid on 5- or 6-foot centers 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 summer squash may not provide satisfactory weed control when used under clear plastic mulch on nonfumigated soil. Consult your county agent for latest recommendations. Black plastic or paper can be used without a herbicide. Fertilizer must be applied during bed preparation. At least 50 percent of the nitrogen (N) should be in the nitrate (NO₃) form.

Foil mulches can be used to repel aphids that transmit mosaic in fall-planted (after July 1) squash. Direct seeding through the mulch is recommended for maximum virus protection. Transplants should not be used with foil or other repellent mulches. Also, a herbicide is not necessary. Fumigation will be necessary when there is a history of soil-borne diseases in the field.

Growers may wish to consider trickle irrigation. See the section on "Irrigation" in this publication.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. See the "Mulching" section above for further information on weed control under clear plastic mulch.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tube left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tube several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.

Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar

4E preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E as a banded directed shielded spray preemergence to the weeds and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Clomazone--0.094-0.188 lb/A. Apply 4 to 8 fluid ounces per acre Command 3ME as a banded directed shielded spray preemergence to the weeds to control annual grasses and many broadleaf weeds including common lambsquarter, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use, or use Strategy, the jug-mix that contains clomazone (Command) and ethalfluralin (Curbit).

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several

hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfuralin--0.38-0.75 lb/A. Apply 1 to 2 pints per acre Curbit 3E as a banded directed shielded spray preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarter, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. **DO NOT** preplant incorporate. **DO NOT** apply under plastic mulch or tunnels. **DO NOT** use on transplanted summer squash. **DO NOT** use when soils are cold or wet. Crop injury may result!

Ethalfuralin plus Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfuralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart below to determine the amount of each herbicide at commonly used rates:

Curbit and Command Active Ingredients (ai) in Commonly Used Strategy Rates

Strategy pints/A	Ethalfuralin (Curbit) lb ai/A	Clomazone (Command) lb ai/A
1.5	0.3	0.094
2	0.4	0.125
3	0.6	0.188
4	0.8	0.25
5	1.0	0.312
6	1.2	0.375

Labeled for use in all the mid-Atlantic states. Read and follow all the recommendations and warnings (above) for ethalfuralin (Curbit) and clomazone (Command)

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a banded directed shielded spray between rows of plastic mulch to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with

high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. **Do NOT** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. Do NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, in a year.**

Postemergence

Carfentrazone--0.008-0.031 lb/A. Apply 0.5 to 2 fluid ounces of Aim 2EC or Aim 1.9EW as a banded directed shielded spray between the rows of plastic mulch to suppress or control broadleaf weeds including morningglory species, pigweed species, common lambsquarter, and nightshade species when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Aim applied postemergence will not control annual or perennial grasses. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution), or oil concentrate or methylated seed oil to be 1 -2% percent of the spray solution (1-2 gallons per 100 gallons of spray solution). **The shielded (hooded) sprayer must be designed to prevent spray or drift from contacting the stems, leaves, flowers or fruit of the crop, or severe injury may occur.**

Halosulfuron--0.023-0.031 lb/A. Apply 0.5 to 0.66 dry ounce Sandea 75WG as a banded directed shielded spray between rows of plastic mulch to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). **Do NOT** use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the

development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, in a year.**

Paraquat--0.6 lb/A. A **Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC postemergence as a directed shielded spray in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a directed spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be

needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

For Seeding Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Seeding into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Preemergence

Clomazone--0.094-0.188 lb/A. Apply 4 to 8 fluid ounces per acre Command 3ME preemergence to a direct-seeded crop to control annual grasses and many broadleaf weeds including common lambsquarter, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide

drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfuralin--0.38-0.75 lb/A. Apply 1 to 2 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarter, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfuralin *plus* Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfuralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart under Ethalfuralin *plus* clomazone (jug-mix) in the section **For Soil Strips Between Rows of Plastic Mulch** to determine the amount of each herbicide at commonly used rates.

Read and follow all the recommendations and warnings (above) for ethalfuralin (Curbit) and clomazone (Command).

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

Postharvest

With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Pollination

Honeybees squash bees, bumblebees and other wild bees are important for proper set and pollination. 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 and/or Table D-6 for relative toxicity of various pesticides for hazard to bees.

Insect Control

Seed Corn Maggot

(See "Maggots" section in Soil Pests--Their Detection and Control.) **Note.** The use of imidacloprid at planting will reduce seed corn maggot populations.

Cucumber Beetle

Cucumber beetles can transmit bacterial wilt and cause stand losses by direct feeding injury. If adult beetles are abundant and there is a history of disease problems, insecticides should be applied before beetles feed extensively on the cotyledons and first true leaves. If foliar insecticides

are used, begin spraying shortly after plant emergence, and repeat applications at weekly intervals if new beetles continue to invade fields.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or Baythroid XL--2.4-2.8 fl oz /A, or

bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
 Furadan--A Special Local-Needs Label 24(c) is in effect for the use of liquid Furadan at 3.8 fl oz 4F/1,000 ft of row at planting. Consult your local county Extension office for current restrictions. **Note.** Use of Furadan at planting frequently leads to spider mite outbreaks later in the season, or
 imidacloprid (soil, foliar)--see label for rates and application methods, or
 lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
 Lannate--1.5-3 pt LV/A or OLF, or
 Platinum--5-8 oz 2SG/A.
 Sevin--1.25 lb 80S/A or OLF, or
 Thionex--0.67-1.33 qt 3E/A or OLF

Squash Vine Borer

When vines begin to run, apply to bases of plants four times at 7-day intervals. Pheromone traps for squash vine borer are commercially available. These traps can be used to indicate when moth activity begins. **Note:** Use of SpinTor for looper control will reduce squash vine borer populations.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
 bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
 permethrin--4-8 fl oz 3.2EC/A, or
 Thionex--0.67-1.33 qts 3E/A or OLF

Cutworms

(Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
 Baythroid XL -0.8 – 1.6 fl oz /A, or
 bifenthrin--2.1-6.4 fl oz 2EC/A or OLF

Pickleworm, Melonworm

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

Asana XL--5.8-9.6 fl oz 0.66EC/A (pickleworm only), or
 Avaunt--2.5-6 oz 30WDG/A, or
 Baythroid XL--1.6-2.4 fl oz /A, or
 bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
 Entrust--1.25-2.5 oz 80W/A, or
 Intrepid--4-10 fl oz 2F/A, or
 lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
 Lannate--1.5-3 pt LV/A or OLF, or
 permethrin--4-8 fl oz 3.2EC/A, or
 Radiant--5-10 fl oz SC/A, or
 Sevin--1.25 lb 80S/A or OLF, or
 SpinTor--4-8 fl oz 2SC/A, or
 Thionex--0.67-1.33 qts 3E/A or OLF

Aphids

Note. Aphids transmit mosaic virus. 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.

Note. Virus-resistant cultivars including transgenic varieties are commercially available.

Actara--1.5-3.0 oz 25WDG/A, or
 Beleaf--50 SG (see label for rate), or
 Fulfill--2.75 oz 50WDG/A, or
 imidacloprid (soil, foliar)--see label for rates and application methods, or

Metasystox-R--1.5-2 pt 2SC/A (GPA only), or
 Platinum--5-8 oz 2SG/A, or
 Thionex--0.67-1.33 qts 3EC/A or OLF, or
 Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A

Squash Bug

Begin treatments if greater than one egg mass per plant is present. Sprays should target nymphal stages. **Note.** Use of Venom for aphid control will reduce squash bug populations.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
 bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
 lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
 permethrin--8 fl oz 3.2EC/A, or
 Sevin--1.25 lb 80S/A, or
 Thionex--2/3-1 1/3 qt 3SC/A

Leafminers

abamectin (Agri-mek;generics available)--8-16 fl oz 0.15EC/
 or
 Entrust--2-2.5 oz 80W, or
 permethrin--8 fl oz 3.2EC/A, or
 Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A, or
 SpinTor--6-8 fl oz 2SC/A, or
 Vydate L--2-4 pt 2L/A

Rindworms (Cucumber Beetle Larvae)

Damage to the rinds may result from a complex of insects including cucumber beetle, wireworms, and a number of "worm" species, (beet army worm, etc.). Management of adult cucumber beetles early in the season may help reduce damage. See cucumber beetle section for labeled products

Cabbage Looper

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Bacillus thuringiensis--Consult label for rates and restrictions, or
 Baythroid XL--1.6-2.4 fl oz/A, or
 bifenthrin--2.1-6.4 fl oz 2EC/A or OLF, or
 Danitol--10.66-16 fl oz 2.4EC/A, or
 Entrust--1.25-2.5 oz 80W/A, or
 lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
 Lannate--1.5-3 pt LV/A or OLF, or
 permethrin--4-8 fl oz 3.2EC/A, or
 Radiant--5-10 80W/A, or
 SpinTor--4-8 fl oz 2SC/A

Mites

Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot treated. Begin treatment when 10 to 15 percent of the crown leaves are infested early in the season, or when 50 percent of the terminal leaves are infested later in the season.

Note. Continuous use of Furadan, Sevin, or pyrethroids may result in mite outbreaks.

Acramite--0.75-1.0 50W/A, or
 abamectin (Agri-mek;generics available)--8-16 fl oz
 0.15EC/A, or
 bifenthrin--5.12-6.4 fl oz 2EC/A or OLF, or
 Danitol--10.66-16 fl oz 2.4EC/A, or
 Oberon--7-8.5 fl oz 2SC/A

Thrips

Entrust--2-2.5 oz 80W/A, or

lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or SpinTor--6-8 fl oz 2SC/A, or Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A, or Vydate--2-4 pt 2L/A

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Acramite	G	12	3
Actara	G	12	0
abamectin (Agri-mek)	R	12	7
Asana XL	R	12	3
Avaunt	G	12	3
<i>Bacillus thuringiensis</i>	G	4	0
Baythroid XL	R	12	0
Beleaf	G	12	0
bifenthrin	R	12	3
Danitol	R	24	7
Entrust	G	4	3
Fulfill	G	12	0
Furadan	R	48	At Plant
imidacloprid	G	12	21
lambda-cyhalothrin	R	24	1
Lannate	R	48	3
Metasystox-R	R	48	14
Oberon	G	12	7
Platinum	G	12	30
permethrin	R	12	0
Radiant	G	4	3
Sevin	G	12	3
SpinTor	G	4	3
Thionex	R	24	2
Venom (soil/foliar)	G	12	21/1
Vydate L	R	48	1
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Forum (Group 40)	G	12	0
Gavel (Groups 22 + M3)	G	48	5
Mancozeb (Group M3)	G	24	5
maneb (Group M3)	G	24	5
Nova (Group 3)	G	24	0
Previcur Flex (Group 28)	G	12	2
Pristine (Groups 11 + 7)	G	12	0
Procure (Group 3)	G	12	0
Quadris (Group 11)	G	4	1
Ranman (Group 21)	G	12	0
Ridomil Gold (Group 4)	G	48	0
Tanos (Groups 11 + 27)	G	12	3
Ultra Flourish (Group 4)	G	48	0

See Table D-6.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Nematode Control

See "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section.

Vydate L--1-2 gal 2L/A. Incorporate into the top 2 to 4 inches of soil or 2 to 4 pints 2L per acre applied 2 weeks after planting and repeat 2 to 3 weeks later.

Disease Control

Damping-Off

Apply the following in a 7-inch band after seeding. Use formula in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold or Ultra Flourish needed per acre.

mefenoxam--1-2 pt Ridomil Gold 4EC/A or 2-4 pt Ultra Flourish 2E/A

Viruses (CMV, WMV2, PRSV, and ZYMV)

Varieties with multiple resistance packages are available (see above table). Varieties expressing the precocious yellowing gene such as "Multipik" will mask the greening of fruit caused by WMV and CMV but will become distorted when infected with either PRSV or ZYMV. **All 4 viruses may be detected at some level in squash fields in the region in any given year, therefore plant varieties with resistance to more than one virus** The following control measures should also be used.

If possible, plant fields as far apart as possible from existing cucurbit plantings to reduce the chances for aphid transmission. Using reflective mulch may help to prevent aphid transmission of viruses. (See preceding "Mulching" section.)

Bacterial Wilt

Controlling striped and spotted cucumber beetles are essential for preventing of wilt. See preceding "Cucumber Beetle" section under Insect Control for specific recommendations. Insecticide applications made at seeding may not prevent beetle damage season long, therefore, additional foliar insecticide applications may be necessary.

Powdery Mildew

The fungus that causes cucurbit powdery mildew can develop resistance to several different groups of fungicides. Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern US, therefore proper fungicide resistance management should be followed.

Powdery mildew generally occurs from mid-July until the end of the season. Make first application when powdery mildew is observed in the area or is detected by scouting (one lesion on the underside of 45 old leaves), begin the following fungicide program:

Alternate:

Nova--5 oz 40WP/A plus chlorothalonil-2-3 pt 6F/A , or Procure--4-8 oz 50WS/A plus chlorothalonil--2-3 pt 6F/A ,

With:

a tank mix containing Pristine--12.5-18.5 oz 38WG/A plus chlorothalonil

Downy Mildew

Scout fields for disease incidence early in the growing season. Begin sprays when plants meet in the row or if disease occurrence is predicted for the region. Refer to the Cucurbit Downy Mildew Forecasting website (www.ces.ncsu.edu/depts/pp/cucurbit/) for current status of the disease. Preventative applications are much more effective than applications made after disease is detected. The following are the most effective materials. Tank mix

these products with a protectant such as chlorothalonil--1.5-2 pt 6F/A or OLF:

Ranman--2.1-2.75 fl. oz. 400 SC/A, or

Previcur Flex--1.2 pt 6F/A, or

Gavel--1.5-2 lb 75 DF/A (Gavel contains mancozeb, which is a protectant, and does not need a tank mix partner.)

Curzate--3.2 oz 60DF/A, or

Tanos--8 oz 50WDG/A

Materials with different modes of action (FRAC codes) should be alternated to reduce the chances for fungicide resistance development.

Sprays should be applied on a 7-day schedule. Under severe disease conditions spray interval may be reduced if label allows.

Plectosporium Blight (*Microdochium Blight*)

A three year rotation with crops other than cucurbits is advised. It is important to achieve maximum foliage coverage with the fungicide application. Once symptoms appear on petioles or after fruit form, apply one of the following and repeat every 7 – 10 days.

chlorothalonil--2-3 pt 6F/A, or OLF

mancozeb--2-3 lb 75DF/A, or

maneb (Manex)--1.2-1.6 pt 4F/A

A spray schedule that alternates Cabrio or Flint with chlorothalonil will also provide control.

Blossom Blight

This is a serious problem in some years. The fungus becomes established in senescent blossoms and grows into young fruit. Improve aeration through wider plant spacing and good weed control.

Scab

Disease occurs during cool periods. Use resistant varieties when possible. Begin sprays as true leaves form. Repeat every 5 to 7 days.

chlorothalonil--2-3 pt 6F/A or OLF

Phytophthora Blight

Rotate with crops other than peppers, eggplants, tomatoes, lima and snap beans, and other cucurbits. Fields should be adequately drained to ensure that soil water does not accumulate around the base of the plant. Mefenoxam (Ridomil Gold or Ultra Flourish) should be applied pre-plant for early season control. Once the canopy closes, subsoil between the rows to allow for faster drainage following rainfall. When conditions favor disease development, apply one of the the following for suppression only and always tank mix with fixed copper:

Forum--6.0 oz 4.18SC/A, or

Gavel--1.5-2 lb 75DF/A, or

Tanos--8-10 oz. 50WDG/A, or

Ranman--2.75 fl. oz. 400 SC/A plus an adjuvant, see label for details.

SWEET CORN

Varieties

Varieties ¹	Geno- type ²	DE	MD	NJ	PA	VA
Yellow						
<i>Early</i>						
Sundance (BWMS)	su	D	M	N	P	V
<i>Medium Early</i>						
Bodacious	se			N	P	V
GSS0966 (Bt) (GMO)	sh ₂	D			P	V
Tuxedo	se			N	P	
<i>Main Season</i>						
Incredible (BWR)	su, se				P	V
Prime Time (trial)	sh ₂			N		
Showcase	sh ₂	D	M	N	P	V
Super Sweet 7210	sh ₂	D	M	N	P	
<i>Processing</i>						
Champ	su, se		M	N	P	
Fantasia (white)	su, se	D	M	N	P	
Bonus	su, se	D	M	N	P	
Melody	su, se			N		
Dynamo	su	D		N		
Rival	su, se	D		N	P	
White						
<i>Early</i>						
Seneca Starshine	su, se			N	P	
<i>Medium Early</i>						
Sweet Magic (trial)	sh ₂			N		
Ice Queen	sh ₂	D	M	N	P	V
Silver Princess	su, se			N	P	V
Xtra-Tender 372a (trial)	se, sh ₂					V
Wh0807 (Bt) (GMO)						
triple (trial)	su, se, sh ₂				P	V
WSS0987 (Bt) (GMO)	sh ₂	D			P	V
White Saturn (trial)	sh ₂			N		
Spring Crystal (trial)	su			N		
Sweet Ice	su, se, sh ₂	D	M	N	P	V
<i>Main Season</i>						
Alpine	su, se	D	M	N	P	V
Fantasia	su, se	D	M	N		
Avalon*	su, se, sh ₂				P	V
Rapture (trial)	su, se			N		
Ssuper Sweet 8701	sh ₂		M		P	V
<i>Medium Late</i>						
Argent	su, se	D	M	N	P	V
Even Sweeter	sh ₂		M	N	P	V
Frontier (early plantings only)	sh ₂	D	M	N	P	V
Silver King	su, se	D	M	N	P	V
Bicolor						
Sensor	su, se		M	N	P	V
Dazzle	sh ₂		M	N		V
Hudson	sh ₂			N		
BC0805 (Bt) (GMO) triple	su, se, sh ₂				P	V
BSS0977 (Bt) (GMO) (trial)	sh ₂				P	V
Temptation	su, se		M	N	P	V
Sweet Symphony	su, se, sh ₂	D	M		P	
Providence	su, se, sh ₂	D			P	V
Sweet Rhythm	su, se, sh ₂		M		P	
Delectable	su, se				P	
Cabaret	sh ₂		M	N	P	

(foot notes on next page)

SWEET CORN

¹ ALL SWEET CORN VARIETIES ARE HYBRIDS. Varieties (except bicolor) are listed alphabetically within maturity class. Bicolor corns are listed by maturity, earliest first.

² se = Sugary enhanced, sh₂= Super sweet, su = sugary.

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Fresh Market Sweet Corn	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med Pounds P ₂ O ₅ per Acre	Opt. Pounds P ₂ O ₅ per Acre	Low Pounds K ₂ O per Acre	Med Pounds K ₂ O per Acre	Opt. Pounds K ₂ O per Acre
	125-150 ¹	160 ¹	120 ¹	80 ¹	160 ¹	160 ¹	80 ¹
	40-60 ²	120 ²	100 ²	60 ²	120 ²	100 ²	60 ²
	20 ³	40 ³	20 ³	20 ³	40 ³	20 ³	20 ³
	50-75 ⁴	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast before plowing

³ Band-place with planter

⁴ Sidedress when corn is 12-18 inches tall

Note: For early plantings when soil temperatures are low, band 20 pounds of P₂O₅ and K₂O per acre when soil test levels are above optimum. On very light sandy soils, sidedress 40 pounds of nitrogen (N) per acre when corn is 6 inches tall and another 40 pounds of nitrogen (N) per acre when the corn is 12-18 inches tall.

Processing Sweet Corn	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med Pounds P ₂ O ₅ per Acre	Opt. Pounds P ₂ O ₅ per Acre	Low Pounds K ₂ O per Acre	Med Pounds K ₂ O per Acre	Opt. Pounds K ₂ O per Acre
	125-175 ¹	120 ¹	80 ¹	60 ¹	120 ¹	80 ¹	60 ¹
	55-80 ²	80 ²	60 ²	40 ²	80 ²	60 ²	40 ²
	20 ³	40 ³	20 ³	20 ³	40 ³	20 ³	20 ³
	50-75 ⁴	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast before plowing

³ Band-place 2 inches below and 2 inches to the side of seed with planter

⁴ Sidedress 2 weeks after emergence

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Note: For early plantings when soil temperatures are low, band 20 pounds of P₂O₅ and K₂O per acre when soil test levels are above optimum. A pre-sidedress nitrogen test is effective in determining the need for sidedress nitrogen on sweet corn. See below for information on the use of the pre-sidedress nitrogen test.

Sweet Corn Genetics and Isolation Requirements

Variety Class	Genes Present	Variety Examples	Kernel Properties	Grow apart from class(es) ¹
Normal	su	*Silver Queen *Stowells Evergreen	100% normal	*Supersweet *Augmented Shrunken
Sugary Enhanced (heterozygous)	su, se (1 copy)	*Silverado *Argent	75% normal 25% sugary enhanced	*Supersweet *Augmented Shrunken
Sugary Enhanced (homozygous)	su, se (2 copies)	*Table Sweet™ varieties *Silver King, Sugar Snow II *Imaculata, *Brilliance	100% sugary enhanced	*Supersweet *Augmented Shrunken
Supersweet	sh ₂	*Snow White *Boreal *Millenium	100% supersweet	*Normal *Sugary Enhanced (all) *Synergistic (all)
Synergistic (Heterozygous se with sh ₂)	su, se (1 copy), sh ₂ (1 copy)	*Sweet Breed™ varieties	56% normal 19% sugary enhanced 25% supersweet	*Supersweet *Augmented Shrunken
Synergistic (Homozygous se with sh ₂)	su, se (2 copies), sh ₂ (1 copy)	*TripleSweet™ varieties *Cinderella	75% sugary enhanced 25% tender supersweet	*Supersweet *Augmented Shrunken
Synergistic (Homozygous se with bt ₂)	su, se (2 copies), bt ₂ (1 copy)	*Misquamicut *Avalon	75% sugary enhanced 25% tender supersweet	*Supersweet *Augmented Shrunken
Augmented Shrunken	se (2 copies), sh ₂ (2 copies)	*Gourmet Sweet™ varieties *Multisweet™ varieties *Xtra-Tender™ varieties	100% tender supersweet	*Normal *Sugary Enhanced (all) *Synergistic (all)
Mirai™	su, se (2 copies), sh ₂ (2 copies)	*Mirai 002	100% tender supersweet	None necessary

¹To avoid starchy kernels, isolate by ≥ 300 feet or ≥ 12 days in silking.

All sweet corn must be isolated from field and pop corn varieties.

The sweetness of the corn kernel is determined by both the tassel and silk parent, while the tenderness is determined entirely by the silk parent. Therefore, any pollen from varieties other than the one planted in the field may interfere with sweetness, for example field and popcorn. Certain sweet corn varieties must also be isolated from other sweet corn by greater than 300 feet or 12 days difference in silking date. The table on the preceding page may be used to determine which corn varieties must be isolated from each other during pollination. Super sweet (sh₂) varieties are more difficult to establish than other types of sweet corn. Handle seed gently and use plateless planters to prevent damage to seed. Soil temperature and soil moisture should be optimum to reduce seed decay and obtain good stands.

Seed Treatment

Request that seed be treated with one or more of the following fungicides: Apron XL LS, Imazalil, or Maxim. Seed treatment with these fungicides is especially important for early seedings of Super Sweet (sh) varieties. **See insect control section for seed treatments available for seed corn maggot and wireworm control.**

Seeding and Spacing

Seed is sown as early as the last week in March on the light, sandy soils. Use a cold-tolerant variety for early plantings. Successive plantings can be made into early July. Corn is drilled in the field at the rate of 12 to 15 pounds per acre at about 1 inch deep. The smaller eared early varieties are planted in rows 36 inches apart and about 8 to 10 inches between plants in the row. The two-eared varieties and the later large-eared varieties are planted 36 inches between rows and 10 to 12 inches apart in the row. Recommended planting rates are between 14,500 and 19,000 plants per acre.

Pre-sidedress Soil Nitrogen Test (PSNT)

A soil test (PSNT) to determine the need for sidedress nitrogen on sweet corn has been developed. The test is effective for sweet corn grown on soils with loamy-textured, high organic matter or where manure has been applied. Sandy soils with low organic matter are known to have low nitrogen availability without using the PSNT. Contact your local county Extension agent for information on sampling and using the PSNT.

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. Before using this system, it is recommended that a test be run to determine if nematodes are present. If nematodes are present in the soil, control measures are necessary before the above procedure can be used. Use a cold-tolerant variety to avoid uneven stand and uneven vigor.

Weed Control

Identify the weeds in each field and select recommended

herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

No-Till

For Trial Use. Consider sweet corn variety, date of planting, soil fertility practices, insect control, planting equipment, mulch, and weed species in the field. Consult state agricultural specialists for advice.

Paraquat *plus* S-metolachlor *plus* atrazine--0.3-0.6 lb/A *plus* 0.96-1.91 lb/A *plus* 1-2 lb/A. Apply 1.2 to 2.4 pints per acre Gramoxone Inteon 2SC *plus* 1 to 2 pints per acre Dual II Magnum 7.64E *plus* 1.1 to 2.2 pounds per acre atrazine 90DF (or other atrazine formulations). Add surfactant as indicated on the Gramoxone Inteon 2SC label. Use this combination when existing vegetation includes small annual grasses and/or broadleaf weeds. Gramoxone Inteon 2SC will control existing vegetation, Dual II Magnum will provide residual annual grass control, and atrazine will provide residual annual broadleaf weed control. (See atrazine restrictions under the "Early Emergence" section).

Glyphosate *plus* S-metolachlor *plus* atrazine--0.75-1.5 lb acid equivalent/A *plus* 0.96-1.91 lb/A *plus* 1-2 lb/A. Apply the appropriate acid equivalent rate of Glyphomax Plus, Roundup products or Touchdown products, or OLF (Other Labeled Formulations) *plus* 1 to 2 pints per acre Dual II Magnum 7.64E *plus* 1.1 to 2.2 pounds per acre atrazine 90DF (or other atrazine formulations). Use this combination when existing vegetation includes dense, well-established annual weeds and/or perennial weeds. Roundup Ultra Max will control existing vegetation in 1 to 3 weeks. Perennial weeds must be treated at the proper growth stage to obtain effective control. (See label for application time and rate.) Dual II Magnum will provide residual annual grass control, and atrazine will provide residual annual broadleaf control. (See atrazine restrictions under the "Early Emergence" section.)

See "Conventional Tillage" section for useful early emergence and postemergence weed control recommendations.

Conventional Tillage Preplant Incorporated

Butylate--3-6 lb/A. Apply 3.75 to 7.33 pints per acre of Sutan+ 6.7EC. Incorporate immediately 2 to 3 inches deep by disking twice with disk blades set to run 4 to 6 inches deep to prevent Sutan+ loss by evaporation. The second disking may be delayed for up to 8 hours. Corn may be planted immediately after herbicide incorporation. Primarily controls annual grasses, yellow nutsedge, and certain broadleaf weeds. Combine with atrazine to improve broadleaf weed control.

Preplant Incorporated or Preemergence

Alachlor--1.5-3 lb/A. Apply 1.5 to 3 quarts Micro-Tech or 2.3 to 4.6 lb Partner 65DF. Primarily controls annual grasses and certain broadleaf weeds, including pigweed, nightshade, and galinsoga, and suppresses yellow nutsedge when preplant incorporated. Combine with atrazine to improve control of other broadleaf weeds. Also available as a jug-mix with atrazine sold as Bullet.

S-metolachlor--0.96-1.91 lb/A. Apply 1 to 2 pints per acre Dual II Magnum 7.64E (or OLF). Primarily controls annual grasses, controls or suppresses yellow nutsedge, and suppresses certain broadleaf weeds. Use preplant incorporated to improve yellow nutsedge control. Combine with atrazine or Extrazine to improve control of most broadleaf weeds. Also available as jug-mixes with atrazine sold as Bicep II Magnum and Bicep II Magnum Lite. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop and may or may not include the safener for corn.**

Atrazine--1-1.5 lb/A. Apply 1 to 1.5 quarts atrazine 4FL (or OLF). Primarily controls broadleaf weeds. Combine with Micro-Tech, Partner, or Dual II Magnum to improve control of annual grasses. Use the lowest recommended rate when combined with an annual grass herbicide or to reduce the risk of herbicide residues which may affect certain crops planted the following year. Also sold as jug-mixes, with alachlor sold as Bullet, and with s-metolachlor sold as Bicep II Magnum and Bicep II Magnum Lite.

RESTRICTIONS: Do not double-crop the season atrazine or any atrazine-containing products are used. Grass cover crops can be established after corn harvest provided the recommended rate of atrazine was not exceeded. Moldboard plowing before planting a crop sensitive to atrazine will minimize the risk of injury from atrazine residue. *See label for specific crop rotation restrictions.*

Preemergence

Mesotrione—0.094 lb/A. Apply 3 fluid ounces of Callisto 4SC per acre. Primarily controls Common lambsquarter and many other annual broadleaf weeds, including triazine resistant biotypes, but Callisto is weak on ragweed and morningglory species. Combine with Micro-Tech, Partner, or Dual II Magnum to control annual grasses. Temporary injury, appearing as whitening of the foliage after emergence, may occur. Rainfall or irrigation after planting and treatment, but before emergence increases the likelihood of crop injury. Cold weather that slows corn growth will also retard recovery from injury following preemergence treatments. Sweet corn varieties differ in sensitivity to mesotrione. The majority of varieties exhibit slight injury symptoms when weather conditions after application are favorable. Certain varieties are tolerant, while others exhibit more noticeable injury. Although no variety was severely injured by the recommended rate, postemergence application is preferred when weather conditions that favor injury occur at planting. Severe crop injury may occur if an organophosphate or carbamate insecticide is applied within 7 days of Callisto. Lexar and Lumax are labeled jug-mixes that contain mesotrione or s-metolachlor and atrazine. Camix is a labeled jug-mix that contains mesotrione and s-metolachlor. The mesotrione rate applied when the jug-mixes are used may be higher than the recommended rate, which may increase the risk of crop injury and herbicide carryover. **See the sweet corn section of the Callisto label for additional use precautions.**

Spike

Pendimethalin--0.71-0.95 lb/A. Apply 1.5 to 2.0 pints Prowl H₂O per acre or OLF (Other Labeled Formulations). Primarily controls annual grasses, and certain annual broadleaf weeds, including triazine resistant common lambsquarters. Combine with atrazine to improve the

control of other broadleaf weeds. Cold wet conditions after application increase the risk of crop injury. Choose a different weed control program when cold wet conditions after application are anticipated. Plant the sweet corn seed a *minimum* of one and one-half inches deep. Shallow planting increases the risk of crop injury. Do NOT use Prowl when planting sweet corn varieties that do not tolerate planting depths of greater than one and one-half inches. Sweet corn tolerance to Prowl is due to placement.

Do NOT mechanically incorporate or attempt to replant a sweet corn field treated with Prowl. The risk of crop injury will be increased by moving the herbicide into the root zone of the crop by the tillage.

Early Emergence

(Annual grass control will be minimal.)

Atrazine--1-2 lb/A. Apply 1 to 2 quarts per acre Atrazine 4L (or OLF). Primarily controls broadleaf weeds. Apply postemergence when weeds and corn are up to 2 inches tall. Add oil concentrate to be 1% of the spray solution. Do Not exceed the maximum rate per acre per year listed on the label for your soil's erodibility class. Also sold as a jug-mix with bentazon sold as Laddok S-12.

RESTRICTIONS: When this and other atrazine treatments are used, do not double-crop during this season. Cover crops after corn are satisfactory providing the recommended rate of atrazine is not exceeded. Mold-board plowing before planting grain or vegetables the following spring will minimize the risk of atrazine residue injury.

Halosulfuron--0.023-0.031 lb/A. Apply 0.5 to 0.66 dry ounces Sandea 75WG to control yellow nutsedge and broadleaf weeds, including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and velvetleaf. Spray before corn reaches 8 inches in height, or use drop nozzles when corn is over 8 inches tall to avoid spraying the foliage and into the whorl. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade, and will only suppress morningglory species. Always add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant, and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated, but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Corn varieties may vary in sensitivity to Sandea. Use caution when treating new varieties. DO NOT apply to Jubilee. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. **DO NOT use if organophosphate (OP) insecticides have been applied to the crop, or the risk of crop injury may increase.**

Carfentrazone--0.008 lb/A. Apply 0.5 fluid ounces per acre Aim 2EC or Aim 1.9EW before corn reaches 8 inches in height to control seedling broadleaf weeds including pigweed species, common lambsquarter, morningglory species, eastern black nightshade, and velvetleaf. Aim will not control ragweed species. Tank-mix with atrazine at reduced rates or another broadleaf weed herbicide to increase the spectrum of weeds controlled. Always add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). Expect to see speckling on the crop foliage after application. Initially the injury may appear to be substantial, but it is not systemic and corn outgrows the injury rapidly. Variety sensitivity to Aim may vary. Use caution when treating new varieties. Weather conditions may affect the degree of injury observed. Injury may be more severe during periods of warm, cloudy weather with high humidity and plentiful soil moisture when corn growth is rapid and "soft." To reduce the risk of crop injury, use drop nozzles when corn is over 8 inches tall to avoid spraying the foliage and into the whorl.

Postemergence

(Annual grass control will be minimal.)

Atrazine--1-2 lb/A. Apply 1 to 2 quarts per acre Atrazine 4L (or OLF). See atrazine in **Early Postemergence** section.

Bentazon--0.75-1 lb/A. Apply 1.5 to 2 pints per acre Basagran 4SC. See label for susceptible broadleaf weeds; results are better when weeds are young. Will provide partial control of yellow nutsedge. Grasses will NOT be controlled. Cultivation within 10 to 14 days will increase control. Also sold as a jug-mix with atrazine sold as Laddok S-12.

2,4-D Amine--0.25-0.5 lb/A. Use 0.5 to 1 pint 4EC. Apply after corn and weeds emerge. Use drop nozzles when corn is over 8 inches tall to avoid spraying the foliage or into the whorl of the corn. Warm, wet weather at application may increase the possibility of crop injury. Use the lower recommended rate when these conditions prevail. Delay cultivation for 8 to 10 days after treatment to avoid damaging corn due to temporary brittleness sometimes caused by 2,4-D. Sweet Corn varieties differ in 2,4-D tolerance. Super sweet varieties may be more sensitive than other varieties. Injury will be less when the minimum recommended rate is used. Use with caution on new varieties.

Do not apply from tasseling to dough stage. At high rates, 2,4-D may cause temporary injury to corn.

Do not use a sprayer to apply 2,4-D that will be used to spray sensitive crops postemergence.

Ester formulations, although labeled, are more subject to volatilization and movement to sensitive crops and, therefore, are not recommended.

Clopyralid--0.047-0.25 lb/A. Apply 2 to 10.5 fluid ounces of Stinger 3A per acre in one or two applications to control certain annual and perennial broadleaf weeds when sweet corn is less than 18 inches tall. Stinger controls weeds in the Composite and Legume plant families. Common annuals controlled include galinsoga, ragweed species, common cocklebur, groundsel, pineappleweed, clover, and vetch. Perennials controlled include Canada thistle, goldenrod species, aster species, and mugwort (wild chrysanthemum). Stinger is very effective on small seedling

annual and emerging perennial weeds less than 2 to 4 inches tall, but is less effective and takes longer to work when weeds are larger. Use 2 to 4 fluid ounces to control annual weeds less than 2 inches tall. Increase the rate to 4 to 8 fluid ounces to control larger annual weeds. Apply the maximum rate of 10.5 fluid ounces, in one or split into two applications to suppress or control perennial weeds. Do not exceed 10.5 fluid ounces in one year. Spray additives are not needed or required by the label, and are not recommended. Observe a minimum preharvest interval (PHI) of 30 days. Stinger is a postemergence herbicide with residual soil activity. Observe follow crop restrictions or injury may occur from herbicide carryover.

Mesotrione--0.094 lb/A. Apply 3 fluid ounces of Callisto 4SC per acre. Primarily controls common lambsquarter and many other annual broadleaf weeds, including triazine resistant biotypes, but Callisto is weak on ragweed and morningglory species. Always add nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution), but DO NOT add oil concentrate, liquid fertilizer, or AMS, or tank-mix Callisto and bentazon (Basagran), or severe crop injury may be observed. Temporary minor injury, appearing as whitening of the new foliage may occur. The crop will quickly outgrow minor injury with no effect on yield or earliness. Sweet corn varieties differ in sensitivity to mesotrione. The majority of varieties may exhibit slight injury symptoms. Certain varieties are tolerant while others exhibit more noticeable injury. No variety was severely injured by the recommended rates applied with nonionic surfactant. DO NOT tank-mix Callisto with organophosphate or carbamate insecticides, or apply if the crop was treated with Counter or Lorsban, or severe crop injury may occur. Lexar and Lumax are labeled jug-mixes that contain mesotrione or s-metolachlor and atrazine. Camix is a labeled jug-mix that contains mesotrione and s-metolachlor. The mesotrione rate applied when the jug-mixes are used may be higher than the recommended rate, which may increase the risk of crop injury and herbicide carryover. **The following is a link to an extensive sweet corn variety herbicide tolerance trial results: www.rec.udel.edu/weed_sci/WeedFacts/SweetCorn%20Trial%20Summary.htm. See the sweet corn section of the Callisto label for additional use precautions.**

Nicosulfuron--0.031 lb/A. Apply 0.66 dry ounces of Accent 75DF per acre as a broadcast or with drop nozzles as a directed spray as an early postemergence rescue treatment to control emerged annual grasses. Treat sweet corn with a broadcast spray or with drop nozzles as a directed spray up to 12 inches tall or up to and including 5 leaf collars, or as a directed spray with drop nozzles only to sweet corn up to 18 inches tall. Do not treat sweet corn more than 18 inches tall to control many annual grasses and certain annual broadleaf weeds. Tank-mix with atrazine to increase the spectrum of weeds controlled. Add nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution). Accent is safe to apply to certain varieties, injures others, and kills certain sweet corn varieties. Contact your DuPont Crop Protection Sales Representative for information on local sweet corn varieties that have been evaluated for tolerance to Accent. **The following is a link to an extensive sweet corn variety herbicide tolerance trial results:**

www.rec.udel.edu/weed_sci/WeedFacts/SweetCorn%20Trial%20Summary.htm. Crop injury may be apparent within 1 to 2 weeks of application as yellowing and death of sweet corn foliage, beginning with the youngest leaves first, or the injury may not be observed until harvest. Injury at harvest is seen as a constriction at the top, middle, or bottom of the ear, depending on the time of application. Late postemergence applications are more likely to result in ear injury than early postemergence applications. Accent is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. **DO NOT use if organophosphate (OP) insecticides have been applied to the crop, or the risk of crop injury may increase.**

Topramezone--0.016 lb/A Apply .75 fluid ounces of Impact 2.8SC per acre postemergence to control many annual broadleaf weeds, including common lambsquarter and triazine-resistant broadleaf weed biotypes, and annual grasses. Add oil concentrate (COC) to be 1% of the spray solution (1 gallon per 100 gallons of spray solution). In addition, the label requires nitrogen fertilizer (liquid or AMS). Tank mix with 0.25 to 1 lbs ai/A of atrazine for improved control and to broaden the spectrum of weeds control. Local university data supports the use of at least 0.5 lb ai/A of atrazine. Do not apply tank-mixes of Impact and atrazine to corn greater than 12 inches tall. Do not use postemergence if Callisto, Lumax or Lexar was used preemergence. Do not tankmix with Callisto. Impact will control/suppress crabgrass and most other annual grass species, but may not control certain grass species or grasses larger than the maximum recommended size when treated. Most broadleaf weeds should be treated before they are 6 inches tall and grass weeds should be treated before 3 inches in height. Impact has an 18 month replant restriction for most vegetables.

Postemergence "Poast Protected" Sweet Corn ONLY!

Sethoxydim--0.15-0.3 lb/A. **Use ONLY on sweet corn hybrids designated as "Poast Protected" ONLY! Other sweet corn varieties will be severely injured or killed.** Apply 0.75 to 1.5 pint per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. Applications of Poast to "Poast Protected" sweet corn may be made until the onset of pollen shed. Do NOT apply Poast after pollination has occurred. A second application of Poast may be made 10 days after the first application. For best results, treat annual grasses when they are actively growing and before tillers are present. The rate of 0.75 pints/A should only be used when annual grasses are less than 3 inches tall and temperatures and moisture are favorable for rapid growth. Use a minimum of 1 pint/A when weeds are 3 inches tall or larger, or when growing conditions are not optimum. Control may be reduced if grasses are large or if

hot, dry weather or drought conditions occur. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with Aim due to the potential for severe leaf burn. Volunteer "Poast Protected" sweet corn can be controlled with clethodim (Select, Select Max, or Arrow). Other postemergence grass herbicides such as Fusilade, Assure II, and Targa will NOT control volunteer "Poast Protected" sweet corn. Observe a minimum preharvest interval of 30 days and apply no more than 3 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Nuisance Bird Management and Repellency

Preharvest Treatment

Noise-producing devices are useful to scare away injurious birds. A permit is required to use an exploding device in New Jersey. Permits may be obtained from New Jersey Division of Fish and Wildlife, Clinton WMA, 7 Van Syckels Road, Hampton, NJ 08827, 908/735-8793.

Avitrol is labeled for use in sweet corn, but each state has different regulations and permit processes. Read the label carefully before use. Consult your local county Extension office for current restrictions.

Insect Control

Seed Corn Maggot (SCM), Wireworms (WW)

Seed corn maggot is controlled with planter-box seed treatments, commercially treated seed, or in-furrow treatments. Rescue treatments applied post-planting are not effective. (See also Soil Pests--Their Detection and Control.)

Note: see labels for rotational restrictions.

Seed Treatment

- Hopper Box Treatments
 - Concure (imidacloprid)—NJ, PA, Va only. 1.5 oz/42 lb seed.
 - Latitude (imidacloprid)--1.5 oz/42 lbs of seed.
- Commercially Applied Seed Treatments
 - Cruiser 5FS (thiamethoxam)--1.0 oz/137,000 kernels--1 oz/22,000 kernels, or
 - Gaucho 480 (imidacloprid)--2-8 fl oz/cwt seed, or
 - Lorsban 50W(chlorpyrifos)--2 oz/1000 lb seed. (SCM only), or
 - Poncho 600 (clothianidin)--1.13 fl oz/80,000 units of seed.

Soil-Applied Treatment

- Aztec (Pennsylvania only)--6.7 oz 2.1G/1,000 ft of row in-furrow, or
- Counter--8 oz 15G/1,000 ft of row in seed furrow (SCM only), or

Force--4-5 oz 3G/1,000 ft of row in- furrow, or
 Fortress--6-7.5 oz 2.5G/1,000 ft of row, or
 Furadan--2.5 fl oz 4F/1,000 ft of row in the seed furrow at planting, or
 Lorsban--8 oz 15G/1,000 ft of row in furrow or 4 pt 4E/A (SCM only) preplant broadcast incorporated

Grubs

Aztec (Pennsylvania only)--6.7 oz 2.1G/1,000 ft of row in- furrow, or
 Counter--6-8 oz 15G/1,000 ft of row in seed furrow, or
 Force--4-5 oz 3G/1,000 ft of row in- furrow, or
 Fortress--6-7.5 oz 2.5G/1,000 ft of row, or
 Lorsban--8-12 oz 15G/1,000 ft of row in furrow or 13.5 lb 15G/A preplant broadcast incorporated or 4 pt 4E/A preplant broadcast incorporated

Cutworms (Also see the "Cutworms" section of Soil Pests—Their Detection and Control.)

Preplanting Treatment

Lorsban--2-4 pt 4E/A in minimum of 10 gallons of water. Apply as a broadcast spray and incorporate into top 2 to 4 inches of soil or OLF

Planting Treatment

Aztec (Pennsylvania only)--6.7 oz 2.1G/1,000 ft of row in a T-band only, or
 Force--3-4 oz 3G/1,000 ft of row banded, T-banded, or in-furrow (first year corn only), or
 Fortress--6-7.5 oz 2.5G/1,000 ft of row in a T-band or in-furrow, or
 Lorsban--8 oz 15G/1,000 ft of row. Apply as a 6- to 7-inch wide band behind the planter shoe and incorporate into top 1 inch of soil.

Postplanting Treatment

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
 Baythroid XL--0.8-1.6 fl oz/A, or
 bifenthrin Not labeled in coastal counties--2.1-6.4 fl oz 2EC/A or OLF, or
 lambda-cyhalothrin--1.92-3.0 fl oz/A or OLF, or
 Lorsban--1-2 pt 4E/A as an aerial or ground equipment broadcast application, or
 Mustang MAX--2.24-4.0 fl oz/A, or
 permethrin--4-8 fl oz 3.2EC/A or OLF, or
 Renounce--1-2 oz 20WP or OLF, or
 Sevin Bait--30-40 lb 5% bait/A or OLF

Corn Rootworms Larvae

Crop rotation is the most effective control. Avoid planting corn after corn, cucumbers, pumpkins, or squash. Rotation distance of even 3 feet is effective. Soil insecticides applied at planting aim to protect the root zone for about 6 to 8 weeks after application. To be effective, corn rootworm egg hatch must occur during that time. When allowed on the label, T-band tends to be more effective than in-furrow application.

Planting Treatment:

Aztec (Pennsylvania only)--6.7 oz 2.1G/1,000 ft of row, or
 bifenthrin Not labeled in coastal counties--0.3 oz 2EC/1,000 ft of row or OLF, or
 Counter--6-8 oz 15G/1,000 ft of row, or
 Force--4-5 oz 3G/1,000 ft, or

Fortress--6-9.0 oz 2.5G or 3 oz 5G/1,000 ft of row in a T-band or in-furrow, or
 Lorsban--8 oz 15G/1,000 ft of row or 2.4 oz 4EC/1,000 ft

Poncho 600 (clothianidin)--1.13 fl oz/80,000 unit of seed.
Available only as a commercially applied seed treatment.

Postplanting Treatment:

Counter--6 oz 20CR/1,000 ft of row, or
 Force--4-5 oz 3G/1,000 ft of row, or
 Lorsban--2 pt 4E/A or OLF

Corn Rootworm Adults

Insecticides used for worm control at silk will control corn rootworm adults. **Note.** *Bacillus thuringiensis* sweet corn will NOT control corn rootworm adults.

Asana--5.8-9.6 fl oz 0.66EC/A, or
 Baythroid XL--1.6-2.8 fl oz /A, or
 bifenthrin Not labeled in coastal counties--2.1-6.4 fl oz 2EC/A or OLF, or
 lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
 Lannate--0.25-0.5 lb 90SP/A or 0.75-1.5 pt LV/A, or
 Lorsban--1-2 pt 4E/A, or
 Metasystox-R--1.5-2 pt 2SC/A, or
 Mustang Max--2.24-4.0 fl oz /A, or
 permethrin--4-8 fl oz 3.2EC/A, or
 Renounce--2-3.5 oz 20WP or OLF

Corn Flea Beetle

Flea beetles transmit bacterial wilt disease (also known as Stewart's wilt) and are numerous after mild winters. Use varieties resistant to bacterial wilt disease or those listed in the Sweet Corn varieties table. Treat susceptible varieties at spike stage when 5% of the plants are infested.

Note. Soil-applied insecticides may be ineffective if soil temperatures are cool. Foliar applications of an insecticide may be necessary during this period.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
 Baythroid XL--0.8-1.6 fl oz/A, or
 bifenthrin Not labeled in coastal counties--2.1-6.4 fl oz 2EC/A or OLF, or
 Counter--6-8 oz 15G/1,000 ft of row in the seed furrow or 8-16 oz 20CR/1,000 ft of row if banded, or
 Cruiser 5FS (thiamethoxam)--1.28-5.1 fl oz/100 lbs of seed, or
 Furadan--2.5 fl oz 4F/1,000 ft of row in the seed furrow at planting, or
 Mustang MAX--2.24-4.0 fl oz/A, or
 Gaucho 480--8 oz/cwt seed. **Available only as a commercially applied seed treatment,** or
 lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
 Lannate--1.5 pt LV/A or OLF, or
 Lorsban--1-2 pt 4E/A or OLF, or
 permethrin--4-8 fl oz 3.2EC/A, or
 Poncho 600 (clothianidin)--1.13 fl oz/80,000 units of seed.
Available only as a commercially applied seed treatment, or
 Renounce--2-3.5 oz 20WP or OLF, or
 Sevin--1.25-2.5 lb 80S/A or OLF

Corn Leaf Aphid

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Lannate--1.5 pt LV/A or OLF, or
Thionex--1.33 qt 3EC/A or OLF

Mites

bifenthrin Not labeled in coastal counties 5.12-6.4 fl oz
2EC/A or OLF, or
Metasystox-R--1.5-2 pt 2SC/A

Sap Beetle (SB)

Loose-husked varieties and ears damaged by other insects are more susceptible to sap beetle attack. Varieties with long, tight silk tubes can reduce SB damage by 50%.

Begin sampling at pollen shed and treat when 5 percent of the ears have adults and/or eggs. **Note.** Insecticides used for worm control at silk may not control SB infestations. *Bacillus thuringiensis* sweet corn will NOT control SB.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
bifenthrin Not labeled in coastal counties--2.1-6.4 fl oz 2EC/A
or OLF, or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Lannate--0.75-1.75 fl oz LV/A, or
Mustang MAX--2.24-4.0 fl oz/A

Japanese Beetle (JB)

Note. Insecticides used for worm control at silk may not control JB infestations. *Bacillus thuringiensis* sweet corn will NOT control JB.

Baythroid XL--1.6-2.8 fl oz/A, or
bifenthrin Not labeled in coastal counties--2.1-6.4 fl oz
2EC/A or OLF, or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Mustang MAX--2.24-4.0 fl oz/A, or
Sevin--1-2 qt XLR/A or OLF

Grasshoppers

Baythroid XL--2.0-2.8 fl oz/A, or
bifenthrin Not labeled in coastal counties--2.1-6.4 fl oz
2EC/A or OLF, or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Mustang MAX--2.8-4.0 fl oz/A, or
PennCap-M--2-3 pt 2FM/A, or
Renounce--2.5-3.5 oz 20WP or OLF, or
Sevin--1.25-2.25 lb 80S/A or OLF

Note. Use PennCap-M 2FM and Sevin only after pollen shed is complete to prevent bee loss.

Worm Pests (Also see "Insect Control-Decision Making" in the following section.)

Loose husked varieties and ears with short or no silk tubes are more susceptible to worm damage.

Bacillus thuringiensis--Attribute® insect protection varieties are available that provide control of worm pests that infest corn. Bt sweet corn hybrids provide virtually 100% protection against European corn borers, thus no insecticides are needed during the whorl or tasseling stages, or even during silking if this pest is the only concern. However, corn earworms and fall armyworms are more tolerant to the expressed Bt protein, and unsprayed corn is also exposed to silk feeding by corn rootworm adults which can reduce pollination, thus insecticide sprays may be

needed to ensure fresh market quality when these pests are active. Under moderate moth activity and good growing conditions, one and sometimes two applications may be warranted, depending on the ear quality standards required for marketing. When moth activity is high (late August-early September), many eggs are laid later in ear development after the expressed protein has degraded in wilted/brown silk tissue. This loss of Bt activity is also accelerated by hot, dry conditions which cause rapid desiccation of the silk tissue. As a result, earworms and armyworms have a greater chance of surviving and invading the ear. Under these conditions, up to 40% of the ears can become infested with small earworm or fall armyworm larvae, which may pose a quality problem. Spray regimes of three or four applications spaced 3-4 days apart may be required when moth activity is high. The first insecticide application in Bt sweet corn should be directed at the ear zone at 100% silking (usually 3-4 days later than the first silk spray in non-Bt corn), and applications repeated if high moth activity continues.

Corn rootworm adults, Japanese beetles, other silk-feeders, and sap beetles also can cause ear quality problems in Bt corn, because the expressed protein is not active on these insects. High rates of silk feeding prevent adequate pollination. On farms with a known history of sap beetle problems, an insecticide spray should be applied when 50 to 75% of the ears have wilted silks (the time when sap beetle larvae begin to hatch on silks). Usually one spray is enough for sap beetle control, especially for hybrids that exhibit good tip coverage. When more than 50% of ears have fresh silks cut back by rootworm adults and the plants are still pollinating, an insecticide spray is recommended.

European Corn Borer (ECB)

Thorough spray coverage in whorls and on plants is essential. Select an insecticide that has low toxicity to bees (refer to Table D-6).

Granular formulations, if applied over the whorl, are generally more effective than liquid formulations for ECB control.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Avaunt--2.5-3.5 oz 30WDG/A (up through tassel only), or
Baythroid XL--1.6-2.8 fl oz /A, or
bifenthrin Not labeled in coastal counties--2.1-6.4 fl oz
2EC/A or OLF, or
Entrust--0.5-2.0 oz 80W/A, or
Intrepid--4-8 fl oz 2F/A (for early season whorl treatment), or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Lannate--1.5 pt LV/A or OLF, or
Larvin--20-30 fl oz 3.2 F/A, or
Mustang MAX--2.8-4.0 fl. oz/A, or
PennCap-M--2-3 pt 2FM/A

Note. Do NOT use PennCap-M during tasseling and pollen shed as it will seriously reduce bee populations, or permethrin--4-8 fl oz 3.2EC/A, or OLF, or
Radiant--3-6 oz SC/A, or
Renounce--2-3.5 oz 20WP or OLF, or
SpinTor--1.5-6 fl oz 2SC/A

Corn Earworm (CEW)

Many insecticides are highly toxic to bees. For more information concerning toxicity of insecticides to bees, refer to Table 3.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
 Baythroid XL--1.6-2.8 fl oz/A, or
 bifenthrin Not labeled in coastal counties--2.1-6.4 fl oz
 2EC/A or OLF, or
 Entrust--2.0 oz 80W/A, or
 lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
 Lannate--1.5 pt LV/A or OLF, or
 Larvin--20-30 fl oz 3.2 F/A, or
 Mustang MAX--2.8-4.0 fl. oz/A, or
 permethrin--4-8 fl oz 3.2EC/A, or OLF, or
 Radiant--3-6 oz SC/A, or
 Renounce--2-3.5 oz 20WP or OLF, or
 SpinTor--3-6 fl oz 2 SC/A

Fall Armyworm (FAW)

For whorl applications, direct spray over the plants so that it penetrates leaf whorls when FAW first appears and repeat application, if necessary. For foliar spray applications, high-spray gallonage (50 to 75 gallons per acre) is necessary for effective FAW control.

Avaunt--2.5-3.5 oz 30WDG/A (up through tassel only), or
 Baythroid XL--2.8 fl oz /A (first and second instar only), or
 bifenthrin Not labeled in coastal counties -2.1-6.4 fl oz 2
 EC/A or OLF, or
 Entrust--1.0-2.0 oz 80W/A, or
 lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
 Lannate--1.5 pt LV/A or OLF, or
 Larvin--20-30 fl oz 3.2 F/A, or
 Radiant--3-6 oz SC/A, or
 Renounce--2-3.5 oz 20WP or OLF, or
 Spintor--1.5-6.0 oz 2SC/A

True Armyworm

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
 Baythroid XL--1.6-2.8 fl oz /A, or
 bifenthrin Not labeled in coastal counties--2.1-6.4 fl oz
 2EC/A or OLF, or
 Entrust--1.0-2.0 oz 80W/A, or
 Intrepid-4-8 fl oz 2F/A (for early season whorl treatment), or
 Lannate--1.5 pt LV/A or OLF, or
 Mustang MAX--2.8-4.0 fl. oz/A, or
 PennCap-M--2-3 pt 2FM/A
 Radiant--3-6 oz SC/A, or
 Renounce--2-3.5 oz 20WP or OLF, or
 Spintor--1.5-6.0 oz 2SC/A

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Asana XL	R	12	1
Avaunt	G	12	3 ³
Aztec	R	48	--
Baythroid XL	R	12	0
bifenthrin	R	12	1
Counter	R	48	60 ⁴
Entrust	G	4	1
Force	R	0	--
Fortress	R	48	--
Intrepid	G	4	3 ³
lambda-cyhalothrin	R	24	1
Lannate	R	48	0
Larvin	R	48	0
Latitude	G	24	--
Metasystox-R	R	48	7 ⁵

(table continued)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Mustang MAX	R	12	3
PennCap-M	R	120	3
permethrin	R	12	1
Radiant	G	4	1 ³
Renounce	R	12	0
Sevin/Sevin Bait	G	12	2 ³
SpinTor	G	4	1
Thionex	R	24	1
FUNGICIDE (FRAC code)			
chlorothalonil (Group M5)	G	12	14
Headline (Group 11)	G	12	7
mancozeb (Group M3)	G	12,24	7
maneb (Group M3)	G	12	7
Quadris (Group 11)	G	4	0
Quilt (Groups 11 + 3)	G	12	14
Stratego (Groups 11 + 3)	G	24	14
Tilt (Group 3)	G	24	14

See Table D-6.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. **CONSULT LABEL**

³ See label for days to harvest for feed, forage and/or stover. Days to harvest as listed in table are for grain/ears only.

⁴ When Counter is used at cultivation for rootworm control, days to harvest is 60.

⁵ 7 (1 application), 21 (2 or more applications)

**Insect Control--Decision Making
 Fresh Market**

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 when 15 percent of the plants show fresh feeding signs. Additional applications may be necessary if infestation remains above 15 percent. 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 percent of the plants are infested. During mid- to late-whorl stages, treatment for both FAW and ECB may be necessary if more than 30 percent of the plants are infested. Treat fields in early tassel stage if more than 15 percent of the emerging tassels are infested with ECB, FAW, or young CEW larvae.

Ear Infestation

Direct sampling for CEW, FAW, and ECB during silking is not practical because of the low thresholds of ear damage. Begin treatment when 10 percent 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 the low populations can be terminated 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 infestations, maximize the gallowage of water per acre, use a wetting agent, and make applications during the early morning. If irrigation or rains wash off the spray within 24 hours after an application, repeat treatment as soon as the foliage dries.

For more precise timing of silk sprays, use blacklight and pheromone traps to determine the actual moth activity on your farm. **Monitoring data from pheromone and black light traps are available on the websites:** www.pestwatch.psu.edu and www.mdipm.umd.edu. Contact your county Extension agent or consult your state pest management newsletter for more information on these techniques.

Processing

Whorl/Tassel Infestation

The ECB is the major whorl pest in early planted corn. Larvae that hatch prior to tassel emergence feed on the whorl leaves and cause yield losses. Decisions to treat whorl infestations are based on the percentage of "infested" plants with light (LD), moderate (MD), or heavy (HD) feeding damage.

"Infested" plants are classified as: light damage (LD less than 10 percent of the leaf area is affected), moderate damage (MD = 10 to 50 percent of the leaf area is affected), and heavy damage (HD = all leaves are damaged). Treat if the market value of the expected yield loss exceeds twice the cost of a whorl application. Expected yield loss is calculated as $0.08 \times LD + 0.24 \times MD + 0.44 \times HD$. Count only damaged plants with live larvae.

Ear Infestation

The four insects that normally infest the ears of corn grown for processing are the ECB, CEW, SB, and FAW. Decisions to treat are based on the percent-age of ears that are potentially damaged by a combination of these pests that occur during the silking period. A primary ear on a plant is potentially damaged if: (1) the plant has one or more ECB or FAW egg masses on it, (2) there are one or more CEW or SB eggs in the silk of the primary ear, or (3) young larvae of any of the four species are feeding in the silk of the ear.

When 50 percent of the corn in a field is silking, treat if 5 percent of the plants in silk meet one or more of the above criteria. At 100 percent silking (about 16 to 18 days before harvest), treat if 10 percent of the plants fall into one or more of the above categories. At 100 percent brown silking (10 to 12 days from harvest), treat if 20 percent of the ears have larvae feeding on the silks or in the silk tube.

When overall moth activity is high, fixed-treatment schedules according to blacklight trap catches should be used. Moth units are calculated by multiplying the average number of CEW moths in a region over 5 days times 5 and adding the

value of the average number of corn borer moths in a region over 5 days. If moth units fall between 75 and 150 per 5 days, fixed schedules of 1 to 2 insecticide treatments are recommended. Fixed schedules of 2 to 5 insecticide treatments applied 3 or 4 days apart are recommended if the average number of moth units for a region exceeds 150 per 5 days. Consult your pest management specialist for more detailed information.

Processing Sweet Corn Fodder Use Restrictions

Pesticide	Hours to Reentry ¹	Days to Harvest	Days after Treatment
			before Feeding to Livestock
diazinon	12,24	0	10
Furadan	48	7	21 ²
Lannate	48	0	3
Pennacap-M	48	3	12

See Table D-6.

¹ Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

² Cannery waste can be fed 7 days after treatment.

Nematode Control

Nematode control is very important to the production of this crop. See "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or use Counter 20CR or Mocap 15G. Consult labels for use directions.

Disease Control

Bacterial Wilt

Use resistant varieties where bacterial wilt is a problem. It is very important to control flea beetles early in the season. Use an insecticide at seedling emergence or insecticide treated seed. Flea beetles transmit bacterial wilt disease (also known as Stewart's wilt) and are numerous after mild winters. Use varieties resistant to bacterial wilt disease or those listed in the Sweet Corn varieties table. Treat susceptible varieties at spike stage when 5% of the plants are infested. See Insect Control Section for flea beetle control recommendations.

Maize Dwarf Mosaic Virus (MDMV)

MDMV is most likely to occur on corn planted after July 1. The virus is transmitted by aphids to sweet corn from infected weeds, especially Johnsongrass. For control, keep fields as weed-free as possible, maintain strict aphid control, and plant resistant varieties for fall harvest.

Smut

There is no real resistance to smut in sweet corn. Some varieties seem to escape infection due to differences in silk emergence and weather conditions. Since damaged tissue is more prone to infection control corn borers as first tassel appears.

Leaf Spots and Blights (Gray leaf spot, Northern corn leaf spot; Southern, Northern and Anthracnose leaf blights)

For optimal control begin sprays before symptoms appear. In most years, chemical control is not needed for these diseases. Apply on a 7- to 14-day schedule.

Alternate:

chlorothalonil (Do not apply to corn to be processed.)--0.75-2 pt 6F/A (7-day schedule) or OLF, or mancozeb--1.5 lb 75DF/A (5- to 7-day schedule), or maneb--1.5 lb 75DF/A (5- to 7-day schedule) or OLF

With one of the following:

Quadris--9.2-15.4 fl oz 2.08F/A, or
Headline--9-12 fl oz 2.1EC/A (7-14 day schedule), or
Tilt--2-4 fl oz 3.6 EC/A (7- to 14-day schedule), or

Stratego--10 fl oz .2.08 EC/A, or
 Quilt--7-14 fl oz 1.67 SC/A

Do not make more than 2 consecutive applications of one of the above fungicides before alternating to another fungicide from a different FRAC code.

Rust

Rust occasionally can become troublesome with some varieties. In most years chemical control measures are not warranted. However, corn warrants spraying if infection occurs prior to the whorl stage. Observe fields on a regular basis, and if lesions are observed prior to the whorl stage, apply one of the following:

- Quadris--6.2-9.2 fl oz 2.08F/A (Apply on a 7 to 14 day schedule and do not make more than 2 consecutive applications without alternating with another fungicide from a different FRAC code)
- chlorothalonil (Do not apply to corn to be processed.)--0.75-2 pt 6F/A (7-day schedule) or OLF, or
- Headline--6-9 fl oz 2.1EC/A (7-14 day schedule), or mancozeb--1.5 lb 75DF/A (5- to 7-day schedule) or OLF, or maneb--1.5 lb 75DF/A (5 to 7 day schedule) or OLF, or Tilt--4 fl oz 3.6 EC/A (7 to 14 day schedule), or
- Quilt--10.5-14 fl oz 1.05F/A, (14 day schedule as soon as symptoms are seen), or
- Stratego--10 fl oz. 2.08 EC/A (7 to 14 day schedule)

SWEET POTATOES

Varieties

Varieties ¹	
Beauregard-14 ² (FR)(rosy skin)	These varieties are recommended for DE, MD, NJ, PA, VA, WV
Beauregard-24 ² (FR)(rosy skin)	
Covington (trial)	
Yellow and Red Jersey strains	

¹ Varieties listed alphabetically.
² Beauregard sizes rapidly. Plant late and sample fields beginning in early September.
 Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Sweet Potatoes	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
	50-75 ¹	200 ¹	100 ¹	50 ¹	300 ¹	200 ¹	100 ¹
	25 ²	200 ²	100 ²	50 ²	300 ²	200 ²	100 ²
	25-50 ³	0	0	0	0	0	0

¹ Total amount nutrient recommended
² Broadcast and disk-in
³ Sidedress when vines start to run

Plant Production

For hard-to-sprout varieties, a presprout procedure started 3 to 4 weeks before normal bedding time is recommended. To presprout, store seed roots at 85°F (29.4°C) and 90 percent relative humidity until the sprouts that appear are 1 to 1½ inches long (20 to 28 days). Seed roots can then be bedded normally.

Bed seed stock about April 1 to 10 in new, clean sand and cover with 2 to 3 inches of clean sand. Fertilize with 5 ounces per square yard 10-10-10 or its equivalent. A Special Local-Needs label 24(c) has been approved for the use of Devrinol - 50DF on sweet potato plant beds in Virginia. See the Weed Control section for details. Cover beds with floating row cover or clear plastic. Floating row cover may be left on the bed until danger of frost has passed. Clear plastic should be ventilated after 7 days with one, ½-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 (23.9° to 29.4°C). About 1,000 sprouts can be produced from 1 bushel of seed stock at a single cutting. One bushel of seed stock requires 11 to 15 square feet of bed area. When sprouts are ready to be transplanted, they should be cut from the beds by snipping at the soil line. This minimizes the transfer of diseased sweet potato tissue. See the "Disease Control" section.

Field Planting

Plant in the field between May 5 and June 15 in warmer, southern areas and May 20 and June 5 in cooler areas. Well-rooted, 6- to 8-inch long sprouts can be set with the transplanter on ridges 8 to 10 inches high. Row spacing is

30 to 36 inches; distance between plants in the row is 12 to 18 inches. Use a high-phosphate starter solution (15-30-15 or equivalent at the rate of 3 pounds in 50 gallons of water) at transplant time.

Research has shown that the variety Beauregard yields a more uniform crop if no nitrogen is applied before or at transplanting. For maximum production, apply the recommended nitrogen as a sidedressing 3 to 4 weeks after transplanting.

Harvesting and Storage

A 4- to 5-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 (26.7° to 29.4°C) and 90 percent relative humidity for 6 to 8 days. After curing, temperature should be lowered to 55°F (12.8°C), but relative humidity should be maintained at 85 percent.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in sweet potatoes.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Plant Beds

Napropamide--1-1.5 lb/A. **A Special Local-Needs label 24(c) has been approved for the use of Devrinol 50DF on sweet potato plant beds in Virginia.** Apply 2 to 3 pounds per acre Devrinol 50DF to the plant beds immediately after planting and irrigate to ensure herbicide "activation." The field rate of 2 to 3 pounds per acre of Devrinol 50DF is equal to 0.7 to 1.1 ounces of product per 1,000 square feet of plant bed. Annual grasses and certain broadleaf weeds will be controlled.

Pretransplant

Flumioxazin—0.078 lb/A. Apply 2.5 dry ounces of Valor 51WDG after all tillage has been completed, but 2 to 5 days before planting the crop to control annual broadleaf weeds. Tillage or cultivation after Valor application reduces or eliminates weed control. Do not till or cultivate after applying Valor unless weeds emerge. Use in combination with other recommended herbicides to control annual grasses. Valor can be difficult to clean out of a spray tank. Follow tank cleaning recommendations on the label to avoid injury to other crops after spraying valor. Do not use prior to planting greenhouse-grown transplants. Do not use on any variety other than 'Beauregard' unless the user has tested Valor on the variety and has found crop tolerance to be acceptable.

Preemergence after Transplanting

Clomazone--0.5-1 lb/A. Apply 1.33 to 2.66 pints per acre Command 3ME before weeds emerge. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Cultivate or irrigate after application to reduce the risk of vapor drift. Command 3ME is an excellent herbicide for the control annual grasses and many annual broadleaf weeds, except pigweed sp., carpetweed, morningglory sp., and yellow nutsedge. Some temporary injury, seen as a partial whitening of leaf and/or stem of the crop, may be observed after seedling emergence. Complete recovery from early injury will occur without affecting yield or delaying maturity.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. DO NOT apply when wind or weather conditions favor spray drift. Avoid preemergence applications when fields are adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from off-site Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command has been used.

DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre Dacthal 6F at time of transplanting or 10 to 14 days after planting to weed-free, freshly cultivated soil. Cultivation after application may reduce weed control. Moisture following application is essential. Primarily controls annual grasses and certain broadleaf weeds including carpetweed, common purslane, and common lambsquarter.

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF after transplanting, but before weed emergence

to control annual grasses and certain annual broadleaf weeds. Irrigate or cultivate within 24 hours of application to incorporate the herbicide. Use the lower rate on coarse-textured sandy soils low in organic matter. Use may reduce the stand and yield of fall planted small grains. Moldboard plowing will reduce the injury to small grain cover crops.

Postemergence

Fluazifop--0.125-0.188 lb/A. Apply 0.5 to 0.75 pints per acre Fusilade DX 2E with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or a nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. It will not control yellow nutsedge or any broadleaf weed. Do not tank-mix with any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 55 days and apply no more than 6 pints per acre in one season. Do not plant corn, sorghum, cereals, or any other grass crop within 60 days of the last application.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Sethoxydim--0.2-0.5 lb/A. Apply 1 to 2.5 pint per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot, humid cloudy conditions prevail. To reduce the risk of crop injury, omit the additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control

of the grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 5 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Wireworm, Flea Beetle Larvae, Grubs (See the "Wireworms" and "Grubs" sections of Soil Pests--Their Detection and Control.)

bifenthrin--19.2 fl oz 2 EC/A (at plant) or 3.2 fl oz 2 EC/A (lay-by) (wireworm and grubs only), or

Lorsban--4 pt 4E/A or 13.5 lb 15G/A. Just before transplanting, broadcast on soil surface and incorporate into the top 4 to 6 inches of soil, or

Mocap--2-2.67 qt 6EC/A. Apply in a 12- to 15-inch band or broadcast 1-1.33 gal 6EC/A 2 to 3 weeks before planting and incorporate into the top 4 inches of soil or OLF

Wireworm Adults (Click Beetles)

bifenthrin--2.1-6.4 fl oz 2EC/A (foliar)

Cutworms (Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Baythroid XL--0.8-1.6 fl oz/A, or

lambda-cyhalothrin--1.9-3.2 fl oz 3/A or OLF, or

Sevin Bait--20-40 lb 5% bait/A

Southern Corn Rootworm Larvae

bifenthrin--2.1-6.4 fl oz 2EC/A (foliar), or

Mocap--5.1-6.9 fl oz 6EC/1000 ft of row (banded) or 1-1.3 gal 6EC/A (broadcast), (See label for application directions).

Flea Beetle Adults

Look for beetles after transplanting. Repeat spray in 10 days if needed.

Actara--1.5-3.0 oz WDG/A, or

Assail--1.5-2.5 oz 30SG/A, or

Baythroid XL--1.6-2.8 fl oz /A, or

bifenthrin--2.1-6.4 fl oz 2EC/A (foliar), or

imidacloprid (soil, foliar)--see label for rates and application methods, or

lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or

Sevin--1.25-1.5 lb 80S/A, or

Thionex--0.67 qt 3EC/A or OLF

Note: Mid-summer foliar sprays of Sevin or Thionex may aid in wireworm control by killing egg-laying click beetles (the adult stage of the wireworm).

Tortoise Beetles, Cucumber Beetles

bifenthrin--2.1-6.4 fl oz 2EC/A (cucumber beetles only)

(foliar), or

lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or

Sevin--1.25-2.5 lb 80S/A

Note: Use of Actara for flea beetle control will reduce cucumber beetle population.

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Actara	G	12	14
Assail	G	12	7
Baythroid XL	R	12	0
bifenthrin	R	12	21
imidacloprid (soil/foliar)	G	12	21/7
lambda-cyhalothrin	R	24	7
Lorsban	R	24	At Plant
Mocap	R	48	Preplant
Sevin/Sevin Bait	R,G ²	12	7
Thionex	R	24	1
FUNGICIDE (FRAC code)			
Botran (Group 14)	G	12	0
Mertect (Group 1)	G	12	0

See Table D-6.

¹ G = general, R = restricted

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

Nematode Control

See "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section or Mocap (60 to 80 pounds per acre of 10G or 1 to 1.5 gallons of 6EC), or Vydate L or Temik 15G. Use as recommended on the label.

Disease Control

Black Rot and Scurf

Avoid bruising roots during harvest. Maintain a temperature of 80° to 85°F (26.71° to 29.4°C) during the curing period, and do NOT allow temperature during storage to drop below 55°F (12.8°C). Maintain a relative humidity of 85 to 90 percent during curing and storage.

Seedbed soil should be new or sterilized sand, and a bed temperature of 80° to 85°F (26.7° to 29.4°C) should be maintained. Use a 2-year rotation to reduce potential for disease development in the fields. Avoid applying fertilizer after July 1.

Use seed potatoes that are free of scurf for sprout production. During bedding, dip "seed roots" for 1-2 minutes in a suspension containing 8 fluid ounces of Mertect 340F per 7.5 gallons of water and plant immediately.

Use sprouts that are cut above the soil line whenever possible to reduce incidence of scurf.

Soft Rot (*Rhizopus*)

Use a resistant variety (eg. Beauregard)

At harvest: Dip or spray harvested table or seed-stock roots after cleaning and before packaging. Use 1 pound of Botran 75WP in 100 gallons of treating solution.

During bedding: Just before bedding, use a 10- to 15-second root dip. Use Botran 75WP (1 pound per 10 gallons of water).

Pox (Soil Rot)

Maintain a pH between 4.8 and 5.2 to assist in control. Use crop rotation, clean seed, and clean beds.

Fusarium Wilt

Use resistant varieties.

Surface Rot

Minimize injury during harvest. Cure as soon as possible under proper storage conditions. Use clean seed for bedding.

TOMATOES

Varieties					
Varieties ¹	DE	MD	NJ	PA	VA
Heirloom: Large Fruit					
Mortgage Lifter			N		
Hawaiian Pineapple			N	P	
Prudens Purple			N	P	
Mister Stripy					V
Heirloom: Medium Fruit					
Eva Purple Ball			N	P	
Arkansas Traveler			N		
Box Car Willie			N		
Lemon Boy*			N		
Costoluto Genovese			N		
Brandywine Red			N	P	V
Heirloom: Small Fruit					
Snow White			N		
Yellow Pear			N		
Market: Early					
SunStart* (VFS)		M		P	
Sunshine*	D	M	N	P	V
Applause*			N		V
Market: Mid-Season					
Sunbrite* (VF)	D	M	N	P	V
Sunbeam* (VF)	D	M	N	P	V
Mountain Spring* (VF)				P	V
Amelia*(VF,TSWV) (trial)	D		N	P	V
Florida 47*	D		N		V
Floralina*	D		N	P	
Florida 91*	D		N		V
Crista* (VF,TSWV,N)			N		V
RFT6153* (trial)					V
Mountain Fresh Plus *(NR, VFFN)		M	N	P	V
Scarlet Red (VFF)			N	P	V
Red Defender (VFFN,TSWV,trial)					V
Market: Late Summer/Fall					
Sunguard* (VF)	D		N		
Floralina* (VF)	D		N		
Florida 91* (VF)	D		N		V
RFT6153* (trial)					V
Mountain Fresh Plus *(NR, VFFN)		M	N	P	V
Market: High Tunnels					
SunStart* (VFS)				P	
Sunbrite* (VF)(trial)	D		N		
Daybreak* (VF)				P	
Applause				P	
Sunleaper* (VF)				P	V
RFT6153* (trial)					V
Mountain Fresh Plus *(NR, VFFN)				P	V
Market: Pear/Plum					
Heinz H-132* (trial)			N		
Plum Crimson* (VF)					
(Harvest blush-pink)	D		N	P	V
Plum Dandy* (VF)					
(Harvest blush-pink)	D	M	N	P	V

(table continued)

Varieties (continued)

Varieties ¹	DE	MD	NJ	PA	VA
Market: Pear/Plum					
Victoria Supreme*(VF,S,ASC)					P
(large fruit)					P
Health Kick* *(TSWV)(high lycopene)			N		P
Market: Cherry					
Sugar Snack					P
Sun Sugar*(VF) (orange)					P
Mountain Bell* (VF)	D		N	P	V
Sweet Chelsea* (large)					
(TMV,VFN)		M		P	
Market: Grape					
Mini Charm* (VF,TMV)			N	P	V
Smarty* (short, indeterminate)			N	P	V
Jolly Elf*			N		
St. Nick* (indeterminate)			N	P	
Cupid* (indeterminate)	D	M	N	P	
Juliete* (large grape, indeterminate)	D		N	P	V
Santa* (limited seed availability)	D		N	P	
Market: Yellow					
Carolina Gold*	D	M	N	P	V
BHN641					V
Roadside Stand					
RFT6153* (trial)					V
BHN589*			N	P	V
Sunbeam*			N	P	
Sunbrite*			N		
Fabulous*			N	P	
Processing					
TSH4* (early plantings)	D		N		
H-3402*			N		
H-9704*	D		N	P	
H-9423* (VF)	D		N		
H-9997*			N	P	

¹ Varieties listed by maturity within each category, earliest listed first.

* Indicates hybrid varieties. Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

Fresh market Tomatoes	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds per Acre	Med P ₂ O ₅ per Acre	Opt. P ₂ O ₅ per Acre	Low Pounds K ₂ O per Acre	Med Pounds K ₂ O per Acre	Opt. Pounds K ₂ O per Acre
Sandy loams and Loamy sands	80-90 ¹ 40-45 ² 40-45 ³	200 ¹ 200 ² 0	150 ¹ 150 ² 0	100 ¹ 100 ² 0	300 ¹ 300 ² 0	200 ¹ 200 ² 0	100 ¹ 100 ² 0
Loams and silt loams	50-80 ¹ 50 ² 25-30 ⁴	200 ¹ 200 ² 0	150 ¹ 150 ² 0	100 ¹ 100 ² 0	250 ¹ 250 ² 0	150 ¹ 150 ² 0	100 ¹ 100 ² 0

(foot notes on next page)

¹ Total amount nutrient recommended

² Broadcast and plow down

³ Sidedress when first fruits are set

⁴ Sidedress when first fruits are set if needed

Apply 1 1/2 -3 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Drip/Trickle Fertilization: see below for drip/trickle fertilization guides.

Processing Tomatoes Transplants for Machine harvest	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre	Pounds P ₂ O ₅ per Acre	Pounds P ₂ O ₅ per Acre	Pounds K ₂ O per Acre	Pounds K ₂ O per Acre	Pounds K ₂ O per Acre
Sandy loams and Loamy sands	50-75 ¹	200 ¹	150 ¹	100 ¹	250 ¹	150 ¹	100 ¹
	0 ²	100 ²	50 ²	0 ²	150 ²	50 ²	0 ²
	25 ³	100 ³	100 ³	100 ³	100 ³	100 ³	100 ³
	25-50 ⁴	0	0	0	0	0	0
Loams and silt loams	50 ¹	200 ¹	150 ¹	100 ¹	250 ¹	150 ¹	100 ¹
	0 ²	100 ²	100 ²	50 ²	150 ²	100 ²	50 ²
	50 ³	100 ³	50 ³	50 ³	100 ³	50 ³	50 ³

¹ Total amount nutrient recommended

² Broadcast and plow down

³ Broadcast and disk-in

⁴ Sidedress at first cultivation

Excess nitrogen hinders concentration of fruit maturity for machine harvest.

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

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 Clorox and 4 quarts of water plus ½ teaspoon of surfactant for 1 minute. 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. Dust with 1 teaspoon of thiram 65WP per pound of seed.

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 [15.6° to 18.3°C] day and 50° to 60°F [10° to 15.6°C] night) for one week or more causes catfacing. Harden plants by withholding nitrogen and reducing water. Allow plants to wilt slightly between light waterings.

Drip/Trickle Fertilization

Before laying plastic mulch, adjust soil pH to around 6.5 and then apply enough farm-grade fertilizer to supply 40 pounds per acre of N, P₂O₅, and K₂O, then thoroughly incorporate into the soil. If the soil tests medium or less in soil potassium, apply a fertilizer with a ratio of 1-1-2 or 1-1-3 containing 40 pounds of nitrogen per acre.

After laying plastic mulch and installing the trickle irrigation system, apply completely soluble fertilizer to supply 40 pounds (in Pennsylvania use 5 to 15 pounds) of N,

P₂O₅, and K₂O per fertilized-mulched acre during each application. (A description of a fertilized-mulched acre may be found in the "Irrigation" section of this publication.) On soil testing low and low to medium in boron, also include 0.5 pound of actual boron per fertilized-mulched acre in each of the three or four fertilizer applications. **For convenience, rates of fertilizer nutrients can be converted from a mulched acre to linear foot basis. See Table C-8.**

The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting the tomatoes. The same rate of soluble fertilizer should be applied again when the first fruit reach 1 inch in diameter and again when the fruit begin to turn color and ripen. A fourth application of the same rate of soluble fertilizer 2 weeks after the third application has helped to increase yield, but may not be economical. In Pennsylvania, do not exceed 90 pounds of nitrogen per acre per season.

Fresh Market

Yield, fruit size, and fruit quality of market tomatoes is increased by the use of black plastic mulch in combination with trickle irrigation. Form raised, dome-shaped beds to aid in disease control. Lay 4-foot wide black plastic mulch tightly over the beds.

For early summer harvest of market tomatoes, start transplanting April 10 to 20 in southern or normally warmer areas, and May 10 to 25 in cooler, northern areas.

See the "Trickle Irrigation" section of General Production Recommendations for detailed recommendations on fertilizing tomatoes grown with plastic mulch and trickle irrigation.

Ground Culture

Space *determinate* vined 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. Recommendations below are for the short-stake cultural system using determinate cultivars that grow 3 to 4 feet in height. Row widths of 5 to 6 feet with in-row spacings from 18 to 24 inches between plants are recommended.

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 improve 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 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 bacterial diseases. Pruning should be done before the first stringing

because the string can slow down 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 4½-feet long by 1-inch square are driven approximately 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, and approximately 30 pounds per acre are required. To make tying convenient, use a homemade stringing tool. This tool can be made from a length of metal conduit, PVC pipe, broom handle, or wooden dowel. With conduit or PVC pipe, the string is fed through the pipe. With a broom handle or wooden dowel, two small parallel holes, each approximately ½ to 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, looping the twine around each stake until you reach the end of a row or section (100-foot sections with alleys may be helpful for harvesting). The same process is continued on the other side of the row. The string tension must be tight enough to hold the plants upright but harvest can be difficult and strings can scar fruit if they are too tight.

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 4 stringings are required for most determinate varieties. Stringing should be done when the foliage is dry to prevent the spread of bacterial diseases.

No-Till Tomatoes in a Hairy Vetch Cover Crop

(For use in Delaware, Maryland, and Pennsylvania) – not recommended for use in New Jersey)

Transplanting tomatoes into a hairy vetch cover crop can produce yields equivalent to or greater than those achieved with black plastic mulch and eliminate the expenses for installation and disposal of plastic mulch. Tomatoes grown in hairy vetch remain vigorous and produce fruit over a longer period of time compared to conventional production systems. Other benefits of using a no-till system include erosion control, moisture conservation during the summer, increased

soil organic matter, improved soil fertility and structure, and weed suppression. **Cautions:** The no-till system is not adapted to heavy, poorly drained soils with high weed populations. Tomatoes will mature at least one week later on hairy vetch mulch than on black plastic due to decreased soil warming in all soil types. The living cover crop can remove soil moisture during the spring. This may increase the difficulty of transplanting tomatoes and require irrigation immediately after transplanting.

Cover Crop Establishment. Form beds before planting the cover crop. Inoculate hairy vetch seed for maximum nitrogen fixation and plant with a forage/grass seeder or grain drill with a grass seed hopper. Seed hairy vetch over the top of the beds at 25 to 40 pounds per acre between August 15 and September 15 in cool areas and September 1 and October 1 on the Delmarva Peninsula and southern New Jersey. For erosion control and greater mulch bio-mass, seed rye or "spring" oats at up to 40 pounds per acre in addition to 25 to 40 pounds per acre of vetch. The "spring" oats will winter kill, leaving an almost pure stand hairy vetch in the spring. (Note. Little winter kill may occur in mild winters on the Delmarva Peninsula and normally warm areas.) Rye will overwinter and form a support for the vetch during the spring. For trial: Plant crimson clover at 10 to 20 pounds per acre with the vetch and rye to increase the biomass of mulch and increase nitrogen fixation. However, this may increase the difficulty of transplanting tomatoes.

Cover Crop and Weed Management. Timing: Allow vetch to grow until the flower bud stage (early to late May) or several weeks longer to obtain adequate mulch biomass and nitrogen fixation. Be sure to kill the vetch before it produces mature seed. Seeds are immature when they are easily crushed between your fingers. **Caution:** Delay in killing vetch until mature seed formation may result in vetch weeds in succeeding crops.

Mowing: Flail mowing can desiccate hairy vetch without herbicides. If mowing is delayed until hairy vetch begins flowering and oats and rye are heading, minimal regrowth will occur. If hairy vetch is mowed while vegetative, regrowth may require a postemergence herbicide application. Vetch regrowth often occurs approximately 3 to 4 weeks after transplanting when the first flush of weeds emerge through the mulch. A directed application of metribuzin (0.33 lb/A Sencor/Lexone 75DF) has successfully controlled vetch regrowth and provided weed control when applied at this time. A second directed application of metribuzin may be required for full-season weed control. Grass weeds emerging after this time can be controlled with sethoxydim. **Caution:** Hairy vetch decomposes rapidly and emerging weeds will eventually require control. The use of the vetch mulch system eliminates the possibility for mechanical cultivation. Organic growers will need alternative weed control strategies (mowing, hand weeding, etc.) to control winter annuals, perennials, and escaped annual weeds.

Herbicides: An alternative method of killing hairy vetch is with an application of paraquat Gramoxone Inteon 2SC (at 2.4 pints per acre). Sethoxydim (1 to 2 pints per acre of Poast 1.5EC) or clethodim (3 fluid ounces per acre of Select 2EC) with oil concentrate can be used to control oat or rye cover crops that escaped control by mowing or paraquat application. Prior to planting tomatoes, apply napropamide

(2 to 4 pounds per acre Devrinol 50DF) to control grasses. Rainfall or sprinkler irrigation is required to incorporate residual herbicides. Use recommended postemergence herbicides to control weeds that escape this preplant herbicide application.

Tomato Management. Planting: Tomato plants should be transplanted with minimal disturbance to the cover crop mulch. Mechanical transplanters with spades that insert plants through the mulch into the soil are available. Mount coulters ahead of the spades to aid in loosening the soil. Care should be taken to avoid catching the viny vetch mulch on axles or protrusions that would disturb the uniform layer. After transplanting, lay drip irrigation tubing over the top of the mulch 2-3 inches from the tomato plants, with the emitter pores up. Staking will improve fruit quality.

Fertility: Apply phosphorus, potassium, and other nutrients (at rates determined by soil test) when forming beds in the fall or broadcast over the beds after cover crop is killed or mowed. Hairy vetch will supply a significant portion of the nitrogen requirement for tomatoes and good yields can be achieved with no additional nitrogen applications. Maximum yields can be obtained using one-half the fertilizer nitrogen applied to tomatoes grown on plastic mulch.

Apply a high phosphorus starter solution at planting. Within 1 week after transplanting, apply a complete soluble fertilizer to supply 10 to 40 pounds (5 to 15 pounds on heavy soils) of N, P₂O₅, and K₂O per fertilized-mulched acre through the drip irrigation system. The same rate of soluble N-P₂O₅-K₂O fertilizer should be applied when first fruit are 1 inch in diameter and again when the fruit begin to ripen. On soils testing low or low to medium in boron, include 0.5 pound of actual boron per fertilized-mulched acre in each fertilizer application.

Processing Tomatoes

Transplanting

Processing tomatoes can be trans-planted starting April 15 to 20 in warmer, southern areas to May 5 to 10 in Pennsylvania and normally cooler areas. Successive plantings can be made through early June.

Space transplants 9 to 12 inches apart in single rows 5 feet apart or to accommodate machine harvesters. *For trial use in New Jersey:* Small, determinate varieties may be grown in double rows. Space double rows 12 inches apart and space plants 12 to 18 inches apart in each of the double rows.

Fruit Ripening

Ethephon is labeled for use on processing tomatoes. Proper application increases earliness and yield and decreases sorting of green fruit in machine-harvested tomatoes. Rate and time of application are critical for successful use of ethephon. See state fact sheets or product label for details on rates, time of application, and temperature effects on the successful use of ethephon.

Tomato Disorders

Catfacing

Fruits are malformed and scarred, usually at the blossom end. Catfacing is caused by exposure of seedlings to cool temperatures (60° to 65°F [15.6° to 18.3°C] day and 50° to 60°F [10° to 15.6°C] night for one week) approximately 4 weeks before the time of pollination. The first flower cluster is susceptible to low temperature-induced catfacing

when seedlings have 4 to 5 true leaves. Fruits on later clusters will show catfacing if exposed to low temperatures in the field. Avoid hardening seedlings by exposure to low temperatures. Varieties differ in their susceptibility to the disorder.

Internal Browning (IB), Graywall (GW), and Blotchy Ripening (BR)

These problems are a complex of physiological disorders and pathological diseases. Green fruit with IB have brown necrotic areas in the walls and internal tissues. Areas around necrotic tissue ripen slowly and unevenly, resulting in a mottled, greenish-yellow and red fruit color. IB can be caused by tobacco mosaic virus (TMV).

Irregular, grayish-brown blotchy areas (GW) can occur on the upper half of fruit free of TMV. On ripening, fruit with GW or BR have blotchy areas of green and yellow tissue surrounded by areas of normal red tissue. Greenish-white and white tissue are usually present in the fruit walls, and brown necrotic areas may be located around the vascular system of the fruit. Yellow-eye, a ring of yellow tissue surrounding the stem scar, often occurs in fruit with BR and internal white tissue.

GW and BR symptoms often appear on shaded fruit growing in the interior of dense, vegetative plants. Cloudy, moist, cool weather; high soil moisture; high nitrogen; soil compaction; and low potassium increase the incidence and severity of GW and BR.

Yellow Shoulders

Yellowing may occur on the shoulders of the fruit exposed to the sun, especially on varieties having darker green shoulders when immature (those lacking the uniform ripening gene). The tissue beneath the yellow shoulder is usually corky and may vary from greenish white to pale yellow. This disorder can be overcome by selection of varieties with the uniform ripening gene. Provide good fruit cover as described below.

Sunburn and Sunscald

Sunburn and sunscald result from exposure to direct sunlight. Mild sunburn appears as yellowish or yellow-red color of fruit on the side exposed to the sun. Severe symptoms appear as whitish, water-soaked, scalded, or blistered areas. Sunscald is more severe on fruit growing in shaded conditions, followed by exposure to direct sunlight due to defoliation or exposure during harvesting. Under dry conditions, the white areas can become dry and leathery. Secondary infection can produce a dark, dry rot. Under moist conditions, scalded areas can decay from secondary infections. To control sunburn and sunscald, select varieties with good fruit cover and supply sufficient water and nutrients to provide good vegetative growth. Train workers to avoid turning vines during harvesting or to reposition vines to shade fruit.

Blossom-End Rot (BER)

This physiological disorder is caused by inadequate movement of calcium into the fruit. BER occurs when soil moisture is low and is more severe when plants have small, shallow root systems. Plastic mulch can restrict the movement of water to the root zone and increase BER. Hot, windy conditions increase water loss from the plant and increase the incidence of BER.

Be sure soil calcium is sufficient and in balance with other essential plant nutrients. Test the soil and apply lime and fertilizer according to recommendations, then lay plastic mulch when soil moisture is optimum for planting. Apply irrigation to wet the root zone and encourage deep root development.

Fruit Cracking and Russeting

Fruit cracking is due to rapid uptake of water by the fruit, resulting in enlargement of cells and separation of the epidermis of the fruit. Water can be taken up by the fruit through the roots and vascular system or through the fruit tissue around the stem scar.

The type of cracking (*concentric* cracks around the stem, *radial* cracks radiating out from the stem, or *diagonal* or *transverse* cracks across the fruit) is determined primarily by fruit structure and variety. More than one type of cracking may be present in a variety or an individual fruit.

The severity of cracking is determined by rainfall and irrigation amounts, variety and stage of maturity. As the fruit ripens, the strength of bonding between cells progressively decreases, resulting in more severe cracking. Severity of cracking is increased by high rainfall and irrigation, or frequent low to moderate rainfall, especially following a period of low soil moisture.

To minimize cracking, select a crack-resistant variety. Maintain a high level of calcium in the soil. Keep fruit growing at a uniform rate by maintaining uniform soil moisture levels. Maintain good fruit cover by proper fertilization and fungicide applications. Harvest fruit at the earliest stage of maturity that is acceptable by your market.

Russeting or weather checking of the surface of the fruit is caused by the presence of water on the fruit surface for extended periods of time when there are frequent light rainfalls, mist, fog, and dew. Wide fluctuations in temperature of exposed fruit also contribute to russeting. Russeting can cause fruit to be unmarketable. Maintain good fruit cover by proper fertilization and fungicide applications. Plant varieties with good fruit cover. Mountain Pride and Mountain Delight are more resistant to russeting than many other varieties.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tube left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tube several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and

depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.

2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Note: all herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Pretransplant Incorporated

Pebulate--3-4 lb/A. Apply 2 to 2.67 quarts per acre Tillam 6E (or OLF) in a band under the plastic mulch. Incorporate into soil immediately after application to prevent loss by evaporation. Tillam can be applied and incorporated broadcast when the crop will be grown on plastic mulch on flat culture (without raised beds). However, if the crop will be grown on raised beds or ridges, do not broadcast and incorporate Tillam before forming the raised beds, or herbicide rate and depth of incorporation will be increased by the bed or ridge forming operation. When growing on a raised bed or ridge, spray and incorporate the herbicide on bed or ridge and between row areas separately, so the herbicide is incorporated 2 to 3 inches deep in the raised bed or ridge, and in the between row areas. Primarily controls annual grasses and yellow nutsedge. Use in combination with Lexone/Sencor to improve the spectrum of broadleaf weeds controlled.

Pretransplant Incorporated or Pretransplant

Metribuzin--0.25 lb/A. Apply 0.33 pounds per acre Lexone/Sencor 75DF (or OLF) in a band under the plastic, immediately before laying the mulch. Mechanically incorporate before laying the mulch, or apply to the soil surface and incorporate with the condensation that forms on the underside of the mulch. Primarily controls broadleaf weeds. Tank-mix with Devrinol or Tillam to control annual grasses.

Pretransplant

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG in a band under plastic mulch to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Condensation that forms on the underside of the mulch will activate the herbicide. Delay transplanting for seven days after application. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when

herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. **DO NOT** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied pretransplant under plastic mulch.**

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Combine with Lexone/Sencor to improve the spectrum of broadleaf weeds controlled. Use lower rate on coarse-textured or sandy soil. Devrinol may reduce stand and yield of fall grains. Moldboard plowing will reduce the risk of injury to a small grain follow crop.

Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded
3. spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
4. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
5. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Pretransplant/ Preemergence to the Weeds

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a banded directed shielded spray to the soil strips between rows of plastic mulch to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after

application is necessary before weeds emerge to obtain good control. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. **DO NOT** apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a 1 year (12 month) period.**

S-metolachlor--0.95-1.9 lb/A. Apply 1.0 to 2.0 pints per acre Dual Magnum 7.62E as a banded directed shielded spray to control annual grasses, yellow nutsedge, nightshade species, galinsoga, and certain other broadleaf weeds. Use as a surface-applied banded spray, preemergence to the weeds. Posttransplant banded directed shielded sprays should be applied to weed-free soil. Dual Magnum will not control emerged weeds. Control emerged weeds with Graomoxone added to the shielded and directed banded herbicide spray. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Apply only when the soil surface is dry to avoid risk of vapor drift injury to the crop. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Make only one application during the growing season. **DO NOT** apply within 65 days of harvest. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Metribuzin--0.25 lb/A. Apply 0.33 pounds per acre Lexone/Sencor 75DF (or OLF) as a banded directed shielded spray. Primarily controls broadleaf weeds. Tank-mix with Devrinol, Tillam, or Treflan to control annual grasses at planting, or use a postemergence herbicide. An additional postemergence application of Lexone/Sencor may be necessary to control broadleaf weeds.

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use the lower rate on coarse-textured or sandy soils. May reduce stand of and yield of fall grains. Mold-board plowing will reduce the risk of injury.

Pendimethalin—0.48 – 1.42 lb/A. Apply 1 to 3 pints per acre Prowl H₂O as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds. Use the lower rate on coarse-textured or sandy soils. **Do NOT apply “over the top” of**

the crop, or severe injury may occur. Observe a 70 day PHI (PreHarvest Interval).

Postemergence

DCPA--6-10.5 lb/A. Apply 8 to 14 pints per acre Dacthal 6F as a banded directed shielded spray 4 to 6 weeks after transplanting for preemergence weed control. Emerged weeds will not be controlled. Dacthal will not injure crop foliage. Spray as a band directed between the rows of plastic mulch. Controls late season annual grasses, common purslane, and other broadleaf weeds.

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a banded directed shielded spray to the soil strips between rows of plastic mulch to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). Do NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied in a 1 year (12 month) period

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone Inteon 2SC as a **banded directed shielded spray between the rows ONLY**, to control emerged grass and broadleaf weed seedlings. Do not allow spray to contact plants as injury or residues may result. Use shields to prevent spray contact with crop plants. Do not exceed a spray pressure of 30 psi. Add wetting agent as per label.

Pendimethalin—0.48 – 1.42 lb/A. Apply 1 to 3 pints per acre Prowl H₂O as a banded directed shielded spray and activate with one-half inch of rainfall or sprinkler irrigation within 48 hours of application to control most annual grasses and certain broadleaf weeds preemergence. Use the lower rate on coarse-textured or sandy soils. Tank-mix with paraquat to control emerged weeds. **Do NOT apply “over the top” of the crop, or severe injury may occur. Observe a 70 day PHI (PreHarvest Interval).**

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution)

or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

For Transplanting Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **planting into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. Irrigate if rainfall does not occur, to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preplant Incorporated-Transplants

Napropamide--1-2 lb/A. Apply 2 to 4 pounds per acre Devrinol 50DF prior to transplanting. Incorporate thoroughly to a depth of 2 to 3 inches the same day as application. Use lower rate on coarse-textured or sandy soils. Primarily controls annual grasses and certain broadleaf weeds. Use in combination with Lexone/Sencor to improve the spectrum of broadleaf weeds controlled. May reduce stand and yield of fall grains if fields are only disked. Moldboard plowing will reduce the risk of injury.

Pebulate--3-4 lb/A. Apply 2 to 2.67 quarts per acre Tillam 6E (or OLF). Incorporate into soil immediately after application to prevent loss by evaporation. Primarily controls annual grasses and yellow nutsedge. Use in combination with Lexone/Sencor to improve the spectrum of broadleaf weeds controlled.

Trifluralin--0.5-1 lb/A. Apply 1 to 2 pints per acre Treflan4EC (or OLF). Incorporate with double-disking into 2 to 3 inches of soil within 8 hours after application. Mount the boom on the front of disk. Primarily controls annual grasses and certain broadleaf weeds. Use in combination with Lexone/Sencor to improve the spectrum of broadleaf weeds controlled. Stunting may result if weather is cool and damp. Will not control ragweed, jimsonweed, or morningglory.

Metribuzin--0.25 lb/A. Apply 0.33 pounds per acre Lexone/Sencor 75DF (or OLF) and incorporate before transplanting. Primarily controls broadleaf weeds. Tank-mix with Devrinol, Tillam, or Treflan to control annual grasses at planting, or use Poast 1.5EC to control grasses postemergence. An additional postemergence application of Lexone/Sencor may be necessary to control broadleaf weeds.

Pretransplant Incorporated or Pretransplant

S-metolachlor--0.95-1.9 lb/A. Apply 1.0 to 2.0 pints per acre Dual Magnum 7.62E as a pretransplant incorporated or pretransplant surface applied spray to control annual grasses, yellow nutsedge, nightshade species, galinsoga, and certain other broadleaf weeds. Apply Dual Magnum before weeds germinate. Dual Magnum will not control emerged weeds. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Make only one application during the growing season. DO NOT apply within 65 days of harvest. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Pretransplant

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development

of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied pretransplant. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a 1 year (12 month) period**

Postemergence-Transplanted

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days.

DCPA--4.5-10.5 lb/A. Apply 6 to 14 pints per acre Dacthal 6F to weed-free soil 4 to 6 weeks after transplanting or after direct-seeded plants are a minimum of 6 inches tall. The crop should be well established and growing under conditions that are favorable for good growth. Dacthal will provide residual control of annual grasses and certain broadleaf weeds, including common purslane, but will not control emerged weeds. Applications can be made over the top of the crop when grown without plastic mulch but must be banded between the rows when plastic mulch is used.

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga after the crop has been transplanted at least 14 days. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). Do NOT use oil concentrate. Susceptible broadleaf weeds

usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. **DO NOT** apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1.0 dry ounces of Sandea, applied postemergence. DO NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea, applied preemergence and postemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea applied preemergence and postemergence to multiple crops in a 1 year (12 month) period.**

Metribuzin--0.25 lb/A. Use 0.33 pound per acre Sencor/Lexone 75DF or 0.5 pint Sencor/Lexone 4F. Primarily controls broadleaf weeds, but does NOT control nightshades. Use Devrinol, Tillam, or Treflan preplant incorporated or apply Poast 1.5EC postemergence to control annual grasses. Applications should be delayed until transplants have recovered from transplant shock and new growth is evident, or at least 2 weeks. Do not apply within 3 days after periods of cool, wet, or cloudy weather or crop injury will occur. Do not apply within 24 hours of treatment with other pesticides. Treatment with Sencor may be repeated in 14 days if necessary. Repeat application to suppress or control yellow nutsedge. Do not apply within 7 days of harvest.

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone Inteon 2SC as a directed spray between the rows. Do not allow spray to contact plants, as injury or residues may result. Use shields to prevent spray contact with crop plants. Do not exceed a spray pressure of 30 psi. Add wetting agent as per label.

Pebulate--3-4 lb/A. Apply 0.5 to 0.67 gallon per acre Tillam 6E (or OLF). Apply over transplants up to fruit formation. Incorporate into soil immediately after application where nutsedge is a problem.

Rimsulfuron--0.0156-0.031 lb/A. Apply 1 to 2 dry ounces per acre of Matrix 25DF early postemergence to control many annual weeds. Optimum results are obtained when the weeds are very small, less than one inch in height, but not before the crop has at least two full-sized true leaves. Common lambsquarter, common ragweed, jimsonweed, morningglory species, and yellow nutsedge may only be suppressed. Tank mix with metribuzin to increase the

spectrum of weeds controlled. Always check and follow the application instructions on the label for both herbicides related to the size of the crop, size of the weeds, and weather conditions when applying as a tank-mixed combination. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) to improve weed control. Do NOT exceed a total of 4 dry ounces of product per acre per year. **Labeled for use on processing and fresh market tomatoes in all states, except California.** Rimsulfuron (Matrix 25DF) is an ALS inhibitor. Herbicides in this class of chemistry have a single site of action in susceptible plants. Always use sequentially or in a tank-mixed combination with other herbicides with a different site of action in the plant to prevent the development of resistant weed populations. Read and follow label cautions and resistance management recommendations.

S-metolachlor--0.95-1.9 lb/A. Apply 1.0 to 2.0 pints per acre Dual Magnum 7.62E as a shielded directed spray to control annual grasses, yellow nutsedge, nightshade species, galinsoga, and certain other broadleaf weeds. Posttransplant banded directed shielded sprays should be applied to weed-free soil after the first soil settling rainfall or overhead irrigation after transplanting. Dual Magnum will not control emerged weeds. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Apply only when the soil surface is dry to avoid risk of vapor drift injury to the crop. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Make only one application during the growing season. DO NOT apply within 65 days of harvest.

Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.

Sethoxydim--0.2-0.4 lb/A. Apply 1 to 2 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 20 days and apply no more than 4.5 pints per acre in one season.

Postharvest With or Without Plastic Mulch

Paraquat--0.6 lb/A. Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Insect Control (Fresh Market and Processing Tomatoes)

Cutworms (Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Preplanting Field Treatment

Just before seeding or transplanting, broadcast on the soil surface the following:

diazinon--4-8 lb 50WP/A or OLF

Diazinon granules can be used in place of spray. Work treatment into top 4 inches of soil.

Postplanting Treatment

If control is required after seedling emergence or after transplanting, treat soil thoroughly beneath plants with the following:

Asana XL--5.8-9.6 fl oz 0.66EC/A, or

Baythroid XL--2.1-2.8 fl oz/A (variegated cutworm), or

lambda-cyhalothrin--1.92-3.2 fl oz/A or OLF, or

Lannate--1.5 pt LV/A or OLF, or

Proaxis--1.92-3.2 fl oz/A, or

Renounce--2.6-3.5 oz 20WP or OLF, or

Sevin Bait--40 lb 5% bait/A or OLF

Broadcast bait with ground equipment or by aircraft as needed, or

Colorado Potato Beetle (CPB)

Rotation to nonsolanaceous crops (crops other than potato, tomato, eggplant, and pepper) is extremely important in reducing CPB problems. Also, transplants placed into no-till fields, mulches or other crop residue will reduce or delay potato beetle infestations.

Look for CPB adults shortly after seedling emergence or transplanting. Early season populations tend to be concentrated in areas where tomatoes were previously grown. For direct-seeded tomatoes during emergence, treat when CPB adults are reducing plant densities below recommended levels for maximum yields. Thoroughly scout the fields and spray only when necessary. Spot treatment of "hot spots" only is recommended if infestation is localized. For established direct-seeded or transplant tomatoes, begin treatment if the population level exceeds 15 CPB adults per 10 plants throughout the field. If early treatment is not applied, wait for egg hatch and start spray program when larvae are young and exceed 20 CPB larvae and/or adults per 10 plants. Reassess after each treatment to determine need and timing of next spray. Avoid the application of late-season sprays to prevent the buildup of insecticide-resistant beetles.

abamectin (Agri-mek; generics available)--8-16 fl oz 0.15 EC/A, or

Assail--1.5-2.5 oz 30SG/A, or

azadirachtin (Azatin, Ecozin, Neemix)--8-16 fl oz EC/A.

Apply when pests first appear and are in their early larval stages, or

Bacillus thuringiensis tenebrionis (Small CPB larvae only--Novodor, Raven)--Consult label for rates and restrictions.

Make first application when eggs begin to hatch and repeat applications at 5- to 7-day intervals if small larvae are present. Larval reduction may not be noticeable for 48 to 72 hours after application. NOT effective against large larvae or adults. If rainfall occurs within 24 hours posttreatment, reapplication may be necessary, or

cryolite (Kryocide, Prokil cryolite)--15-30 lb 96WP/A or OLF, or

Entrust--2.0-2.5 oz 80W/A, or

imidacloprid (soil, foliar)--see label for rates and application methods, or

Platinum--5-8 fl oz 2SG/A, or

Radiant--5-10 fl oz SC/A, or

SpinTor--2.25-4.5 fl oz 2SC/A, or

Thionex--0.67-1.33 qt 3EC/A, or OLF, or

Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A (Not for tomatoes less than 2 inches in size), or

Vydate L--1-2 qt 2L/A

Vydate L is most effective when plant has adequate foliage and is actively growing. Applications under other conditions may be ineffective.

Flea Beetles (FB)

Asana XL--5.8-9.6 fl oz 0.66 EC/A, or

bifenthrin--2.1-5.2 fl oz 2EC/A, or OLF, or

imidacloprid (soil)--see label for rates and application methods, or

lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or

Mustang MAX--2.4-4.0 fl oz/A

Guthion--2 pt 2S/A or OLF, or

Platinum--5-8 fl oz 2 SG/A, or

Proaxis--2.56-3.84 fl oz/A, or

Thionex--0.67-1.33 qt 3 EC/A, or OLF, or

Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A (Not for tomatoes less than 2 inches in size)

Aphids (Green Peach and Potato)

Note. Thorough spray coverage beneath leaves is important.

Actara--2-3 oz 25WDG/A, or

Assail--2-4 oz 30SG/A, or

Beleaf--50 SG (see label for rates)

dimethoate--0.5-1 pt 4EC/A or OLF, or

Fulfill--2.75 oz 50WDG/A, or

imidacloprid (soil, foliar)--see label for rates and application methods, or

Knack--6-8 fl oz 0.86E/A (use only in combination with 0.66-1.33 lb Orthene 75S), or

Lannate--1.5 pt LV/A or OLF, or

Monitor (Delaware, New Jersey, and Virginia only)--1.5-2 pt 4EC/A, or

Platinum--5-8 fl oz 2SG/A, or

Provado (generics available)--3.75 fl oz 1.6F/A, or

Thionex--0.67-1.33 qt 3EC/A (Greenhouse or field) or OLF, or

Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A (Not for tomatoes less than 2 inches in size), or

Vydate L--1-2 qt 2L/A

Worms (Tomato Fruitworm [CEW], Hornworm [HW], European Corn Borer [ECB], Cabbage Looper [CL])

Asana XL--2.9-9.6 fl oz 0.66EC/A (except ECB), or

Avaunt--3.5 oz 30WDG/A (CEW, HW, CL only), or

Bacillus thuringiensis (CL, HW only) or OLF--consult label for rate and restrictions, or

cyfluthrin--2.1 -2.8 fl oz/A, or

bifenthrin--2.1-5.2 fl oz 2EC/A or OLF (CEW, ECB, CL only, or

Confirm--6-16 fl oz 2F/A (HW, CL, ECB only), or

TOMATOES

cryolite--8-15 lb Kryocide 96WP/A (CEW, HW, CL only) or OLF, or
Danitol--10.67 fl oz 2.4EC/A (CEW, HW, CL only), or
Entrust--1.0-2.0 oz 80W/A, or
Intrepid--4-8 fl oz 2F/A (early season, HW, ECB, CL), 8-16 fl oz 2F/A (late season, HW, ECB, CL), 10-16 fl oz (CEW only), or
lambda-cyhalothrin--2.56-3.84 fl oz/A or 1.92-3.2 fl oz/A (HW only) or OLF, or
Lannate--1.5-3 pt LV/A or OLF (CEW, HW, CL only), or
Monitor (Delaware, New Jersey, and Virginia only.)--1.5-2 pt 4EC/A (CEW, HW, CL only), or
Mustang MAX--2.24-4.0 fl oz/A, or
Proaxis--2.56-3.84 fl oz/A or 1.92-3.2 fl oz/A (HW only), or
Proclaim--2.4-4.8 oz 5 WDG/A (CEW, HW, CL only), or
Radiant--5-10 fl oz SC/A, or
Renounce--2-3.5 oz 20WP or OLF, or
SpinTor--3-6 fl oz 2SC/A

Leafminers

Treat when first mines appear and repeat every 7 days or as needed.

abamectin (Agri-mek; generics available)--8-16 fl oz 0.15EC/A, or
dimethoate--0.5-1 pt 4EC/A or OLF, or
Entrust--2.0-2.5 oz 80W/A, or
Radiant--6-10 fl oz 2SC/A, or
SpinTor--6-8 fl oz 2SC/A, or
Trigard--2.66 oz (one packet) 75WP/A, or
Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A (Not for tomatoes less than 2 inches in size)

True Armyworm (TAW), Fall Armyworm (FAW)

bifenthrin--2.1-5.2 fl oz 2EC/A or OLF, or
Confirm--8-16 fl oz 2F/A, or
Entrust--1.0-2.0 oz 80W/A, or
Intrepid--4-8 fl oz 2F/A (early season), 8-16 fl oz 2F (late season), or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Lannate--1.5 pt LV/A (TAW), 2 pt 2.4LV/A (FAW), or
Mustang MAX--3.2-4 fl oz/A (FAW), 2.24-4.0 fl oz/A, (TAW),
Proaxis--2.56-3.84 fl oz/A, or
Proclaim--2.4-4.8 oz 5 WDG/A (FAW only), or
Radiant--5-10 fl oz SC/A, or
SpinTor--4-8 fl oz 2SC/A

Beet Armyworm

Avaunt--3.5 oz 30WDG/A, or
Confirm--8-16 fl oz 2F/A, or
Entrust--1.25-2.25 oz 80W/A, or
Intrepid--4-8 fl oz 2F/A (early season), 8-16 fl oz 2F (late season), or
Lannate--3 pt LV/A, or
Proclaim--2.4-4.8 oz 5 WDG/A, or
Radiant--5-10 fl oz SC/A, or
SpinTor--4-8 fl oz 2SC/A

Mites

Mite infestations generally begin around field margins, grassy areas, and windbreaks. CAUTION: DO NOT mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot treated. **Note.** Thorough spray coverage beneath leaves is important. The use of dimethoate for aphids and leafminers may help

reduce the mite population.

Acramite--0.75-1 lb 50WS/A, or
abamectin (Agri-mek; generics available)--8-16 fl oz 0.15 EC/A, or
bifenthrin--2.1-5.2 fl oz 2EC/A or OLF, or
Danitol--10.67 fl oz 2.4EC/A, or
Oberon--7-8.5 fl oz 2SC/A

Pinworms

This pest is introduced on southern transplants. Begin sprays if leaf damage is observed. Late evening sprays may be most effective when moths are active.

abamectin (Agri-mek; generics available)--8-16 fl oz 0.15 EC/A, or
cyfluthrin--2.8 fl oz /A, or
Entrust--1.25-2.25 oz 80W/A, or
Mustang MAX--2.24-4.0 fl oz/A, or
NoMate TPW--200 spirals/A

Note. NoMate is a mating disruption technique useful for preventing mating of emerging adults from young transplants. Apply at first sign of leafminers, or
Proclaim--2.4-4.8 oz 5 WDG/A, or
Radiant--5-10 fl oz SC/A, or
Renounce--2.6-3.5 oz 20WP or OLF, or
SpinTor--4-8 fl oz 2SC/A

Thrips

Several species of thrips spread Tomato Spotted Wilt Virus. Scout for thrips and begin treatments when thrips are observed. Do not produce vegetable transplants with bedding plants in the same greenhouse.

Greenhouse

malathion--1.5-2 pt 57EC/100 gal water.

Note. Use of Thionex for control of aphids or whiteflies in the greenhouse will suppress thrips.

Field

Assail--4 oz 30SG/A
Entrust--1.25-2.25 oz 80W/A, or
imidacloprid (soil)--see label for rates and application methods, or
lambda-cyhalothrin--2.56-3.84 fl oz/A (except for Western Flower Thrips) or OLF, or
Monitor (Delaware, New Jersey, and Virginia only.)--1.5-2 pt 4EC/A, or
Proaxis--2.56-3.84 fl oz/A (except for Western Flower Thrips), or
Radiant--6-10 fl oz 2SC/A, or
Renounce--2.6-3.5 oz 20WP or OLF, or
SpinTor--4-8 fl oz 2SC/A, or
Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A (Not for tomatoes less than 2 inches in size)

Stink bug

cyfluthrin--2.8 fl oz /A, or
Danitol--10.67 fl oz 2.4 EC/A, (green stinkbug only), or
lambda-cyhalothrin--2.56-3.84 fl oz/A or OLF, or
Monitor (Delaware, New Jersey, and Virginia only.)--1.5-2 pt 4EC/A, or
Mustang MAX--3.2-4.0 fl oz/A, or
Proaxis--2.56-3.84 fl oz/A, or
Renounce--2.6-3.5 oz 20WP or OLF, or
Thionex--1-1.33 qt 3EC/A or OLF

Whiteflies

Assail--2.5-4 oz 30SG/A, or
 Fulfill--2.75 oz 50W/A, or
 imidacloprid (soil, foliar)--see label for rates and application methods, or
 Knack--8-10 fl oz 0.86EC/A, or
 Oberon--7-8.5 fl oz 2SC/A, or
 Platinum--5-8 oz 2SG/A, or
 Thionex--0.67 qt 3EC/A (Greenhouse or field) or OLF, or
 Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A (Not for tomatoes less than 2 inches in size)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Acramite	G	12	3
abamectin (Agri-me)	R	12	7
Asana XL	R	12	1
Assail	G	12	7
Avaunt	G	12	3
azadirachtin	G	4	0
<i>Bacillus thuringiensis</i>	G	4	0
Beleaf	G	12	0
bifenthrin	R	12	1
Confirm	G	4	7
cryolite	G	12	14
cyfluthrin	R	12	0
Danitol	R	24	3
diazinon	R	24	24
dimethoate	R	48	7
Entrust	G	4	1
Fulfill	G	12	0
imidacloprid (soil/foliar)	G	12	21/0
Intrepid	G	4	1
Knack	G	12	14
lambda-cyhalothrin	R	24	5
Lannate	R	48	1
malathion	G	12	5
Monitor	R	48	7
Mustang MAX	R	12	1
Oberon	G	12	7
Platinum	G	12	30
Proaxis	R	24	5
Proclaim	R	48	7
Radiant	G	4	1
Renounce	R	12	0
Sevin Bait	G	12	0
SpinTor	G	4	1
Thionex	R	24	2
Trigard	G	12	0
Vydate L	R	48	3
Venom (soil/foliar)	G	12	21/1
FUNGICIDE (FRAC code)			
Actigard (Group P1)	G	12	14
Aliette (Group 33)	G	12	14
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
Contans WG (biological)	G	4	0
copper, fixed (Group M1)	G	24	0
Endura (Group 7)	G	12	0
Flint (Group 11)	G	12	3
Flouronil (Groups 4 + M5)	G	48	14
Forum (Group 40)	G	12	4
Gavel (Groups 22 + M3)	G	48	5
mancozeb (Group M3)	G	12, 24	5
ManKocide (Groups M3 + M1)	G	48	5
Nova (Group 3)	G	12	0
Previcur Flex (Group 28)	G	12	5

(table continued)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
FUNGICIDE (FRAC code) (continued)			
Quadris (Group 11)	G	4	0
Ranman (Group 21)	G	12	0
Ridomil Gold (Group 4)	G	48	0
Ridomil Gold Bravo (Groups 4 + M5)	G	48	14
Ridomil Gold Copper (Groups 4 + M1)	G	48	14
Tanos (Groups 11 + 27)	G	12	3
Terraclor (Group 14)	G	12	AP
thiophanate-methyl (Group 1)	G	12	14
Ultra Flourish (Group 4)	G	48	0

See Table D-6.

²Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.¹G = general, R = restricted, AP=At Plant**Nematode Control**

See "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section.

Disease Control**Damping-Off**

Greenhouse: Use seed treatment and plant in a disease-free mix.

Field: At planting apply:

Aliette--2.5-5 lb 80WDG/A, or
 mefenoxam--1-2 pt Ridomil Gold 4E/A or 2-4 pt Ultra Flourish 2E/A. Apply in a 7-inch band at transplanting. Use formula given in the "Calibration for Changing from Broadcast to Band Application" section to determine amount of Ridomil Gold or Ultra Flourish needed per acre.

Bacterial Wilt

Use certified plants. Avoid growing tomatoes in fields where bacterial wilt has occurred. Crop rotation to non-host crops is the best measure to reduce levels of bacterial wilt. In particular, avoid planting where tomatoes or peppers were grown in the preceding year. Some resistant cultivars are also available. Soil fumigation with a fumigant that contains either methyl bromide or chloropicrin may reduce disease occurrence.

Bacterial Canker

Use certified plants. Rotate to allow 3 years between tomato plantings. Be sure to use the Clorox seed treatment described in the "Seed Treatment" section to prevent bacterial canker. When producing transplants, in addition to using the chlorine seed treatment, also be sure to treat re-used plant growing flats with chlorine. See the "Treatment of Flats and Trays" section of Plant Growing. For staked tomatoes, stakes from bacterial canker infested fields should be dipped into a chlorine solution prior to use. In infested fields, pruning and stringing will promote spread of disease. Avoid working plants when foliage is wet to reduce spread within the field. Applications of Actigard 50WG (0.33 oz/A increasing to 0.75 oz/A when plants are full size, see label for details) plus fixed copper (1.5 lb active/A) have been shown to reduce bacterial canker symptoms on fruit.

Bacterial Speck and Bacterial Spot

When producing transplants, be sure to clorox- or heat-treat seed as described under the "Seed Treatment" section to

help reduce seed infestation and carryover into transplant production. Apply streptomycin (Agri-Mycin 17, Agri-Strep) sprays (1 pound per 100 gallons, 1.25 teaspoon per gallon) when the first true leaves appear and continue every 4 to 5 days until transplanting. Streptomycin cannot be used after transplanting. Be sure to reduce moisture on foliage and injurious handling in the greenhouse. Rotate to allow 2 to 3 years between tomato plantings. There can be a high risk of developing bacterial leaf spot and/or speck when using southern-produced transplants. Use only certified transplants. Strains of copper resistant bacterial spot are common in some areas of the mid-Atlantic particularly on the Eastern Shore of Virginia. To ensure successful disease control, utilize Actigard either alone or in conjunction with copper-containing materials.

Where disease is present or anticipated, do not work in fields when plant surfaces are wet. Apply one of the following beginning shortly after transplanting and repeat every 7 days.

Actigard--0.33-0.75 oz 50WG/A (follow label instructions),
or
copper, fixed--1 lb ai/A *plus* mancozeb--1.5 lb 75DF/A or
OLF, or
ManKocide--2.5-5 lb 61WP/A or
Cuprofix MZ--75-7.25 lb 52.5DF/A, or
Tanos—8 oz 50DF/A (suppression only)

Postharvest Rots

To prevent rots in mature green tomatoes, avoid washing freshly harvested fruit in cold water. Avoid harvesting fruit when the foliage is wet. Maintain water temperature in flumes and tanks. Do not allow temperature to get 10 degrees F above fruit temperature to prevent movement of bacteria into the stem end of the fruit. Use a minimum 100 ppm free chlorine and keep pH between 6.5 and 7.0 in the flume. Store at 55 degree F with relative humidity of 80%. For more information see the website, edis.ifas.ufl.edu/HS131

Powdery Mildew

Greenhouse: Once observed, apply one of the following with thorough coverage of the upper and lower leaf surfaces and repeat at 7-day intervals.

JMS Stylet Oil--1-2 gal/100 gal, or
Sun Spray Ultra-Fine Spray Oil--1-2 gal/100 gal

Field: The disease has been observed in unsprayed fields, and has resulted in defoliation. When the disease first appears, apply the following and repeat every 14 days:

Cabrio--8-12 20EG/A, or
Nova--2.5-4 oz 40WP/A

Timber Rot (*Sclerotinia*)

Rotate away from fields where snap or lima beans, peas, peanuts, lettuce or cucurbits have been grown. The following biological fungicide has been tested in some states; however, limited information is available on effectiveness in the Mid-Atlantic region. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches. However, to avoid the chance of infesting the upper soil layer with untreated sclerotia from the lower soil layer **do not plow** between treatment and transplanting times.

Timber rot occurs during prolonged periods of moisture

and cooler temperatures (<80F). Timing fungicide applications to be either just prior to or to coincide with favorable conditions for disease is essential for optimal disease control.

thiophanate-methyl has received Section 18 status in some mid-atlantic states, (check with county extension agent).

Endura labeled for Botrytis Gray Mold control (9-12.5 oz 70W/A), will also help control Sclerotinia Timber Rot. However, Endura cannot be used in greenhouse-like structures.

The following biological fungicide has been tested in some states; however, limited information is available on effectiveness in the Mid-Atlantic region. Apply 3 to 4 months prior to the onset of disease to allow the active agent to reduce inoculum levels of sclerotia in the soil. Following application, incorporate to a depth of 1 to 2 inches. However, to avoid the chance of infesting the upper soil layer with untreated sclerotia from the lower soil layer **do not plow** between treatment and transplanting times.

Contans--2-4 lb 5.3 WG/A

Southern Blight (*Sclerotium rolfsii*)

High soil moisture and temperature favor disease development. Long crop rotations with corn and small grains help reduce disease incidence. Soil fumigation and staking tomatoes will greatly reduce disease incidence. Additionally, use the following in the transplant water:

Terraclor--3 lb 75WP/100 gal of water or OLF and apply 0.5 pt/plant.

Fusarium and Verticillium Wilts

Use resistant varieties. A new race of Fusarium Wilt (Race 3) has appeared in some regions and has overcome varietal resistance. Be certain that you select a variety with resistance to all three races of Fusarium (1,2,and 3). Soil fumigation and crop rotation are essential components of a successful management program for these wilts.

Leaf Spots (Early Blight, Septoria leaf spot) and Fruit Rots (Early blight, Anthracnose)

Follow a crop rotation that provides at least 2 years without tomatoes or potatoes. Use disease-free transplants and disease-resistant varieties when possible. Fresh market varieties with some resistance to early blight include Mountain Supreme and Plum Dandy. Processing varieties with tolerance to ripe fruit rots include Hypeel 696 and H-9423. For fields in mountainous areas, fields not rotated away from tomatoes, and in late planted fields, begin sprays shortly after transplanting. In all other areas, either follow a regular (7-day) spray schedule starting when crown fruit are one-third their final size, or time sprays based on a locally-verified forecaster such as Tomcast® or TomFAST®. Apply the following fungicides using the alternation pattern described to delay development of pathogen strains resistant to Cabrio, Flint or Quadris.

Apply one of the following:

Alternate:

chlorothalonil--2-3 pt 6F/A or OLF (also for gray leaf spot, black mold and soil rot), or

mancozeb--3 lb 75DF/A or OLF (also for gray leaf spot and leaf mold), or
Gavel--1.5-2.0 lb 75DF/A

With:

Quadris--5.0-6.2 fl oz 2.08F/A (Also for buckeye rot and black mold. Do not apply near apples: see label for details), or

Cabrio--8-12 oz 20EG/A, or

Endura--2.5-3.5 oz 70W/A (also for Botrytis at 9-12.5 oz/A), or
Flint--4 oz 50 WDG/A, (Do not apply near Concord grapes), or

Tanos--8 oz 50W/A *plus* protectant fungicide (also for buckeye rot suppression and gray leaf spot).

To provide effective late-season control, one additional may be necessary after the application of a fruit-ripening agent.

Materials in different FRAC codes should be alternated to reduce the chances for fungicide resistance development.

Late Blight

New strains of the fungus that cause Late blight are present in the mid-Atlantic region. These strains are aggressive on tomato and have developed mefenoxam-insensitivity. When plants are 6 inches tall, apply one of the following protectant fungicides and repeat every 7 days, or follow a locally-verified disease forecasting system such as BLITECAST to schedule the fungicide applications:

chlorothalonil--1-3 pt 6F/A or OLF, or
Gavel--1.5-2 lb 75DF/A, or
mancozeb--3 lb 75DF/A or OLF.

Once late blight is detected in the area, switch to one of the following translaminar fungicides which can move into and through leaves. Rotate between the following tank mixtures:

Forum--6.0 fl oz 4.18SC/A *plus* a protectant fungicide, or
Previcur Flex--1.5 pt 6F/A *plus* a protectant fungicide, or
Ranman--2.1-2.75 fl oz 400SC/A *plus* a protectant fungicide, or
Tanos--8 oz 50WG/A *plus* a protectant fungicide.

Return to the use of protectant fungicides when conditions no longer favor the development of late blight.

Fruit Rot caused by Pythium and Buckeye Rot caused by Phytophthora

Apply mefenoxam (Ridomil Gold at 1 pint 4EC per acre or Ultra Flourish at 1 quart 2E per acre) as a soil surface application under the vines 4 to 8 weeks before harvest. Apply broadcast or banded (see the section on "Calibrating Granular Application Equipment" for the amount needed per acre). Irrigate after application. An alternative to soil application of mefenoxam is to apply the following as a foliar spray beginning when crown fruit are one-third their final size and repeat every 14 days up to a total of 3 times:

mefenoxam chlorothalonil (Flouronil, Ridomil Gold Bravo)--2 lb 76WP/A, or
Ridomil Gold Copper--2 lb 65WP/A *plus* copper--1 lb 75DF/A

When conditions favor disease apply one of the following between applications of the above fungicides.

Gavel--1.5-2 lb 75DF/A, or
Tanos--8 oz 50WG/A

Botrytis Fruit Rot (Gray Mold)

Gray mold is a problem during the fall in fields with dense foliage and poor drainage. For fall production, select fields with good drainage. Shortly before harvest when conditions are wet and cool, apply the following:

chlorothalonil--2-2.75 pt 6F/A or OLF (also very good for late blight), or

Endura 9-12.5 oz 70WG/A (also very good for early blight; not for use in greenhouses)

Tomato Spotted Wilt Virus (TSWV)

TSWV can be serious and result in severely stunted plants. The virus is spread by thrips from ornamental plants (flowers) and weeds to tomatoes. Use resistant varieties when available. Do not grow any ornamental bedding plants in the same greenhouse as tomato transplants. Control weeds in and around greenhouses. Monitor greenhouses and tomato fields for thrips and begin an insecticide control program once thrips are observed. In the field, use of reflective mulch can help repel thrips and can reduce the incidence of spotted wilt.

WATERMELONS

Varieties

Varieties¹**Seeded**

Crimson Sweet (AR,FR1, OS) These varieties are recommended
Royal Majesty* (FR1,2) for DE, MD, NJ, PA, VA, WV
Sangria*
Jamboree*(AT,FT)
Royal Star (FR1)
Mardi Gras* (FR 1, AR)
StarBrite (AR, FR1,OS)

Seedless

Imagination* (Sugarbaby Type)
Gypsy*
Millionaire* (OT)
Sugarheart*
SS5244* (OT)
Tri-X-313* (OT)
Tri-x
Palamar
Matrix (oblong)
Revolution* (oblong) (OT)
Amarillo* (yellow)

These varieties are recommended for DE, MD, NJ, PA, VA, WV

Personal (3-7 lbs)

Solitaire*
Vanessa

¹ Varieties listed by maturity, earliest first.

* Indicates hybrid varieties.

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels

Watermelons	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low Pounds P ₂ O ₅ per Acre	Med Pounds P ₂ O ₅ per Acre	Opt. Pounds P ₂ O ₅ per Acre	Low Pounds K ₂ O per Acre	Med Pounds K ₂ O per Acre	Opt. Pounds K ₂ O per Acre
Nonirrigated	80-100 ¹	150 ¹	100 ¹	50 ¹	200 ¹	150 ¹	100 ¹
	50 ²	150 ²	100 ²	50 ²	200 ²	150 ²	100 ²
	25-50 ³	0	0	0	0	0	0
Irrigated	125-150 ¹	150 ¹	100 ¹	50 ¹	200 ¹	150 ¹	100 ¹
	50 ²	150 ²	100 ²	50 ²	200 ²	150 ²	100 ²
	25-50 ³	0	0	0	0	0	0
	25-50 ⁴	0	0	0	0	0	0

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Topdress when vines start to run

⁴ Topdress after first harvest

Note: For seedless watermelons, apply 125 pounds of N per acre. Higher rates of N may increase hollow heart in seedless watermelons.

Drip/Trickle Fertilization: see below for drip/trickle fertilization guides.

Seed Treatment

Check with seedsman to determine if seed has been treated with an insecticide and fungicide. If it has not been treated, use a mixture of thiram 75WP (½ teaspoon per pound or 3 ounces per 100 pounds) and an approved commercially available insecticide.

Plant Production

Transplants should be grown in pots or flats that provide a space of at least 1.52 inches by 2.02 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. The seed coat of seedless watermelons tends to adhere to the seedling as it emerges, at times slowing growth or reducing stand. Temperatures in the greenhouse should be maintained at 80° to 85°F (26.7° to 29.4°C). Seeded trays should be kept slightly drier than normal until 25 percent emergence, then resume normal watering.

The required amount of seed can then be estimated using Table R-2 and knowing how many seeds make up an ounce of the desired variety. See Table R-1 (Vegetable Seed Sizes).

Planting and Spacing

Transplants: Transplant container-grown plants through plastic mulch when daily mean temperatures have reached 60°F (15.6°C). Planting dates vary from May 1 in southern regions to June 20 in northern areas. Early plantings should be protected from winds with hot caps, tents, row covers, or rye strips.

Direct-seeded: Seed April 20 to May 15 in Virginia and normally warmer areas, and May 15 to June 10 in Pennsylvania and normally cooler areas. Seed 3 to 5 pounds of seed per acre.

The recommended spacing for watermelons is 6 to 8 feet between rows with 3 to 4 feet between plants in the row.

Seedless Varieties: Plant every third row with a pollinator variety to provide a 2:1 ratio of seedless to pollinators and assure good fruit.

Drip/Trickle Fertilization

Before mulching, adjust soil pH to around 6.5, apply enough farm-grade fertilizer to supply 50 pounds per acre of N, P₂O₅, and K₂O, then thoroughly incorporate into the soil.

After mulching and installing the trickle irrigation system, apply completely soluble fertilizers to supply 25 pounds (5 to 15 pounds in Pennsylvania) of N, P₂O₅, and K₂O per fertilized-mulched acre during each application. On soils testing low and low to medium in boron, also apply 0.25 pound of actual boron per fertilized-mulched acre in each soluble fertilizer application. **For convenience, rates of fertilizer nutrients can be converted from a mulched acre to linear foot basis. See Table C-8.**

The first soluble fertilizer application should be applied through the trickle irrigation system within 1 week after field transplanting the watermelons. The same rate of soluble fertilizer should be applied 2 weeks later. The third application should be made when the first fruit set. A fourth application needs to be applied 2 weeks before the first harvest. The fifth application should be applied right after the first harvest. To maintain good production late into the season, apply another application three weeks after the fifth complete fertilizer application. In Pennsylvania, do not exceed 80 pounds of nitrogen per acre per season.

Mulching

Fumigated soil aids in the control of weeds and soil-borne diseases. Clear, plastic mulch laid before field planting conserves moisture, increases soil temperature, and increases early and total yield. Plastic and fumigant--Vapam HL (30 to 37 gallons per acre)--should be applied on well-prepared planting beds 30 days before field planting. Plastic should be 4 feet wide (4,000-foot rolls) and laid on 6- or 8-foot centers 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 watermelons may not provide satisfactory weed control when used under clear plastic mulch on nonfumigated soil. Consult your county agent for latest recommendations. Black plastic or paper can be used without a herbicide. Fertilizer must be applied during bed preparation. At least 50 percent of the nitrogen (N) should be in the nitrate (NO₃) form.

Direct seeding through the mulch is recommended for maximum virus protection. Transplants should not be used with foil or other repellent mulches. Also, a herbicide is not necessary. Fumigation will be necessary when there is a history of soil-borne diseases in the field.

Pollination

Honeybees are important for proper set and pollination. 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 and/or Table D-6 for relative toxicity of various pesticides for hazard to bees.

Weed Control

Section 18 Emergency Label requests may be submitted to supplement weed control recommendations in watermelons.

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field. See "Mulching" section above for further information on weed control under clear plastic mulch.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

For Weed Control Under Plastic Mulch

Black plastic mulch effectively controls most annual weeds by preventing light from reaching the germinated seedling. Herbicides are used under plastic mulch to control weeds around the planting hole, and under the mulch when clear plastic is used. Trickle irrigation tube left on the soil surface may cause weed problems by leaching herbicide away at the emitters. The problem is most serious when clear plastic mulch is used. Bury the trickle tube several inches deep in the bed to reduce this problem.

1. Complete soil tillage, and form raised beds, if desired, prior to applying herbicide(s). Do not apply residual herbicides before forming beds, or herbicide rate and depth of incorporation may be increased, raising the risk of crop injury. When beds are formed and plastic mulch laid in a single pass, the herbicide should be applied after the bed is formed, as a part of the same operation.
2. Apply herbicide(s) recommended for use under plastic mulch in a band as wide as the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Use the trickle irrigation to provide moisture if the soil is too dry for condensation to form on the underside of the mulch.
3. Complete by laying the plastic mulch and trickle irrigation tubing, if used, immediately after the herbicide application. Delay punching the planting holes until seeding or transplanting.

Note: All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E preemergence in a band under the plastic, immediately before laying the mulch. Condensation that forms on the underside of the mulch will activate the herbicide. Annual grasses and certain annual broadleaf weeds will be suppressed or controlled under the mulch and around the plant hole. Use the maximum recommended rate to improve control of annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Halosulfuron--0.023-0.031 lb/A. Apply 0.5 to 0.75 of a dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Condensation that forms on the underside of the mulch will activate the herbicide. Delay seeding or transplanting the crop for 7 days after the application of Sandea under plastic mulch. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this

mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.75 dry ounces of Sandea, applied preemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year. Observe a 57 day PHI (PreHarvest Interval).**

Terbacil—0.1-0.2 lb/A. Apply 2 to 4 dry ounces of Sinbar 80WP preemergence in a band under the plastic, immediately before laying the mulch, to control many annual broadleaf weeds under the mulch and around the planting hole. Sinbar will not control pigweed species. Condensation that forms on the underside of the mulch will activate the herbicide. Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. Sinbar may be used for direct seeded or transplanted watermelons. **Do NOT apply "over the top" or allow spray to contact crop foliage, or injury may result. Observe a 70 day PHI (PreHarvest Interval).**

For Soil Strips Between Rows of Plastic Mulch (Directed and Shielded Band Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop to treat **Soil Strips Between Rows of Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil preparation, apply herbicide(s) under the mulch (see above), and lay plastic and trickle irrigation (optional) before herbicide application between the rows.
2. Spray preemergence herbicide(s), registered and recommended for use on the crop in bands onto the soil and the shoulders of the plastic mulch before planting and weeds germinate, **OR** apply after planting as a shielded spray combined with a postemergence herbicide to control emerged weeds. **DO NOT broadcast spray over the plastic mulch at any time!**
3. Incorporate preemergence herbicide into the soil with ½ to 1 inch of rainfall or overhead irrigation within 48 hours of application.
4. Apply Gramoxone in bands to the soil strips between the plastic mulch before the crop emerges or is transplanted, **AND/OR** as a shielded spray postemergence to control emerged weeds. Use in combination with residual herbicides that are registered for use.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E as a banded directed shielded spray preemergence to the weeds and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum recommended rate preemergence followed by

irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Naptalam--2 lb/A. Apply 1 gallon per acre Alanap 2SC preemergence as a banded directed shielded spray before seeding or transplanting. Weed control may not be satisfactory on sandy soils with less than 1 percent organic matter.

Bensulide plus naptalam--5-6 lb/A plus 2 lb/A. Apply 5 to 6 quarts Prefar 4EC plus 1 gallon Alanap 2SC as a banded directed shielded spray preemergence as a banded directed spray before seeding or transplanting. Tank mix is approved.

Clomazone--0.094-0.188 lb/A. Apply 4 to 8 fluid ounces per acre Command 3ME as a banded directed shielded spray preemergence to the weeds to control annual grasses and many broadleaf weeds including common lambsquarter, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use, or use Strategy, the jug-mix that contains clomazone (Command) and ethalfluralin (Curbit).

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfluralin--0.38-0.75 lb/A. Apply 1 to 2 pints per acre Curbit 3E as a banded directed shielded spray preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarter, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfluralin plus Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC as a banded directed shielded spray preemergence to control annual grasses and many annual broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfluralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart below to determine the amount of each herbicide at commonly used rates:

Curbit and Command Active Ingredients (ai) in Commonly Used Strategy Rates

Strategy pints/A	Ethalfluralin (Curbit) lb ai/A	Clomazone (Command) lb ai/A
1.5	0.3	0.094
2	0.4	0.125
3	0.6	0.188
4	0.8	0.25
5	1.0	0.312
6	1.2	0.375

Labeled for use in all the mid-Atlantic states. Read and follow all the recommendations and warnings (above) for ethalfluralin (Curbit) and clomazone (Command).

Halosulfuron--0.023-0.047 lb/A. Apply 0.5 to 1.0 dry ounce Sandea 75WG as a banded directed shielded spray between rows of plastic mulch to suppress or control broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. Do NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application. **DO NOT exceed a total of 0.047 pound per acre, equal to 1 dry ounce of Sandea, applied preemergence. Do NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, in a 1 year (12 month) period.**

Terbacil--0.1-0.2 lb/A. Apply 2 to 4 dry ounces of Sinbar 80WP preemergence as a banded, shielded, directed spray between rows of plastic mulch to control many annual broadleaf weeds. Sinbar will not control pigweed species. Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. Sinbar may be used for direct seeded or transplanted watermelons. **Do NOT apply "over the top" or allow spray to contact crop foliage, or injury may result. Observe a 70 day PHI (PreHarvest Interval).**

Postemergence

Halosulfuron--0.023-0.031 lb/A. Apply 0.5 to 0.66 dry ounce Sandea 75WG as a banded, shielded, directed spray between rows of plastic mulch to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot pigweed, smooth pigweed, ragweed species, and galinsoga when the crop has 2 to 5 true leaves but has not yet begun to bloom or run. Sandea applied postemergence will not control common lambsquarter or eastern black nightshade. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution). Do NOT use oil concentrate. Susceptible broadleaf weeds usually exhibit injury symptoms within 1 to 2 weeks of treatment. Typical symptoms begin as yellowing in the growing point that spreads to the entire plant and is followed by death of the weed. Injury symptoms are similar when yellow nutsedge is treated but may require 2 to 3 weeks to become evident and up to a month for the weed to die. Occasionally, slight yellowing of the crop may be observed within a week of Sandea application. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. Do NOT apply Sandea to crops treated with a soil applied organophosphate (OP) insecticide, or use a foliar applied organophosphate (OP) insecticide within 21 days before or 7 days after a Sandea application. DO NOT exceed a total of **0.031 pound per acre, equal to 0.66 dry ounces of Sandea, applied postemergence. Do NOT exceed total of 0.094 pounds per acre, equal to 2.0 dry ounces of Sandea per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, in a 1 year (12 month) period.**

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC postemergence as a banded directed shielded spray between the rows of plastic mulch in Delaware, Maryland, New Jersey, Pennsylvania, and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a banded directed shielded spray to control emerged weeds between the rows after crop establishment. Add nonionic surfactant according to the labeled instructions. Do not allow spray or spray drift to contact the crop or injury may result. Use shields to prevent spray contact with the crop plants. Do not exceed a spray pressure of 30 psi. See the label for additional information and warnings.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the

risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence as a banded directed shielded spray to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

For Seeding Into Soil Without Plastic Mulch (Broadcast Applications)

Use the following land preparation, treatment, planting sequences, and herbicides labeled for the crop when **Seeding into Soil Without Plastic Mulch**, or crop injury and/or poor weed control may result.

1. Complete soil tillage, apply preplant incorporated herbicide(s), and incorporate. Use a finishing disk or field cultivator that sweeps at least 100% of the soil surface twice, at right angles, operated at a minimum of 7 miles per hour (mph), OR a PTO driven implement once, operated at less than 2 miles per hour (mph).
2. Seed and apply preemergence herbicide(s) immediately after completing soil tillage, and mechanical incorporation of preplant herbicides. If rainfall does not occur, irrigate to move the herbicide into the soil and improve availability to germinating weed seeds within 2 days of when the field was last tilled, or plan to control escaped weeds by other methods.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Preplant Incorporated or Preemergence

Bensulide--5-6 lb/A. Apply 5 to 6 quarts per acre Prefar 4E before planting and incorporate 1 to 2 inches deep with power-driven rotary cultivators, or apply preemergence and activate with one-half inch of sprinkler irrigation within 36 hours to control most annual grasses. Use the maximum

recommended rate preemergence followed by irrigation to suppress certain annual broadleaf weeds including common lambsquarter, smooth pigweed, and common purslane.

Naptalam--2 lb/A. Apply 1 gallon per acre Alanap 2SC as a preplant incorporated (2 inches) treatment before seeding or transplanting or as a preemergence treatment after seeding. Weed control may not be satisfactory on sandy soils with less than 1 percent organic matter.

Bensulide *plus* naptalam--5-6 lb/A *plus* 2 lb/A. Apply 5 to 6 quarts Prefar 4EC *plus* 1 gallon Alanap 2SC as a preplant incorporated (2 inches or less) treatment before seeding or transplanting or as a preemergence treatment after seeding. Tank mix is approved.

Preemergence

Clomazone--0.094-0.188 lb/A. Apply 4 to 8 fluid ounces per acre Command 3ME preemergence to a direct-seeded crop to control annual grasses and many broadleaf weeds including common lambsquarter, velvetleaf, spurred anoda, and jimsonweed. Mustards, morningglory species, and pigweed species will not be controlled. Use lowest recommended rate on coarse-textured, sandy soils low in organic matter. Higher rates should only be used on medium- and fine-textured soils and sites that have been heavily manured. Combine with Curbit 3EC to control pigweed species where Curbit is registered for use. Some temporary crop injury (partial whitening of leaf or stem tissue) may be apparent after crop emergence. Complete recovery will occur from minor early injury without affecting yield or earliness. Banding the herbicide reduces the risk of crop injury and offsite movement due to vapor drift.

WARNING: Command spray or vapor drift may injure sensitive crops and other vegetation up to several hundred yards from the point of application. Do not apply when wind or weather conditions favor herbicide drift. Do not apply to fields adjacent to horticultural, fruit, vegetable, or other sensitive crops (see label). Drift injury from offsite Command movement is extremely apparent; therefore, do not use Command on fields near sensitive locations.

Herbicide residues may limit subsequent cropping options when Command is used for weed control in cucumbers. See planting restrictions on the label or consult your local Cooperative Extension office for information regarding subsequent cropping options when Command is used.

Ethalfuralin--0.38-0.75 lb/A. Apply 1 to 2 pints per acre Curbit 3E preemergence to control annual grasses and certain annual broadleaf weeds, including carpetweed and pigweed sp. Control of many other broadleaf weeds, including common lambsquarter, jimsonweed, morningglory sp., ragweed sp., mustard sp., and others may not be acceptable. Dry weather following application may reduce weed control. Cultivate to control emerged weeds if rainfall or irrigation does not occur prior to weed emergence. DO NOT preplant incorporate. DO NOT apply under plastic mulch or tunnels. DO NOT use when soils are cold or wet. Crop injury may result!

Ethalfuralin *plus* Clomazone (jug-mix)--0.394-1.575 lb/A. Apply 1.5 to 6 pints per acre of Strategy 2.1SC preemergence to control annual grasses and many annual

broadleaf weeds. Use the lowest recommended rates on coarse-textured sandy soils low in organic matter. Higher rates should only be used on medium and fine textured soils and sites that have been heavily manured.

Strategy is a **jug-mix** of ethalfuralin (Curbit 3E) and clomazone (Command 3ME). Refer to the chart under Ethalfuralin *plus* clomazone (jug-mix) in the section **For Soil Strips Between Rows of Plastic Mulch** to determine the amount of each herbicide at commonly used rates.

Read and follow all the recommendations and warnings (above) for ethalfuralin (Curbit) and clomazone (Command).

Halosulfuron--0.023-0.031 lb/A. Apply 0.5 to 0.75 dry ounce Sandea 75WG to suppress or control yellow nutsedge and broadleaf weeds including common cocklebur, redroot, pigweed, smooth pigweed, ragweed species, and galinsoga. Use the lower rate on coarse-textured soils low in organic matter and higher rates on fine-textured soils and on soils with high organic matter. Rainfall or irrigation after application is necessary before weeds emerge to obtain good control. Occasionally, slight stunting may be observed following Sandea use early in the season. When observed, recovery is rapid with no effect on yield or maturity. Sandea is an ALS inhibitor. Herbicides with this mode of action have a single site of activity in susceptible weeds. The risk of the development of resistant weed populations is high when herbicides with this mode of action are used continuously and exclusively to control a weed species for several years or in consecutive crops in a rotation. Integrate mechanical methods of control and use herbicides with a different mode of action to control the target broadleaf weeds when growing other crops in the rotation. DO NOT apply Sandea to crops treated with a soil applied organophosphate insecticide, or use a foliar applied organophosphate insecticide within 21 days before or 7 days after a Sandea application.. **DO NOT exceed a total of 0.031 pound per acre, equal to 0.75 dry ounces of Sandea, applied preemergence, per crop-cycle. DO NOT exceed a total of 0.094 pound per acre, equal to 2 dry ounces of Sandea, applied preemergence and postemergence to multiple crops in a single year.**

Terbacil--0.1-0.2 lb/A. Apply 2 to 4 dry ounces of Sinbar 80WP preemergence to control many annual broadleaf weeds under the mulch and around the planting hole. Sinbar will not control pigweed species. Use the lower rate on fields with coarse-textured soils low in organic matter. Use the higher rates on fields with fine-textured soil and those with high organic matter. Sinbar may be used for direct seeded or transplanted watermelons. Apply to seeded watermelons after planting, but before emergence. Apply to transplanted watermelons before transplanting (PRE-transplant). **Do NOT apply "over the top" or allow spray to contact crop foliage, or injury may result. Observe a 70 day PHI (PreHarvest Interval).**

Postemergence

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual

bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days.

Sethoxydim--0.2-0.3 lb/A. Apply 1 to 1.5 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 14 days and apply no more than 3 pints per acre in one season.

Postharvest

With or Without Plastic Mulch

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use of Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. Use to prepare plastic mulch for replanting, or to aid in the removal of the mulch. See the label for additional information and warnings.

Note. All herbicide rate recommendations are made for spraying a broadcast acre (43,560 ft²).

Pollination

Honeybees, squash bees, bumblebees and other wild bees are important for proper set and pollination. 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 and/or Table D-6 for relative toxicity of various pesticides for hazard to bees.

Insect Control

Seed Corn Maggot

Maggot problems can occur in the field and in transplant bedding trays in the greenhouse. Commercial seed treated with lindane/capthion will not be protected from maggot

infestations. An application of a soil-incorporated insecticide may be needed immediately before planting. Also, see "Maggots" section in Soil Pests--Their Detection and Control. **Note.** The use of imidacloprid at planting may reduce seed corn maggot populations.

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.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--2.4-2.8 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
imidacloprid (soil)--see label for rates and application methods, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A,
Platinum--5-8 oz 2SG/A.
Sevin--1.25 lb 80S/A or OLF, or
Thionex--0.67-1.33 qt 3EC/A or OLF

Cutworms (Also see the "Cutworms" section in Soil Pests--Their Detection and Control.)

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--0.8-1.6 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A

Pickleworm, Melonworm

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

Asana XL--5.8-9.6 fl oz 0.66EC/A (pickleworm only), or
Avaunt--2.5-6 oz 30WDG/A, or
Baythroid XL--1.6-2.4 fl oz /A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-10 fl oz 2F/A, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A, or
Radiant--5-10 fl oz SC/A, or
Sevin--1.25 lb 80S/A or OLF, or
SpinTor--4-8 fl oz 2SC/A, or
Thionex--0.67-1.33 qt 3EC/A or OLF

Aphids

Note. Aphids transmit mosaic virus. 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.

Actara--1.5-3.0 oz 25WDG/A, or
Beleaf--50 SG (see label for rate), or
Fulfill--2.75 oz 50WP/A, or
imidacloprid (soil)--see label for rates and application methods, or
Lannate--1.5-3 pt LV/A or OLF (Melon Aphid only), or
Metasystox-R--1.5-2 pt 2SC/A (GPA only), or
Platinum--5-8 oz 2SG/A, or
Thionex--0.67-1.33 qt 3EC/A or OLF, or
Venom--5-6 oz (soil); 1-4 oz (foliar) 70SG/A

Leafminers

abamectin (Agri-mek;generics available)--8-16 fl oz
0.15EC/A, or
dimethoate--1 pt 4EC/A or OLF, or
Entrust--2-2.5 oz 80W/A, or
permethrin--4-8 fl oz 3.2EC/A, or
SpinTor--6-8 fl oz 2SC/A, or
Venom--1-4 oz (foliar); 5-6 oz (soil) 70SG/A, or
Vydate L--2-4 pt 2L/A

Rindworms (Cucumber Beetle Larvae.)

Damage to the rinds may result from a complex of insects including cucumber beetle, wireworms, and a number of "worm species, (beet army worm, etc). Management of adult cucumber beetles early in the season may help reduce damage. See cucumber beetle and beet armyworm sections for labeled products.

Beet Armyworm

Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-10 fl oz 2F/A, or
Spintor--4-8 fl oz 2SC/A

Cabbage Looper

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Bacillus thuringiensis--Consult label for rates and restrictions, or
Baythroid XL--1.6-2.4 fl oz/A, or
bifenthrin--2.6-6.4 fl oz 2EC/A or OLF, or
Entrust--1.25-2.5 oz 80W/A, or
Intrepid--4-10 fl oz 2F/A, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
Lannate--1.5-3 pt LV/A or OLF, or
permethrin--4-8 fl oz 3.2EC/A, or
Radiant--5-10 80W/A, or
SpinTor--4-8 fl oz 2SC/A

Mites

Mite infestations generally begin around field margins and grassy areas. CAUTION: DO NOT mow or maintain these areas after midsummer since this forces mites into the crop. Localized infestations can be spot treated. Begin treatment when 10 to 15 percent of the crown leaves are infested early in the season, or when 50 percent of the terminal leaves are infested later in the season.

Note. Continuous use of Furadan, Sevin, or the pyrethroids may result in mite outbreaks.

Acramite--0.75-1.0 lb 50WS/A, or
abamectin (Agri-mek;generics available)--8-16 fl oz
0.15EC/A, or
bifenthrin--5.12-6.4 fl oz 2EC/A or OLF, or
Danitol--10.66-16.0 fl oz 2.4EC/A, or
Oberon--7-8.5 fl oz 2SC/A

Note. Use of dimethoate for leafminer control will reduce the mite population.

Thrips

Entrust--2-2.5 oz 80W/A, or
lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or
SpinTor--6-8 fl oz 2SC/A, or
Venom--1-4 fl oz (foliar); 5-6 fl oz (soil) 70SG/A, or
Vydate--2-4 pt. 2L/A

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
INSECTICIDE			
Acramite	G	12	3
abamectin (Agri-mek)	R	12	7
Actara	G	12	0
Asana XL	R	12	3
Avaunt	G	12	3
<i>Bacillus thuringiensis</i>	G	4	0
Baythroid XL	R	12	0
Beleaf	G	12	0
bifenthrin	R	12	3
Danitol	R	24	7
dimethoate	R	48	3
Entrust	G	4	3
Fulfill	G	12	0
Guthion	R	4 days	7
imidacloprid	G	12	21
lambda-cyhalothrin	R	24	1
Lannate	R	48	3
Metasystox-R	R	48	7
Oberon	G	12	7
Platinum	G	12	30
permethrin	R	12	0
Radiant	G	4	3
Sevin	G	12	3
SpinTor	G	4	3
Thionex	R	24	2
Venom(soil/foliar)	G	12	21/1
Vydate L	R	48	1
FUNGICIDE (FRAC code)			
Cabrio (Group 11)	G	12	0
chlorothalonil (Group M5)	G	12	0
copper, fixed (Group M1)	G	24	0
Curzate (Group 27)	G	12	3
Flouronil (Groups 4 + M5)	G	48	14
Forum (Group 40)	G	12	0
Gavel (Groups 22 + M3)	G	48	5
Mancozeb (Group M3)	G	24	5
Nova (Group 3)	G	24	0
Previcur Flex (Group 28)	G	12	2
Pristine (Groups 11 + 7)	G	48	0
Procure (Group 3)	G	12	0
Quadris (Group 11)	G	4	1
Quintec (Group 13)	G	12	3
Ranman (Group 21)	G	12	0
Reason (Group 11)	G	12	14
Ridomil Gold (Group 4)	G	48	0
Ridomil Gold Bravo (Groups 4 + M5)	G	48	0
Ridomil Gold Copper (Groups 4 + M1)	G	48	5
Tanos (Groups 11 + 7)	G	12	3
Topsin M (Group 1)	G	12	0
Ultra Flourish (Group 4)	G	48	0

See Table D-6.

¹ G = general, R = restricted

Nematode Control

See "Nematodes" section of Soil Pests-Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section

Apply Vydate L--1-2 gal 2L/A. Incorporate into the top 2 to 4 inches of soil or 2 to 4 pints 2L per acre applied 2 weeks after planting and repeat 2 to 3 weeks later.

Disease Control

Damping-Off

Apply the following in a 7-inch band at planting. Use formula in the "Calibration for Changing from Broadcast to Band Application" section of Calibrating Granular Application Equipment to determine amount of Ridomil Gold or Ultra Flourish needed per acre.

mefenoxam--1-2 pt Ridomil Gold 4E/A or 2-4 pt Ultra Flourish 2E/A, or
metalaxyl--4-8 pt MetaStar 2E

Bacterial Fruit Blotch

Obtain disease-free seed or seedlings. Practice good sanitation during transplant production. Segregate different seed lots in the transplant house to reduce the chance of cross contamination. Use of infected transplants is risky. If possible, use only transplants from houses in which there were no seedling symptoms of the fruit blotch disease. Rotate to allow 2 years between watermelon plantings. Apply the following fungicide beginning at first bloom and repeat every 7 days:

copper, fixed--at labeled rates, or
Tanos--8-10 oz 50WDG/A (for suppression only)

Viruses (CMV, WMV2, PRSV [WMV1], and ZYMV)

Plant fields as far away from existing cucurbit plantings as possible to prevent aphid transmission of viruses from existing fields to new fields.

Ozone Injury

Ozone will cause chlorosis and upper surface bronzing and scorching on the older leaves, which leads to defoliation. Sugar Baby is one of the more sensitive varieties.

Fusarium Wilt

Use a long rotation of at least 5 years and resistant varieties when possible. The varieties 'Seedless Sangria' and 'Revolution' are the only seedless varieties that have been tested in the region that are tolerant to Fusarium wilt resulting from race 2. 'Royal Majesty' is a seeded variety with tolerance to race 2. Do not plant other watermelon varieties in fields where race 2 is present.

Anthracnose

Excellent resistance is available in some varieties. Use resistant varieties when possible. Begin fungicide applications when vines run or earlier if symptoms are detected.

Under light or moderate disease pressure:

Alternate:

chlorothalonil--2-3 pt 6F/A or OLF (Use low rate early in season), *plus* thiophanate-methyl--0.5 lb 70WP/A

With:

chlorothalonil alone at 2 – 3 pt/A or

Under high disease pressure:

tank mix chlorothalonil with one of the following FRAC code 11 fungicides:
Pristine--18.5 oz 38WG/A, or
Quadris--11-15.4 fl oz 2.08F/A, or
Cabrio--12-16 oz 20EG/A, or
Tanos--8 oz 50 DF/A (must be tank mixed with either chlorothalonil, mancozeb, or copper)

If resistance to FRAC code 11 (strobilurin) fungicides has been detected in the area, do not use Quadris, Tanos or Cabrio.

Downy Mildew

Scout fields for disease incidence on a regular basis. Begin sprays when vines run or if disease occurrence is predicted for the region. Refer to the Cucurbit Downy Mildew Forecasting website (www.ces.ncsu.edu/depts/pp/cucurbit/) for current status of the disease. Preventative applications are much more effective than applications made after disease is detected. The following are the most effective materials (tank mix these products with a protectant fungicide such as chlorothalonil--1.5-2 pt 6F/A or OLF):

Ranman--2.1-2.75 fl oz. 400SC/A, or
Previcur Flex--1.2 pt 6F/A, or
Gavel--1.5-2.0 lb 75DF/A (Gavel contains mancozeb, which is a protectant, and does not need a tank mix partner.), or
Curzate--3.2 oz 60DF/A, or
Tanos--8 oz 50DF/A

Materials with different Modes of Action (FRAC groups) should be alternated.

Sprays should be applied on a 7-day schedule. Cabrio, Pristine and Tanos should not be alternated with each other or used consecutively. Under severe disease conditions spray may be reduced if label allows.

Alternaria Leaf Blight.

Begin sprays when vines begin to run.

Alternate:

chlorothalonil--2-3 pt 6F/A, or OLF (Use low rate early in season)

With:

Pristine--12.5-18.5 oz 38W/A, or
a tank mix of chlorothalonil *plus* one of the following every 14 days:

Quadris--11-15.4 fl oz 2.08F/A, or
Cabrio--12-16 oz 20EG/A, or
Reason--5.5 fl oz 500SC/A

If resistance to FRAC code 11 fungicides exist in the area, do not use Cabrio, Pristine or Quadris. Use a fungicide from a different FRAC group.

Gummy Stem Blight

Gummy stem blight occurs primarily in the late summer. Fungicides with a high-risk for resistance development such as FRAC code 11 fungicides (Cabrio, Pristine and Quadris) should be tank-mixed with a protectant fungicide (see Table E-8). When tank-mixing use at least the minimum labeled rate of each fungicide in the tank mix. Do not apply FRAC code 11 fungicides more than 4 times total per season. If resistance to FRAC code 11 fungicides exists in the area, do not apply. Use fungicides from a different FRAC code.

Under low disease pressure:

Apply chlorothalonil every 7 days at 2-3 pt/A

Under high disease pressure:

Alternate:

chlorothalonil--2-3 pt 6F/A or OLF

With:

Pristine--12.5-18.5 oz 38W/A plus chlorothalonil

Phytophthora Blight.

To minimize the occurrence of this disease, watermelon should be grown on raised beds and fields should be adequately drained to ensure that soil water does not accumulate around the base of the plants. In addition, when the vines begin to run, subsoil between rows to allow for faster drainage following rainfall. Apply the following when conditions favor disease development and always tank mix with copper. These materials will provide suppression only:

Forum--6.0 oz 4.18SC/A or

Gavel--1.5-2 lb 75DF/A, or

Tanos--8-10 oz 50DF/A plus mancozeb, or

Ranman--2.75 fl oz 400 SC/A plus an adjuvant (see label for details)

Powdery mildew

This disease was observed for the past few seasons in Delaware and Maryland and could occur in other States. Detection of powdery mildew is more difficult in watermelons than in other cucurbits because sporulation is

sparse and masked by leaf color. Look for chlorotic spots on upper leaf surface of young, fully expanded leaves, and then inspect the corresponding lower leaf surface with a hand lens to confirm presence of the fungus.

The fungus that causes cucurbit powdery mildew can develop resistance to several different groups of fungicides.

Resistance to strobilurin (FRAC code 11) and DMI (FRAC code 3) fungicides have been reported in the Eastern US, therefore proper fungicide resistance management should be followed.

Powdery mildew generally occurs from mid-July until the end of the season. Observe fields for the presence of powdery mildew. If one lesion is found on the underside of 45 old leaves, begin the following fungicide program:

Alternate:

Nova--5 oz 40WP/A plus chlorothalonil, or

Procure--4-8 oz 50WS/A plus chlorothalonil

With:

Quintec – 6 oz 2.08F plus chlorothalonil, or

Pristine--12.5-18.5 oz 38WG/A plus chlorothalonil

WHITE POTATOES

Varieties

Varieties ¹	DE	MD	NJ	PA	VA	Table Stock	Chipping	Yield	Spacing
Early									
Andover			N	P		+++	+++	+	9-10
Michigan Purple (purple skin)				P		++	No	++	8-10
Dark Red Norland D	D		N	P	V	++	No	+	8-10
Superior (SR,VS)	D	M	N	P	V	+++	+	++	8-12
Midseason									
Atlantic ²	D	M	N	P	V	No	+++	+++	7-9
Chieftain (red skin)				P		++	No	++	7-9
Eva	D			P		++	++	++	8-10
Harley Blackwell	D		N			++	+++	++	9-12
Kanona				P		++	++	++	8-10
Kueka Gold (pale yellow flesh)				P		++	+	+++	9-10
NorDonna (red skin)(trial)			N	P	V	++	No	++	9-12
Norkotah Russet	D		N	P	V	++	No	+	9-12
NYE 11-45				P		+++	+++	+++	9-10
Reba ³	D		N	P	V	+++	++	++	7-9
Yukon Gold ³ (yellow flesh)	D		N	P	V	+++	No	++	8-10
Late									
Katahdin (LR)	D	M	N	P		++	No	+++	8-10
Kennebec (VS,LBT)(not for eastern Virginia)		M		P	V	++	No	+++	7-10
Marcy (NY112)	D		N			++	+++	+++	7-9
Norwis (EBR)(slight yellow flesh)	D		N	P		++	++	+++	7-9
Snowden	D		N	P	V	No	+++	++	12-14

+ = fair ++ = good +++ = excellent

¹ Varieties are listed alphabetically within maturity group.

² Tubers of the chipping variety "Atlantic" are extremely susceptible to internal necrosis and hollow heart.

³ Tubers of "Reba" and "Yukon Gold" are susceptible to hollow heart during cool growing seasons. Apply one-third of the nitrogen at planting and sidedress the remainder when plants are 4 to 6 inches high to help reduce hollow heart.

Letters in parentheses indicate disease resistance possessed by varieties. See the "Abbreviations" section in front portion of this publication.

Recommended Nutrients Based on Soil Tests

Before using the table below, refer to important notes in Plant Nutrient Recommendations in Section B, Soil And Nutrient Information. These notes provide additional suggestions to adjust rate, timing and placement of nutrients depending on soil type cation exchange capacity and existing fertility levels.

White Potatoes	Nitrogen (N) Pounds per Acre	Soil Phosphorus Level			Soil Potassium Level		
		Low	Med	Opt.	Low	Med	Opt.
		Pounds P ₂ O ₅ per Acre			Pounds K ₂ O per Acre		
Sandy loams and Loamy sands	150 ¹ 50 ² 100 ⁴	200 ¹ 200 ² 0	150 ¹ 150 ² 0	100 ¹ 100 ² 0	300 ¹ 300 ² 0	200 ¹ 200 ² 0	100 ¹ 100 ² 0
Loams and silt loams	125-150 ¹ 50 ² 75-100 ³	200 ¹ 100 ² 100 ³	150 ¹ 100 ² 50 ³	100 ¹ 0 100 ³	300 ¹ 200 ² 100 ³	200 ¹ 100 ² 100 ³	100 ¹ 0 100 ³

¹ Total amount nutrient recommended

² Broadcast and disk-in

³ Band place with planter

⁴ Sidedress 4-5 weeks after planting

Note: Additions of 30 pounds of P₂O₅ and K₂O may be applied to replace nutrients removed by the crop when soil test levels are above optimum (high).

Apply 1 pound of boron (B) per acre if soil test for B is low.

Planting and Spacing

The recommended planting dates for potatoes are March 10 to April 5 in Maryland and Virginia, March 20 to April 15 in Delaware, and March 20 to April 25 in New Jersey. In Pennsylvania, the recommended planting dates are March 25 to June 5.

Space seed 7 to 12 inches apart in 34- or 36-inch rows. Use close spacing for large, cut seed pieces and wider spacing for whole (B-size) seed. Use close spacing for potatoes to be 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. Give seed potatoes a warming-up (65° to 70°F [18.3° to 21.1°C]) period of 2 to 3 weeks before planting to encourage rapid emergence. Plant seed pieces immediately after cutting or store under conditions suitable for rapid healing of the cut surfaces (60° to 70°F [15.6° to 21.1°C] plus high humidity). Dust seed pieces immediately after cutting. Some fungicide seed-piece treatments are formulated with fir or alder bark. Bark formulations have been effective treatments. Use one of the following:

For *Fusarium spp.*:

captan--1 lb 7.5D/cwt or OLF, or
maneb*--1 lb 8D/cwt or OLF, or
Polyram--1 lb 7D/cwt or OLF

For *Fusarium spp. and Rhizoctonia spp.*:

Maxim--0.5 lb 0.5D/cwt, or
Maxim MZ*--0.5 lb/cwt
MonCoat MZ*--0.75-1 lb 7.5D/cwt, or
Tops--1 lb 2.5D/cwt, or
Tops MZ*--0.75-1 lb 8.5 D/cwt, or

Evolve* (thiophante-methyl, mancozeb and cymoxanil)--0.75 lb/cwt

For aphids, Colorado potato beetle, flea beetle and potato leafhopper

Cruiser 5FS--see label for application directions and rates,
or

Tops MZ Gaucho--12 oz/cwt

*Seed-piece fungicides that contain EBDC fungicides or cymoxanil also provide protection against seedborne late blight infections.

Weed Control

Identify the weeds in each field and select recommended herbicides that control those weeds. See Tables E-2 and E-3.

Match preplant incorporated and preemergence herbicide rates to soil type and percent organic matter in each field.

Apply postemergence herbicides when crop and weeds are within the recommended size and/or leaf stage.

Glyphosate--1.5-3.75 lb acid equivalent/A. Apply 3.2 to 8.1 pints per acre Roundup Ultra Max 4SC, 4 to 10 pints per acre Touchdown or 4 to 10 pints per acre Glyphomax Plus in the fall after harvest to control perennial grasses and broadleaf weeds, including quackgrass, field bindweed, Canada thistle, and others. Delay application after harvest to allow for adequate weed regrowth to intercept the spray. Apply before frost to weeds with cold-sensitive foliage. Do not till or mow for 1 week after application. Consult the label for additional details and the rate to use for each weed species.

Preemergence/Drag-Off

EPTC--3-4.5 lb/A. Apply 3.4 to 5.1 pints per acre Eptam 7E or 30 to 45 pounds per acre of Eptam 10G at one of the times listed below.

1. Just before planting and disking. This treatment is best for early season control of nutsedge and other weeds, but on plantings before April 1, it may reduce early vigor and yields slightly.
2. Just after "dragging off." Incorporate into soil in one or two cultivations with a spiketooth harrow or similar piece of equipment.
3. Just before first or second cultivation. This treatment is best for late-season control of nutsedge and other weeds. Do not apply within 45 days of harvest.

Primarily controls annual grasses, yellow nutsedge, and a few broadleaf weeds. Use linuron or metribuzin according to recommendations after planting to increase the spectrum of broadleaf weeds controlled.

Linuron--0.4-1 lb/A. Apply 0.8 to 2 pounds per acre Lorox 50DF (or OLF) after planting or before potatoes emerge, but after final drag-off and before grasses are 2 inches tall and broadleaf weeds are 6 inches tall. Primarily controls broadleaf weeds. Tank-mix with Dual Magnum or Prowl, or use in addition to Eptam for preemergence annual grass control. Use lower rates if tank-mixed. Do not plant to crops not on the label for 4 months after treatment.

S-metolachlor--0.96-1.91 lb/A. Apply 1 to 2 pints per acre Dual Magnum 7.62E or Dual II Magnum 7.64E before potatoes emerge, but after final drag-off. Dual Magnum will primarily control annual grasses. Nutsedge (nutgrass,

coffeegrass) control may be adequate if weed pressure is light. Tank-mix Dual Magnum with linuron or metribuzin for broadleaf weed control. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Metribuzin--0.38-0.5 lb/A. Apply 0.5 to 0.66 pound per acre Sencor/Lexone 75DF (or OLF) (use comparable rates of liquid) just prior to emergence. If drag-off is practiced, then the application should be made after drag-off. Primarily controls broadleaf weeds. Tank-mix with Dual Magnum or Prowl, or use in addition to Eptam for preemergence annual grass control. Read label for rotation crop restrictions. Do not apply within 60 days of harvest.

Note. Preemergence application to Atlantic and Norland or to any early maturing, smooth, white- or red-skinned potato varieties, may cause crop injury, especially under adverse weather conditions and when higher labeled rates are used.

Pendimethalin--0.48-1.42 lb/A. Apply 1 to 3 pints per acre Prowl H₂O before potatoes emerge. Prowl primarily controls certain broadleaf weeds, including velvetleaf and early-season annual grasses, but does not control yellow nutsedge. Combine with Lorox to improve velvetleaf control, or with linuron or metribuzin to improve the control of most other broadleaf weeds.

Postemergence

Rimsulfuron--0.0156 lb/A. Apply 1 ounce per acre Matrix 25DF early postemergence to control many weeds including foxtail species, pigweed species, wild mustard, and wild radish. Common lambsquarter, common ragweed, jimsonweed, morningglory species, and yellow nutsedge may only be suppressed. Tank-mix with reduced rates of metribuzin, following label instructions, to increase the spectrum of weeds controlled. Repeat the application 2 to 4 weeks after the initial spray to improve the suppression or control of common purslane and perennial weeds, such as field and hedge bindweed. Results may be most effective when used following a preemergence residual weed control program. Add nonionic surfactant to be 0.25 percent of the spray solution (1 quart per 100 gallons of spray solution) to improve weed control. **DO NOT** exceed 2 ounces of Matrix 25DF per acre per year.

Rimsulfuron (Matrix 25DF) is an ALS inhibitor. Herbicides in this class have a single site of action in susceptible plants. Always use in combination with other herbicides with a different site of action in the plant to prevent the development of resistant weed populations. Read and follow label cautions and resistance management recommendations.

S-metolachlor--1.6 lb/A. Apply 1.67 pints Dual Magnum 7.62E as a directed spray after hilling/at lay-by to provide preemergence control of sensitive weeds for the remainder of the growing season. Emerged weeds will not be controlled. This treatment may be applied in addition to a previous (drag-off) application of Dual Magnum or Dual II Magnum, but do not apply more than 3.6 pints Dual Magnum per acre in one season. Maintain a 40-day preharvest interval between the after hilling/at lay-by application of Dual Magnum and harvest. **Other generic versions of metolachlor and s-metolachlor may be available, and may or may not be labeled for use in the crop.**

Metribuzin--0.25-0.5 lb/A. Apply 0.33 to 0.66 pound per

acre Lexone/Sencor 75DF (or OLF) before weeds are 1 inch tall. Primarily controls broadleaf weeds. Apply only if there have been at least three successive sunny days prior to application. Do not use on red-skinned or early maturing, smooth, white-skinned varieties. Treatment may cause some yellowing or minor burn. Read label for soil texture, crop rotation, and varietal restrictions.

Clethodim--0.094-0.125 lb/A. Apply 6 to 8 fluid ounces per acre Select 2EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) or 12 to 16 fluid ounces of Select Max 0.97EC with nonionic surfactant to be 0.25% of the spray solution (1 quart per 100 gallons of spray solution) postemergence to control many annual and certain perennial grasses, including annual bluegrass. Select will not consistently control goosegrass. The use of oil concentrate with Select 2EC may increase the risk of crop injury when hot or humid conditions prevail. To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days.

Sethoxydim--0.2-0.4 lb/A. Apply 1 to 2 pints per acre Poast 1.5EC with oil concentrate to be 1 percent of the spray solution (1 gallon per 100 gallons of spray solution) postemergence to control annual grasses and certain perennial grasses. **The use of oil concentrate may increase the risk of crop injury when hot or humid conditions prevail.** To reduce the risk of crop injury, omit additives or switch to nonionic surfactant when grasses are small and soil moisture is adequate. Control may be reduced if grasses are large or if hot, dry weather or drought conditions occur. For best results, treat annual grasses when they are actively growing and before tillers are present. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Do not tank-mix with or apply within 2 to 3 days of any other pesticide unless labeled, as the risk of crop injury may be increased, or reduced control of grasses may result. Observe a minimum preharvest interval of 30 days and apply no more than 5 pints per acre in one season.

Postharvest

Paraquat--0.6 lb/A. **A Special Local-Needs 24(c) label has been approved for the use Gramoxone Inteon 2SC for postharvest desiccation of the crop in Delaware, New Jersey and Virginia.** Apply 2.4 pints per acre Gramoxone Inteon 2SC as a broadcast spray after the last harvest. Add nonionic surfactant according to the labeled instructions. See the label for additional information and warnings.

Insect Control

Wireworms (Also see "Wireworms" section in Soil Pests--Their Detection and Control.)

Preplant Application

Mocap--40-60 lb 10G/A. Broadcast and incorporate just before planting

Note: A special local needs label (24-C) is in effect in Delaware for the use of diazinon AG500 on white potatoes for the control of wireworms. Apply 2 lb. 50W/A as a preplant broadcast application.

Planting Application

bifenthrin--19.2 fl oz 2EC/A, or
Mocap--30 lb 10G/A in the row or OLF, or
Regent--0.184-0.22 fl oz 4SC/A (rate depends on row spacing-see label) in-furrow only
Thimet--8.5-11.3 oz 20G/1000 ft of row (light soils) or 13-17.3 oz 20G/1000 ft row (heavy soils).

Lay-by Application

bifenthrin--3.2-9.6 fl oz 2EC/A

Foliar Application (for control of the adult stage of wireworms)

bifenthrin--2.1-6.4 fl oz 2EC/A

Cutworms (Also see "Cutworms" section in Soil Pests--Their Detection and Control.)

Cutworms are present during July and August. They are especially troublesome to tubers where soil cracking occurs. Variegated cutworms feed on lower leaves and petioles, and protective sprays should be applied if numbers exceed six worms per plant or foliar loss is more than 10 percent. Black cutworms are largely underground feeders, but will occasionally feed on leaves. No materials are effective if larvae do not feed aboveground (foliar and systemic insecticides are ineffective). Several spray applications may be required for control.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or
Baythroid XL--0.8-1.6 fl oz /A, or
lambda-cyhalothrin--1.92-3.2 fl oz 3/A or OLF, or
Lannate--1.5 pt LV/A (variegated cutworm only) or OLF, or
permethrin--4-8 fl oz 3.2EC/A, or
Renounce--1-2 oz 20WP or OLF, or
Sevin--2.5 lb 80S/A or OLF, or
Sevin Bait--40 lb 5% bait/A

Colorado Potato Beetle (CPB)*Pesticide Resistance Management*

Do not rely exclusively on the neonicotinoid class of insecticides (Class 4: Actara, Assail, Cruiser, Gaucho, imidacloprid, Platinum or Venom) for CPB control. It is important to use all available effective pest management strategies, including crop rotation, pest scouting, treatment thresholds, and alternative (different class) insecticides, such as abamectin, Avaunt plus PBO, cryolite, Entrust, Rimon, SpinTor, Thionex or Vydate.

For rotated fields adjacent to beetle overwintering sites or contiguous to previous year's potato fields, most of the colonizing adults can be killed by treating only a strip of rows along the field edge where the invasion front is expected. Fields should still be monitored for beetles and other insect pests throughout the season.

Preplant or Planting Application

Cruiser--5SF (seed treatment only; see label for rates)

Gaucho Tops MZ--12 oz ST/100 lb. seed (seed treatment only), or

imidacloprid (soil)--see label for rates and application methods, or

Platinum--5-8 oz 2SG/A, or
Radiant--6-8 fl oz SC/A, or
Venom--6.5-7.5 oz 70SG/A

Postemergence Application

Rotation to nonsolanaceous crops (crops other than potato, tomato, eggplant, and pepper) is extremely important in reducing CPB problems. The further you can plant your fields from last year's solanaceous crop, the more beneficial it will be to 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 50 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. 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 percent defoliation without yield loss.

Note. Several of these insecticides may no longer be effective in certain areas due to CPB resistance. Check with your county Extension agent for most effective control.

Actara--1.5-3.0 oz 25WDG/A, or
abamectin (Agri-mek; generics available)--8-16 fl oz 0.15EC/A, or

Assail--1.5-4 oz 30SG/A, or
Avaunt--3.5-6.0 30WDG/A (Larvae only). The addition of 0.25 lb ai/A of the synergist piperonyl butoxide (PBO) is necessary when using Avaunt.

azadirachtin (Azatin, Ecozin, Neemix)--7-16 fl oz EC/A.
Apply when pests first appear and are in their early larval stages, or

Bacillus thuringiensis tenebrionis (Small CPB larvae only--Novodor)--Consult label for rates and restrictions. Make first application when eggs begin to hatch and repeat applications at 5- to 7-day intervals if small larvae are present. NOT effective against large larvae and adults. If rainfall occurs within 24 hours posttreatment, reapplication may be necessary. Larval reduction may not be noticeable for 48 to 72 hours after application, or
cryolite (Kryocide, Prokil cryolite)--10-12 lb 96WP/A, or
Entrust--1.0-2.0 oz 80W/A, or
imidacloprid (foliar)--see label for rates and application methods, or

Imidan--1.33 lb 70W/A (See chart below.), or
Rimon--9-12 fl oz 0.83 EC/A, or
SpinTor--3-6 fl oz 2SC/A, or
Thionex--0.66-1.33 qt 3EC/A or OLF, or
Venom--1-1.5 oz 70SG/A, or
Vydate L--1-4 pt 2L/A

Note: DO NOT use foliar applications of neonicotinoid insecticides (Actara, imidacloprid; Leverage or, Venom) in

fields treated with at planting neonicotinoids (Admire, generic imidacloprid, Platinum, or Venom).

Flea Beetles (FB), Potato Leafhoppers (PLH)

Monitor fields for the buildup of leafhoppers from early June until early August. Treatment is suggested if leafhopper counts exceed 1 adult per sweep or 1 nymph per 10 leaves.

Actara--1.5-3.0 oz 25WDG/A (PLH only). **Note.** Control may require 2 applications at 7- to 10-day intervals), or Asana XL--2.9-5.8 fl oz 0.66 EC/A (PLH) or 5.8-9.6 fl oz 0.66 EC/A (FB), or Assail--1.5-2.5 oz (FB); 1.5-4 oz (PLH) 30SG/A, or Baythroid XL--1.6-2.8 fl oz/A, or bifenthrin--2.1-6.4 fl oz 2EC/A, (FB only), or dimethoate--0.5-1 pt 4EC/A (leafhoppers only), or imidacloprid (soil, foliar for LH only)--see label for rates and application methods, or Imidan--2 lb 50WP/A, or lambda-cyhalothrin--see label for rates Lannate--1.5-3 pt LV/A or OLF, or Platinum--5-8 oz 2SG/A, or permethrin--4-8 fl oz 3.2EC/A, or Renounce--1-2 oz (PLH), 2-3.5 oz (FB) 20WP OLF, or Thionex--0.66-1.33 qt 3EC/A or OLF, or Venom--6.5-7.5 oz (soil); 1-1.5 oz (foliar) 70SG/A, or Vydate L--2-4 pt 2L/A

European Corn Borer (ECB)

Proper timing of ECB sprays is critical. Apply first spray when 10% of the stems have entry holes in fresh market varieties or 25% in processing varieties. Make two to three applications on a 5- to 10-day schedule. Consult your county Extension agent and/or area pest management newsletter.

Avaunt--3.5-6.0 oz 30WDG/A, or Baythroid XL--1.6-2.8 fl oz /A, or Furadan--1-2 pt 4F/A, or lambda-cyhalothrin--2.56-3.84 fl oz 3/A or OLF, or Monitor--1.5-2 pt 4EC/A, or PennCap-M--2-4 pt 2FM/A, or Radiant--6-8 fl oz SC/A, or Renounce--2-3.5 oz 20WP or OLF, or Rimon--9-12 fl oz 0.83, or SpinTor--3-6 fl oz 2SC/A

Note. If a pyrethroid (Asana XL, Baythroid XL, permethrin) is used for ECB control, make first application when 8 to 10 ECB moths are being trapped in local pheromone or blacklight traps. Apply two to three additional applications at 5- to 7-day intervals, based on moth activity.

Asana XL--5.8-9.6 fl oz 0.66EC/A, or permethrin--4-8 fl oz 3.2EC/A

Aphids

Insecticide treatments are recommended when aphid counts exceed 2 per leaf prior to bloom, 4 aphids per leaf during bloom, and 10 aphids per leaf within 2 weeks of vine kill.

Actara--3.0 oz 25WDG/A, or Assail--1.5-4.0 oz 30SG/A, or Beleaf--50 SG (see label for rates), or dimethoate (POA only)--0.5-1 pt 4EC/A, or Fulfill--2.75 oz 50WDG/A, or

imidacloprid (soil, foliar)--see label for rates and application methods, or

Lannate--1.5-3 pt LV/A or OLF, or Monitor--1.5-2 pt 4EC/A, or Platinum--5-8 oz 2SG/A, or Thionex--0.67-1.33 qt 3EC/A or OLF, or Venom--6.5-7.5 (soil); 1-1.5 oz (foliar) 70SG/A, or Vydate L--2-4 pt 2L/A

Potato Tuberworm

Note. Treat when foliage injury is first noted. Four to five applications at 7- to 14-day intervals may be needed. Tuberworms are primarily a problem on the fall crop.

Because moths are actively flying at dusk, sprays are most effective when applied early evening.

Asana XL--2.9-5.8 fl oz 0.66EC/A, or Baythroid XL--1.6-2.8 fl oz /A, or Lannate--1.5-3 pt LV/A or OLF, or Monitor--1.5-2.0 pt 4EC/A, or permethrin--4-8 fl oz 3.2EC/A, or OLF, or Renounce--2-3.5 oz 20WP or OLF

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
Actara	G	12	14
abamectin(Agri-mek)	R	12	14
Asana XL	R	12	7
Assail	G	12	7
Avaunt	G	12	7
azadirachtin	G	4	0
<i>Bacillus thuringiensis</i>	G	4	0
Baythroid XL	R	12	0
Beleaf	G	12	7
bifenthrin	R	12	21
Cruiser	G	12	At plant
cryolite	G	12	0
dimethoate	R(NJ),G	48	7
Entrust	G	4	7
Fulfill	G	12	14
Furadan 4F	R	48	14
Gaicho	G	12	At plant
imidacloprid (soil/foliar)	G	12	12/7
Imidan	G	24	7
lambda-cyhalothrin	R	24	7
Lannate	R	48	6
Mocap	R	48	At plant
Monitor	R	48	14
PennCap-M	R	5 days	5
Platinum	G	12	30
permethrin	R	12	14
Radiant	G	4	7
Regent	R	0	90
Renounce	R	12	0
Rimon	R	12	14
Sevin/Sevin Bait	G	12	7/12
SpinTor	G	4	7
Thimet	R	48	90
Thionex	R	24	1
Venom	G	12	pre-plant, pre-emerge cracking- soil 7-foliar
Vydate L	R	48	7

(table continued next page)

(continued)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
FUNGICIDE (FRAC code)			
Blocker (Group 14)	G	12	at plant
chlorothalonil (Group M5)	G	12	0
Curzate (Group 27)	G	12	14
Endura (Group 7)	G	12	30
Flouronil (Groups 4 + M5)	G	48	14
Forum (Group 40)	G	12	4
Gavel (Groups 22 + M3)	G	48	14/3 ³
Gem (Group 11)	G	12	7
Headline (Group 11)	G	12	3
iprodione (Group 2)	G	12	14
mancozeb (Group M3)	G	12,24	14/3 ³
Moncut (Group 7)	G	12	at plant
Omega (Group 29)	G	48	14
Polyram (Group M3)	G	24	14/3 ³
Previcur Flex (Group 28)	G	12	14
Quadris (Group 11)	G	4	14
Quadris Opti (Groups 11 + M5)	G	12	14
Ranman (Group 21)	G	12	7
Reason (Group 11)	G	12	14
Ridomil Gold Bravo (Groups 4 + M5)	G	48	7
Ridomil Gold Copper (Group 4 + M1)	G	48	7
Ridomil Gold MZ (Groups 4 + M3)	G	24	14/3 ³
Rovral (Group 2)	G	12	14
Super Tin (Group 30)	G	24,48	21
Tanos (Groups 11 + 27)	G	12	14
thiophanate-methyl (Group 1)	G	12	14
Ultra Flourish (Group 4)	G	48	0

See Table D-6.

¹ G = general, R = restricted² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.³ 14 days = NJ, MD, VA; 3 days = DE, PA

Nematode Control

See "Nematodes" section in Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section, or use the following:

Mocap--20 lb 15G/A or OLF. Apply in a 12-inch band on the row at planting (avoid contact with seed piece).

Disease Control

Air Pollution

Symptoms appear as tiny spots of brown tissue on the upper surface of leaves and a bronzing of the lower surfaces. Some varieties such as Kanona, Norland, Red Lasoda, Red Norland, and Snowden are particularly sensitive.

Early Blight

Begin sprays in mid-June and continue every 7 to 10 days or apply fungicides according to a disease forecasting system. If late blight is a threat, then begin sprays when plants are 8 inches tall. Gem, Headline and Quadris, are particularly effective on early blight susceptible varieties.

Alternate one of the following fungicide programs:

chlorothalonil--1-1.5 pt 6F/A or OLF, or
Endura--2.5-4.5 oz 70WG/A, or
mancozeb--1.5-2 lb 75DF/A or OLF (**Note: DO NOT apply**

more than a total of 15 pounds of mancozeb or Polyram per acre per crop), or
Polyram--2 lb 80DF/A or OLF (**Note: DO NOT apply more than a total of 15 pounds of mancozeb or Polyram per acre per crop**), or
Super Tin--6 fl oz 4L/A or OLF *plus* mancozeb--2 lb 75DF/A or OLF

With one of the following FRAC code 11 fungicides:

Quadris--6.2-15.4 fl oz 2.08F/A, or
Gem--6-8 oz 25WDG/A, or
Headline--6-9 fl oz 2.1F/A, or
Quadris Opti--1.6 pt/A, or
Reason--5.5- 8.2 fl oz 500SC/A

Late Blight

Begin fungicide applications when plants are 6 inches tall and repeat every 7 days or apply fungicides according to a disease forecasting system such as BLITECAST or WISDOM. The following protective fungicides should be applied early in the season prior to the occurrence of any disease in the region:

chlorothalonil--1-1.5 pt 6F/A or OLF, or
mancozeb--1.5-2 lb 75DF/A or OLF. (**Note. DO NOT apply more than a total of 15 pounds per acre per crop**), or
Polyram--2 lb 80DF/A or OLF. (**Note. DO NOT apply more than a total of 15 pounds per acre per crop**).

The following fungicides can be used when the threat of the disease is high or present in the area and protectant fungicides have been used prior to disease occurrence:

Curzate--3.33 oz 60DF/A plus a protectant fungicide (ie, chlorothalonil or mancozeb), or
Forum--4.0-6.0 fl oz 4.18SC/A plus a protectant fungicide, or
Gavel--1.5-2 lb 75DF/A, or
Headline--6-9 oz 2.1F/A, or
Omega--5.5 fl oz. 500F/A, or
Previcur Flex--1.2 pt 6F/A plus a protectant fungicide (ie, chlorothalonil or mancozeb), or
Ranman--1.4-2.75 fl oz 400SC/A, or
Tanos--8 oz 50W/A *plus* a protectant fungicide (ie, chlorothalonil or mancozeb)

When a field contains new late blight infections and harvest is near, vines should be killed immediately to help prevent tuber infection.

Rhizoctonia stem canker and black scurf

Apply one of the following as an in-furrow spray at planting:

Quadris--0.4-0.6 fl oz 2.08F 1,000 ft of row , or
Moncut--0.71-1.1 lb 70DF/A, or
Blocker--5.2-10 fl. oz 4F/1,000 ft row

Verticillium Wilt

Select fields with a low incidence of wilt. Use resistant varieties where possible. Do not use tomato, eggplant, or pepper in rotation with potato may. The use of sudangrass in rotation with potato may reduce nematode levels. The use of Mocap (see "Nematode Control" section) will reduce lesion nematode levels in the soil, resulting in less Verticillium wilt.

Apply one of the following through center pivot irrigation in the fall to fallow fields for suppression of Verticillium and lesion nematode:

WHITE POTATOES

K-Pam HL--30-60 gal/A, or
metam-sodium (Vapam HL)--37.5-70 gal/A

White Mold

Apply the following immediately prior to row closing and repeat 28 days later:

Endura--5.5-10 oz 70WG/A, or
Omega--5.5-8 fl oz 500F/A, or
iprodione (Rovral--2 pt 4F/A or OLF), or
thiophanate-methyl--1.0-1.5 lb 70WP/A

Common Scab

Use resistant varieties and rotate with green cover crops.

Bacterial Soft Rot

Prevent wounding and make certain tubers are dry before packing. Free chlorine wash maintained at 25 ppm or use a fresh chlorine rinse maintained at 50 ppm may help reduce soft rot.

Leak (Pythium) and Pink Rot (Phytophthora)

Leak is a disease that usually enters the tubers through bruises occurring in conjunction with the harvesting of immature tubers during hot weather. Pink rot generally occurs in poorly drained areas. Be sure to rotate out of potatoes for at least 2 years. Apply one of the following fungicides with as much gallonage as possible. Make three applications of one of the following fungicides. The first application should be made at nickel size tubers. The second and third applications should occur 14 and 28 days later. Be sure to get some coverage of the soil surrounding plants for root uptake to occur.

mefenoxam chlorothalonil (Ridomil Gold Bravo, Fluoronil)--
2 lb 76WP/A, or
Ridomil Gold Copper--2 lb 70WP/A, or
Ridomil Gold MZ--2.5 lb 68WP/A

An alternative application technique is to apply one of the following in a 6- to 8-inch band directly over the seed-piece prior to row closure.

Platinum Ridomil Gold--2.2 fl oz 1.6E/1000 feet of row, or
Ridomil Gold--0.42 fl oz 4E/1,000 feet of row, or
Ultra Flourish--0.84 fl oz 2E/1,000 feet of row, or
Ranman--0.42 fl. oz/1,000 ft row

Vine Killing

Potato vines are frequently killed prior to harvest. Vine desiccation facilitates harvest by reducing excessive potato foliage or weed growth. In early harvests, vine desiccation can hasten or improve skin set on relatively immature potatoes, thus reducing tuber damage during grading, packing and shipping. Proper skin set of the potato, improves shelf life, assists with retention of potato quality during transport and improves eye appeal. Also, market demand for smaller (B-size) potatoes of some varieties may be greater for mid-size tubers than for large tubers and continued tuber sizing soon stops following vine desiccation. Decisions as to when to apply vine desiccants must be based on intended market, demand for a given size and the need for high quality, non-skinned tubers.

Diquat--0.25 to 0.5 lb/A. Apply 1 to 2 pts/A of Reglone for preharvest vine desiccation in a minimum of 20 gallons of water per acre by ground application. Add a non-ionic surfactant (NIS) containing 75% or greater surface active

agent at 0.25 to .05% v/v (1 to 2 qts/100 gals) of the finished spray volume. Rainfall 30 minutes following application will not affect the activity of Reglone. Do not apply to drought stressed potatoes. A second application may be made if necessary in dense vine growth. Do not exceed a total of 4 pts/A of Reglone. If two applications are made, allow at least 5 days between applications.

Glufosinate-ammonium--0.38lb/A. Apply 3 pt/A Rely at the beginning of natural vine senescence in a single application. Potatoes with heavy or dense vines may require an application of another desiccant (diquat) to complete vine desiccation. Thorough coverage of vines is essential for satisfactory results. Do not harvest potatoes within 9 days of Rely application nor apply to potatoes grown for seed. Do not plant treated areas to wheat, barley, buckwheat, millet, oats, rye, sorghum or triticale until 30 or more days after Rely application.

Sprout Inhibitors

Apply the following directly to tubers:

Chloroprotham--1% Solution. Apply Sprout Nip 3EC as a 1% solution (1 gallon of Sprout Nip per 35 gallons of water) on the drying table after potatoes have been washed. The spray nozzle should be set to spray evenly across the rollers moving the potatoes. The spray solution should be applied at the rate of 1 quart of the 1% solution per 2000 pounds (20 cwt bags) of potatoes. Rollers will distribute the spray solution and assure complete coverage of each potato. Note – other formulations of Sprout Nip are available.

Maleic hydrazide (MH-30 SG) Apply to crop 2-3 weeks after full bloom or when harvestable tubers are at least 1.5" in diameter. Do not apply when the temperature is expected to exceed 80°F (26.6°C) that day. Read the label carefully and follow the labeled rate.

Storage

Vines of potatoes going into storage should be completely dead at least 14 to 21 days before harvest. Healing of cuts and bruises is most rapid at a tuber temperature of 50° to 60°F (10° to 15.6°C) and a relative humidity of 90 to 95%, but no free water. This temperature should be provided for 2 to 3 weeks at the beginning of the storage period. After this, the temperature should be lowered to 40°F (4.44°C) for table stock or seed potatoes. Where a "rot potential" such as field frost, late blight, or soft rot is present, the curing period should be eliminated, and the temperatures lowered to 45°F (7.22°C) as soon as possible with increased air flow. Monitor the storage daily and if the rot continues the crop should be sold.

2008 SPRAY RECORD

Federal law requires that all growers keep records of their application of **restricted use** pesticides. Cooperative Extension also recommends that accurate records of **all** pesticides used by kept (New Jersey Law 7:30-8.8 requires growers [private applicators] to maintain records of all applications of pesticides for 3 years, and that they must be made available to the New Jersey Department of Environmental Protection and medical personnel upon request). These records include: date and place, crop/field treated, brand name or trade name of pesticide, **the amount of pesticide used and the pest for which the crop was treated**. A separate list of the EPA registration numbers for all restricted-use pesticides (all pesticides in New Jersey) must be kept, if these numbers are not kept on the application record.

The crop/field designation must be specific. **Example:** Assign a number to all fields, or parts of a field planted to different crops, or the same crop in a different growth stage. Then use this number on the application record for each application to that specific location. For all pesticides having a reentry time, the date of application must include the time the application is completed and when it is safe to reenter the field (date and time). The information below is required to be kept by all private applicators in **Maryland and New Jersey**.

Location and Field of Application				Pesticide Applied			Quantity Applied		Date & Time		Signature/ Pesticide License Number
County, City, Or Township of Application	Field Name Sitio Aplicado	Acres	Crop Treated Cosech Tratada	Name of Pesticide Nombre del Pesticida	EPA Registration Number Numero de Registracion EPA	Active Ingredient Ingrediente Acitvo	Amount of Pesticide used before mixing	Total Volume Candidad Usada	Date/Time of Application Fecha y Hora de la Aplicacion	Date/Time of Reentry Fecha Y Hora de Reentrada	
Agriville	G-11	8	Tomatoes	VydateL	352-372	Oxamyl	12 Qts.	400 gal	6/15-9:30 a.m.	6/17-9:30 a.m.	John Smith C080569

2008 SPRAY RECORD

Location and Field of Application				Pesticide Applied			Quantity Applied		Date & Time		Signature/ Pesticide License Number
County, City, Or Township of Application	Field Name Sitio Aplicado	Acres	Crop Treated Cosech Tratada	Name of Pesticide Nombre del Pesticida	EPA Registration Number Numero de Registracion EPA	Active Ingredient Ingrediente Activo	Amount of Pesticide used before mixing	Total Volume Candidad Usada	Date/Time of Application Fecha y Hora de la Aplicacion	Date/Time of Reentry Fecha Y Hora de Reentrada	

PESTICIDE REGISTRATION NUMBERS

Use the space below to list the pesticides that you use and their EPA registration numbers. These numbers are printed on the label. The information below is to be kept by all private applicators in Maryland and New Jersey.

Pesticide*	EPA Registration No.*	Active Ingredient*	Formulation
<i>Example:</i> Sevin	264-314	carbaryl	50W

* A form listing all pesticides stored on site must be sent each year to your local Fire Department with an explanatory cover letter.

VEGETABLE SEED SIZES

Table R-1. Vegetable Seed Sizes¹

Crop	Seeds/Unit Weight	Crop	Seeds/Unit Weight
Asparagus	13,000-20,000/lb	Mustard	15,000-17,000/oz
Beans: baby lima	1,150-1,450/lb	Okra	450-550/oz
fordhook	440-550/lb	Onions: bulb	105,000-144,000/lb
snap	1,600-2,200/lb	bunching	180,000-200,000/lb
Beets	24,000-26,000/lb	Parsnips	7,500-12,000/oz
Broccoli	8,500-9,000/oz	Parsley	240,000-288,000/lb
Brussels sprouts	8,500-9,000/oz	Peas	1,440-2,580/lb
Cabbage	8,500-9,000/oz	Peppers	4,000-4,700/oz
Carrots	300,000-400,000/lb	Pumpkins	1,900-3,200/lb
Cauliflower	8,900-10,000/oz	Radishes	40,000-50,000/lb
Celery	60,000-72,000/oz	Rutabaga	150,000-192,000/lb
Collards	7,500-8,500/oz	Spinach	25,000-50,000/lb
Cucumbers	15,000-16,000/lb	Squash: summer	3,500-4,800/lb
Eggplants	6,000-6,500/oz	winter	1,600-4,000/lb
Endive, escarole	22,000-26,000/oz	Sweet corn: normal, sugary enhanced	1,800-2,500/lb
Kale	7,500-8,900/oz	Super sweet (Sh)	3,000-5,000/lb
Leeks	170,000-180,000/lb	Tomatoes: fresh	10,000-11,400/oz
Lettuce: head	20,000-25,000/oz	processing	160,000-190,000/lb
leaf	25,000-31,000/oz	Watermelons: small seed	8,000-10,400/lb
Muskmelons	16,000-19,000/lb	large seed	3,200-4,800/lb

¹Use this table to estimate your seed requirements. Varieties and seed lots can differ in seed size. Check with your seed supplier and the label on the container for more precise information.

PLANT SPACINGS AND POPULATIONS

Table R-2. Population of Plants per Acre at Several Between-Row and In-Row Spacings

Inches between Rows	Inches Apart in Row												
	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 (3½ 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

USEFUL WEBSITES

The following is a list of websites that may be of interest and value to vegetable growers. Growers should carefully evaluate the source and accuracy of the information. Cooperative Extension DOES NOT confirm the accuracy of information at these websites. No endorsement of the information found at these websites is implied and no lack of endorsement is implied for sites not listed.

AGRICULTURAL SEARCH ENGINES	
cris.csrees.usda.gov	USDA Agricultural Search Engine
www.produceoasis.com/	About produce--recipes, nutrition, etc.
www.agview.com/	Agricultural Search Engine
VEGETABLE PRODUCTION	
www.rcrc.rutgers.edu/pubs/	2007 Commercial Vegetable Production Rec.
www.aesop.rutgers.edu/~horteng	Horticultural Engineering
www.vric.ucdavis.edu/	California Vegetable Crops Information
postharvest.ucdavis.edu/Pubs/publications.shtml	UC Davis Postharvest Handling of Perishables
edis.ifas.ufl.edu/AA006	Florida Commercial Veg. Information
weedid.aces.uiuc.edu	Univ. of Illinois Weed Identification
www.ces.ncsu.edu/hil/veg-index.html	North Carolina Vegetable Information
aggie-horticulture.tamu.edu/vegetable/vegetable.html	Texas Vegetable Information
msucare.com/index.html	Mississippi. Vegetable Information
www.extension.psu.edu	Penn State Extension Page
plasticulture.cas.psu.edu	Penn State Center for Plasticulture
www.ppath.cas.psu.edu/EXTENSION/VEGDIS/Identification.html	Penn State Disease Management Publication
www.ag.arizona.edu/extension	General Arizona Extension Information
www.gov.on.ca/omafra	Ontario Ministry of Agriculture
www.msue.msu.edu/iac/vegevege.html	Michigan Vegetable Site List
www.hort.cornell.edu/extension/commercial/vegetables/index.html	Cornell Vegetable Information
oregonstate.edu/dept/hort/	Oregon Vegetable Information
ag.arizona.edu/hydroponictomatoes/	Growing Hydroponic Tomatoes
www.ag.ohio-state.edu/~vegnet/	Ohio VegNet
www.umassvegetable.org/	Univ. of Mass. Veg. Information
www.pollinator.com/	The Pollination Home Page
www.ext.vt.edu/	Virginia Cooperative Extension Information
www.ppws.vt.edu/weedindex.htm	Virginia Tech Weed ID
www.ca.uky.edu/agc/pubs/id/id36/id36.htm	Kentucky Vegetable Growers Guide
www.agnr.umd.edu/users/agron/nutrient/	Maryland Nutrient Manager
entweb.clemson.edu/pesticid/saftyed/pstident.htm	Multi-university Resource Insect Pest ID
SUSTAINABLE/ALTERNATIVE CROP PRODUCTION	
www.ibiblio.org/farming-connection	Sustainable Farming
www.sarep.ucdavis.edu	California Sustainable Ag Program
www.sfc.ucdavis.edu	California Small Farm Center
www.hort.purdue.edu/newcrop	Purdue's New Crop Information
www.ams.usda.gov/nop/indexiE.htm	USDA National Organic Program
www.ianr.unl.edu/ianr/csas/	Center for Sustainable Agr. Systems
www.nal.usda.gov/afsic/	Alternative Farm Systems Inform. Ctr.
attra.ncat.org/	ATTRA horticulture series
www.sare.org	Sustainable Agriculture Network
www.kerrcenter.com/	The Kerr Center for Sustainable Agr.

continued

USEFUL WEBSITES (continued)

INTEGRATED PEST MANAGEMENT (IPM)

www.omri.org	Approved organic nutrients and sources
www.rcrc.rutgers.edu/weeds	New Jersey Weed Photos
www.nysaes.cornell.edu/recommends/	Cornell Vegetable IPM
www.pestmanagement.rutgers.edu/IPM/Vegetable/index.htm	Corn earworm and corn borer flights
www.ipm.ucdavis.edu	California IPM
www.hort.uconn.edu/ipm/ipmveg.htm	U Connecticut Vegetable IPM for growers
www.ipmworld.umn.edu	Minnesota IPM Newsletter
www.nysipm.cornell.edu/	New York Vegetable IPM
www.ipmnet.org/cicp/vegetable/vegindex.htm	Database of IPM Resources (DIR)
www.nysaes.cornell.edu/ent/biocontrol/	Biocontrol NY
www.udel.edu/extension/IPM/index.html	Delaware IPM
www.mdipm.umd.edu/	University of Maryland IPM
www.ces.ncsu.edu/depts/pp/cucurbit	Cucurbit Downy Mildew Forecasting
www.pestwatch.psu.edu	Sweet Corn Pest Maps (U.S.)

PESTICIDE NEWS AND INFORMATION

www.ace.orst.edu/info/nptn/	Natl. Pesticides Information Center
www.cdms.net/manuf/manuf.asp	Pesticide Labels & MSDS sheets
www.pested.unl.edu/softrec.htm	Pesticide Education Resources Univ. of Neb
www.greenbook.net/	C&P Press Greenbook.net
www.ipmcenters.org/	Office of Pest Management Prog. USDA
www.irac-online.org	Insecticide Resistance Action Committee
www.epa.gov/pesticides/	US EPA Office of Pesticide Programs
www.nj.gov/dep/enforcement/pcp/index.htm	NJDEP Pesticide Control & Local Prog.

NEWSLETTERS

www.rcrc.rutgers.edu/pubs/plantandpestadvisory/	NJ Plant & Pest Advisory Newsletter
www.ag.ohio-state.edu/~vegnet/	Ohio Weekly Newsletter
www.ipm.uiuc.edu/ifvn/index.html	Illinois Weekly Newsletter
www.ag.arizona.edu/crops/vegetables/vegetables.html	SW Arizona Vegetable Pest Reports

MARKETING

www.ams.usda.gov/marketnews.htm	USDA Agr.Mkt.Service Reports
www.farmersmarketonline.com/marketwa.htm	Terminal Market Prices for U.S. Crops
www.fas.usda.gov/commodities.asp	Terminal Mkt.Prices around the World
www.sfproduce.org/home.html	San Francisco Wholesale Mkt.Listings
www.usda.gov/nass/pubs/agr03/acro03.htm	USDA Nat'l Agr. Statistics Service
www.ams.usda.gov/directmarketing/	USDA's Direct Marketing Information
www.agr.ca/newintre.html	Agri-Food Canada Market Information
www.1webblvd.com/coosemans/default.htm	Coosemans Worldwide-Spec. Produce
www.pafarm.com/	PA Farm Market Association
www.cenyc.org/	CENYC: Greenmarkets
www.todaymarket.com/	Today's Market Prices
www.worldcrops.org	Ethnic vegetable production & marketing
www.pma.com/	Produce Marketing Association

FARM MANAGEMENT

www.aesop.rutgers.edu/~farmmgmt/	Farm Management
www.ers.usda.gov/	USDA Economic Research Service

continued

USEFUL WEBSITES (continued)

FARM MANAGEMENT	
www.farminfo.org/	The Small Farm Resource
EDUCATION	
njaes.rutgers.edu	Rutgers NJ Agricultural Experiment Station
www.cookce.rutgers.edu	Cook College Off.of Cont.Prof.Educ.
GOVERNMENT AGENCIES RELATED TO AGRICULTURE	
www.usda.gov/	US Department of Agriculture
www.nalusda.gov/	National Agricultural Library
www.fsa.usda.gov/pas/default.asp	USDA, Farm Service Agency
dda.delaware.gov	Delaware Department of Agriculture
www.state.nj.us/agriculture/	NJ Department of Agriculture
www.mda.state.md.us	Maryland Department of Agriculture
www.agriculture.state.pa.us	Pennsylvania Department of Agriculture
www.vdacs.virginia.gov	Virginia Department of Agriculture
www.rma.usda.gov/	Risk Management Agency USDA
TRADE PUBLICATIONS	
www.americanfarm.com/NJF.html	New Jersey Farmer Newsletter
www.meistermedia.com/	American Vegetable Grower
www.vegetablegrowersnews.com	The Vegetable Grower News
www.agriculture.com/	Agriculture Online
www.growermagazine.com/	The Grower Magazine
WEATHER	
www.nws.noaa.gov/	National Weather Service
climate.rutgers.edu/stateclim/	NJ State Climatologist
www.wx.rutgers.edu/	Rutgers Weather Center
www.usna.usda.gov/Hardzone/	Natl.Arboratum--Hardiness Zone Map
www.state.nj.us/dep/watersupply/precip.htm	NJDEP Hydrologic Information
FOOD SAFETY	
ecommons.library.cornell.edu/handle/1813/2209	Growers Guide to Food Safety
www.foodsafety.gov/~dms/fs-toc.html	National Food Safety Programs

PUBLICATION RESOURCES

The following publications are suggested for agents, growers, agriculture-industry representatives, and others who desire more detailed information on specific crops or production practices.

General Texts and Handbooks

Holcomb, E.J., editor. 1994. *Bedding Plants IV*. 516 pages. Fourth edition. Pennsylvania Flower Growers, Ball Publishing Co., P.O. Box 9, Batavia, IL 60510-0009. A manual on the culture of bedding plants as a greenhouse crop.

Uva, Richard H., Joseph C. Neal and Joseph M. DiTomaso, 1997; *Weeds of the Northeast*; 416 pages, Cornell University Press, 750 Cascadilla St., Ithaca, NY 14851. Comprehensive handbook for identifying 299 common and economically important weeds. 46 color photos and 118 drawings.

Maynard, D.N., and George Hochmuth. 2006. *Knott's Handbook for Vegetable Growers*. 582 pages. Fourth edition, John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10158. A practical handbook on commercial vegetable production.

Meister, R.T., editor. July issue. *Annual Buyer's Guide: American Vegetable Grower*. Meister Publishing Co., 37841 Euclid Ave., Willoughby, OH 44094.

Phillips, Roger, and Martyn Rix. 1993. *The Random House Book of Vegetables*. Random House Publishers, New York, NY. Illustrations and photographs of 650 vegetables with some production information included.

Pierce, Lincoln C. 1987. *Vegetables: Characteristics, Production, and Marketing*. 433 pages. First edition, John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10158. A good technical textbook for temperate vegetables.

(list continued next page)

PUBLICATION RESOURCES *(continued)*

General Texts and Handbooks *(continued)*

- Plucknett, D.L. and H.B. Sprague. 1989. *Detecting Mineral Nutrient Deficiencies in Tropical and Temperate Crops*. Westview Tropical Agriculture Series No. 7, Westview Press, Boulder, CO. 80302.
- Scaife, A. and M. Turner. 1984. *Diagnosis of Mineral Disorders in Plants. Volume 2: Vegetables*. Chemical Publishing Co., New York, NY 10000.
- Shepersky, K. 1984. *The Rain Bird Landscape Drip Irrigation Design Manual*. Rain Bird Sprinkler Mfg. Corp., Glendora, CA 91740.
- Sherf, A.F., and A.A. MacNab. 1986. *Vegetable Diseases and Their Control*. 728 pages. Second edition. John Wiley & Sons, Inc., 605 3rd Ave., New York, NY 10158. Information on diagnosis, disease cycles, and control; includes over 400 diseases and over 200 illustrations.
- Swiader, John M., George W. Ware, and J.P. McCollum. 1992. *Producing Vegetable Crops*. Fourth Edition. Interstate Publishers, Inc., 510 N. Vermillion Street, PO Box 50, Danville, IL 61834.
- Anonymous. 1990. *Western Fertilizer Handbook*, Interstate Publishers, Inc., Danville, IL, 279 pp.
- Anonymous. 2007. *Crop Protection Handbook*, Meister Media, Inc., Willoughby, OH, 828 pp.
- Barenklau, K. E. 2001. *Agricultural Safety*, Lewis Publishers, Boca Raton, FL, 135 pp.
- Brase, T. A. 2005. *Precision Agriculture*, Thomson Delmar Learning, Clifton Park, NY, 224 pp.
- Cloyd, R. A., Nixon, P. L., and Pataky, N. R. 2004. *IPM For Gardeners*, Timber Press, Portland, OR, 204 pp.
- Decoteau, D. R. 2000. *Vegetable Crops*, Prentice-Hall, Upper Saddle River, NJ, 464 pp.
- Jones, J. Benton Jr. 2005. *Hydroponics: A Practical Guide for the Soilless Grower*, CRC Press, Boca Raton, FL, 423 pp.
- McElhatton, A. and Marshall, R. J. 2007. *Food Safety – A Practical and Case Study Approach*, Springer, New York, NY, 311 pp.
- McKinlay, R. G. 1992. *Vegetable Crop Pests*, CRC Press, Inc., Boca Raton, FL, 406 pp.
- Monaco, T. J., Weller, S. C., and Ashton, F. M. 2002. *Weed Science: Principles and Practices, 4th Edition*, John Wiley & Sons, New York, NY, 669 pp.
- Naylor, R. E. 2002. *Weed Management Handbook, 9th Edition*, Blackwell Publishers, Oxford, UK, 423 pp.
- Rechcigl, N. A. and Rechcigl, J. E. 1997. *Environmentally Safe Approaches to Crop Disease Control*, CRC Lewis, Boca Raton, FL, 386 pp.
- Rubatzky, V. E. and Yamaguchi, M. 1997. *World Vegetables: Principles, Production, and Nutritive Values*, Chapman and Hall, New York, NY, 843 pp.
- Singh, H. P., Batish, D. R., and Kohli, R. K. 2005. *Handbook of Sustainable Weed Management*, Food Prod. Press, New York, NY, 892 pp.
- Snowdon, A. L. 1990. *Color Atlas of Post-Harvest Diseases and Disorders Vol. 2: Vegetables*, CRC Press, Inc., Boca Raton, FL, 416 pp.
- Van Emden, H. F. and Service, M. W. 2004. *Pest and Vector Control*, Cambridge University Press, Cambridge, UK, 349 pp.

Publications from Universities, USDA, Societies, and Commercial Companies

Compendium of Bean Diseases, Compendium of Beet Diseases and Insects, Compendium of Corn Diseases, Compendium of Pea Diseases, Compendium of Potato Diseases, Compendium of Sweet Potato Diseases, Compendium of Tomato Diseases. Available from APS Press, The American Phytopathological Society, 3340 Pilot Knob Road, St. Paul, MN 55121.

Hardenburg, R.E., A.E. Watada, and C.Y. Wong. 1995. *The Commercial Storage of Fruits, Vegetables, and Florist and Nursery Stocks*. 136 pages. USDA Agricultural Handbook No.66 (revised).

Kader, Adel A., et al. 1985. *Postharvest Technology of Horticultural Crops*. 192 pages. Special Publication 3311. Univ. of CA, 6701 San Pablo Ave, Oakland, CA 94608-1239.

Integrated Pest Management for Cole Crops and Lettuce. 1992. Publication of the Div. of Agric. and Natural Resources. Univ. of CA, 6701 San Pablo Ave., Oakland 94608-1239.

MacNab, A.A., A.F. Sherf, and J.K. Springer. 1983. *Identifying Diseases of Vegetables*. 62 pages. Order from Publications Distribution Center, Penn State University, 112 Agricultural Administ. Building, University Park, PA 16802. Color photos and description of common vegetable diseases. (\$8)

McGregor, S.E. (continuously updated). *Insect Pollination of Cultivated Crop Plants*. USDA Agricultural Handbook 496. 411 pages. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Specialty and Minor Crops Handbook. 1991. Publication 3346. Publication Div. of Agric. and Natural Resources. Univ. of CA, 6701 San Pablo Ave., Oakland, CA 94608-1239.

Stephens, J.M. 1989. *Manual of Minor Vegetables*. 123 pages. Florida Cooperative Extension Service, Univ. of FL, Gainesville, FL 32611.

Weeds of the North Central States (Bulletin 7). 303 pages. Illustrated book that lists and describes most of the weeds found in New Jersey. Available from the University of Illinois, Champaign, IL 61820.

Grubinger, Vernon P. 1999 *Sustainable Vegetable Production from Start-Up to Market*. 280 pages, Guide for those who are considering beginning a vegetable production business. The Natural Resource, Agriculture, and Engineering Service. Contact NRAES by phone (607) 255-7654 or www.nraes.org.

Zitter, Thomas A., Hopkins, Donald L., and Thomas, Claude E. 1996. *Compendium of Cucurbit Diseases*, American Phytopathological Society, 140 pp. www.shopapspress.org/42074.html

Table R-3 Frequently Used Weights and Measures and Approximate Metric Equivalents

Pint	Liquid			Dry			
	Liters Kilograms	Gallons	Liters	Ounces	Grams	Pounds	
0.5	0.24	1	3.8	0.25	7.1	1	0.5
1.0	0.47	2	7.6	0.50	14.2	2	0.9
1.5	0.71	3	11.4	0.75	21.3	3	1.4
2.0	0.94	4	15.1	1.0	28.4	4	1.8
2.5	1.18	5	18.9	2.0	56.7	5	2.3
3.0	1.42	6	22.7	3.0	85.0	6	2.7
3.5	1.65	7	26.5	4.0	113.4	7	3.2
4.0	1.90	8	30.3	5.0	141.7	8	3.6
4.5	2.13	9	34.1	10.0	283.5	9	4.1
5.0	2.37	10	37.9	16.0	453.6	10	4.5

Length and Area

1 acre	=	0.4 hectares	1 inch	=	2.54 centimeters
1 square mile	=	2.6 square kilometers	1 foot	=	30.0 centimeters
1 square yard	=	0.8 square meters	1 yard	=	0.9 meters
1 square foot	=	0.09 square meters	1 mile	=	1.6 kilometers
1 square inch	=	6.5 square centimeters			

NOTES

NOTES

Delaware Extension Agents and Specialists

County Agents

New Castle County: Carl Davis - 302/831-2506

Kent County: Gordon Johnson - 302/697-4000

Sussex County: Ed Kee and Corey Whaley
302/856-7303

Specialists at Newark

Dewey M. Caron, Entomologist - 302/831-2526

Robert P. Mulrooney, Plant Pathologist - 302/831-4865

Joanne Whalen, Pest Management - 302/831-1303

Specialists at Georgetown

Ed Kee, Vegetable Crops Specialist - 302/856-7303

Mark VanGessel, Weed Specialist - 302/856-7303

Emmalea Ernest, Extension Associate: Vegetable Crops – 302/856-7303

NOTES

Delaware Poison Control Center*

Poison Information Center 302/655-3389
Wilmington Medical Center--Delaware Division
502 West 14 Street
Wilmington, DE 19899

* When telephoning a hospital concerning poisoning, ask for the Poison Control Center

For Information on Certification of Pesticide Applicators, Call:

Delaware Department of Agriculture800/282-8685

For Help with a Pesticide Spill or Emergency, Call:

Delaware Department of Agriculture800/282-8685

Chemtrec800/424-9300

EPA/RCRA Hotline800/424-9346

National Pesticide Hotline800/858-7378

For Help in Case of Pesticide Poisoning, Call:

National Pesticide Hotline800/858-7378

In Memoriam

The 2008 edition of *Commercial Vegetable Production Recommendations* is dedicated to the late Drs. Alan MacNab (Pennsylvania State University) and James G. Kantzes (University of Maryland), who both contributed substantially to the field of plant pathology, and whose efforts greatly benefited agricultural producers in the Mid-Atlantic region.