

lambda-cyhalothrin + thiamethoxam (Endigo ZC)

Flea Beetle Adults

Look for beetles after transplanting. Repeat spray in 10 days if needed:

- acetamiprid (Assail 30SG or OLF)
- beta-cyfluthrin (Baythroid XL)
- bifenthrin (Brigade EC, Sniper or OLF)
- bifenthrin + imidacloprid (Brigadier)
- carbaryl (Sevin 80S or OLF)
- cyfluthrin (Renounce 20WP, Tombstone or OLF)
- endosulfan (Thionex 3EC or OLF)
- imidacloprid (soil–Admire PRO; foliar–Nuprid 1.6F, Provado 1.6F or OLF)
- imidacloprid + cyfluthrin (Leverage 2.7)
- lambda-cyhalothrin (Lambda-Cy, LambdaT, Silencer, Warrior II or OLF)
- lambda-cyhalothrin + chlorantraniliprole (Voliam xpress)
- lambda-cyhalothrin + thiamethoxam (Endigo ZC)
- thiamethoxam (Actara 25WDG)

Note: Mid-summer foliar sprays of carbaryl or endosulfan may aid in wireworm control by killing egg-laying click beetles (the adult stage of the wireworm).

Tortoise Beetles, Cucumber Beetles (CB)

- acetamiprid (**CB only**) Assail 30SG or OLF)
- bifenthrin (**CB only**) (Brigade EC, Sniper or OLF)
- bifenthrin + imidacloprid (**CB only**) (Brigadier)
- carbaryl (Sevin 80S or OLF)
- lambda-cyhalothrin (Lambda-Cy, LambdaT, Silencer, Warrior II or OLF)
- lambda-cyhalothrin + chlorantraniliprole (Voliam xpress)
- lambda-cyhalothrin + thiamethoxam (Endigo ZC)
- zeta-cypermethrin (Mustang Max, Respect or OLF)
- zeta-cypermethrin+ bifenthrin (**CB only**) (Hero EC)

Pesticide	Use Category ¹	Hours to Reentry	Days to Harvest
INSECTICIDE			
acetamiprid	G	12	7
beta-cyfluthrin	R	12	0
bifenthrin	R	12	21
bifenthrin + imidacloprid	R	12	21
carbaryl	G	12	7
chlorpyrifos	R	24	At Plant
cyfluthrin	R	12	21
endosulfan	R	24	1
ethoprop	R	48	Preplant
imidacloprid + cyfluthrin	R	12	7
imidacloprid (soil/foliar)	G	12	21/7
lambda-cyhalothrin	R	24	7
lambda-cyhalothrin+chlorantraniliprole	R	24	14
lambda-cyhalothrin+thiamethoxam	R	24	14
thiamethoxam	G	12	14
zeta-cypermethrin	R	12	1
zeta-cypermethrin+bifenthrin	R	12	21
FUNGICIDE (FRAC code)			
Botran (Group 14)	G	12	0
Mertect (Group 1)	G	12	0
Scholar (Group 12)	G	12	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 or Mocap (60 to 80 pounds per acre of 10G or 1 to 1.5 gallons of 6EC) or Vydate L. Use as recommended on the label.

Disease Control

Black Rot and Scurf

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 scales 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.

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.

Soft Rot (*Rhizopus*)

Use a resistant variety (eg. Beauregard)

During bedding: Just before bedding, use a 10 to 15 second root dip. Use Botran 75WP (1.0 lb per 10 gallons of water).

At harvest: Dip or spray harvested table or seed-stock roots after cleaning and before packaging. Use 1.0 lb of Botran 75WP in 100 gallons of treating solution. Scholar 1.9SC at 16.0 – 32.0 fl oz/100 gallons of dip is also an option.

Pox (Soil Rot)

Maintain a pH between 4.8 and 5.2 to assist in control. Use crop rotation, clean seed, and lean beds. Fumigation prior to planting may also help.

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	WV
Heirloom/specialty: Lg. Fruit						
Mortgage Lifter	D		N			WV
Hawaiian Pineapple	D		N	P		WV
Prudens Purple	D		N	P		WV
Mister Stripy					V	WV

(table continued)

Varieties (continued)

Varieties ¹	DE	MD	NJ	PA	VA	WV
Heirloom/specialty: Med.Fruit						
Eva Purple Ball	D		N			
Arkansas Traveler	D		N	P		WV
Box Car Willie	D		N			WV
Lemon Boy*	D		N			
Costoluto Genovese	D		N			
Brandywine Red	D		N	P	V	WV
Heirloom/specialty: Sm. Fruit						
Snow White	D		N			
Yellow Pear	D		N			
Sun Gold* (indeterminate)						WV
Market: Early						
SunStart* (VF,St)		M		P		WV
Sunshine*	D	M	N	P	V	WV
Applause*			N		V	WV
Primo Red* (VF) (trial)			N			
Market: Mid-Season						
BHN602*	D				V	
Sunbrite* (VF)	D	M	N	P	V	WV
Sunbeam* (VF)	D	M	N	P	V	WV
Mountain Spring* (VF)	D			P	V	WV
Amelia*(VF,TSWV)	D		N	P	V	WV
Florida 47*	D		N	P	V	
Floralina*	D		N			WV
Florida 91*	D		N		V	WV
Crista* (VF,TSWV,N)	D		N		V	WV
Mountain Fresh Plus *(NR, VFFN)	D	M	N	P	V	WV
Scarlet Red* (VFF)	D		N	P	V	WV
Red Defender* (VFFFN,TSWV)	D					V
SunGuard*(VF)	D					V
Mountain Glory* (VF,St)	D			P	V	
Rocky Top* (VF,St)	D			P	V	
Market: Late Summer/Fall						
BHN602*	D				V	
Floralina* (VF)	D		N			WV
Florida 91* (VF)	D		N		V	WV
Mountain Fresh Plus *(NR, VFFN)	D	M	N	P	V	WV
Phoenix*	D				V	
Market: Cluster Type						
Mountain Magic				P		
Market: High Tunnels						
SunGuard* (VF)					V	
SunStart* (VF,St)				P		WV
Sunbrite* (VF)	D		N			WV
Fabulous* (VFT)				P		WV
Daybreak* (VF)				P		
Sunleaper* (VF)				P	V	
Mountain Fresh Plus *(NR, VFFN)	D			P	V	WV
Market: Pear/Plum						
Heinz H-132*			N			
Plum Crimson* (VF)						
(Harvest blush-pink)	D		N	P	V	WV
Plum Dandy* (VF)						
(Harvest blush-pink)	D	M	N	P	V	WV
Picus*				P		V
Mariana*						V
Victoria Supreme*(VF,St,ASC)						
(large fruit)				P		WV
Health Kick*(TSWV)(high lycopene)			N	P		WV
Market: Cherry						
Sugar Snack				P		

(table continued)

Varieties (continued)

Varieties ¹	DE	MD	NJ	PA	VA	WV
Market: Cherry						
Sun Sugar*(VF) (orange)					P	
Mountain Bell* (VF)	D				P	V WV
Sweet Chelsea* (large)(TMV,VFN)	D	M			P	
Market: Grape						
Mini Charm* (VF,TMV)	D		N	P	V	
Smarty* (short, indeterminate)	D		N	P	V	
Jolly Elf*	D		N			WV
St. Nick* (indeterminate)	D		N	P		WV
Cupid* (indeterminate)	D	M	N	P		WV
Juliete* (large grape, indeterminate)	D		N	P	V	WV
Market: Yellow						
Carolina Gold*	D	M	N	P	V	WV
Roadside Stand						
BHN589*	D		N	P	V	WV
BHN961 (red slicer)						WV
BHN871 (yellow slicer)						WV
Sunbeam*			N	P		WV
Sunbrite*	D		N			WV
Fabulous*	D		N	P		WV
Ramapo			N			
Processing						
TSH4* (early plantings)	D		N			
H-3402*			N	P		
H-9704*	D		N	P		
H-9423* (VF)	D		N	P		
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.

Bare-Ground Systems – Fresh Market Tomatoes

Soil Texture	Soil Phosphorus			Soil Potassium			
	Pounds N	Level	Level	Level	Level	Level	
	per Acre	Pounds P ₂ O ₅ per Acre	Low Med Opt.	Low Med Opt.	Low Med Opt.	Low Med Opt.	
Sandy loams and Loamy sands	80-90 ¹	200 ¹	150 ¹	100 ¹	300 ¹	200 ¹	100 ¹
	40-45 ²	200 ²	150 ²	100 ²	300 ²	200 ²	100 ²
	40-45 ³	0	0	0	0	0	0
Loams and silt loams	50-80 ¹	200 ¹	150 ¹	100 ¹	250 ¹	150 ¹	100 ¹
	50 ²	200 ²	150 ²	100 ²	250 ²	150 ²	100 ²
	25-30 ⁴	0	0	0	0	0	0

¹Total amount nutrient recommended.²Broadcast and plow down.³Sidedress when first fruits are set.⁴Sidedress when first fruits are set, if needed.

Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Polyethylene Mulch Systems – Fresh Market Tomatoes

Soil Texture	Pounds N 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	150-210 ¹	200 ¹	150 ¹	100 ¹	300 ¹	200 ¹	100 ¹
Loams and silt loams	50-85 ²	200 ³	150 ³	100 ³	300 ³	200 ³	100 ³
	90-125 ⁴	0	0	0	0	0	0
	120-170 ¹	200 ¹	150 ¹	100 ¹	250 ¹	150 ¹	
	50-70 ²	200 ³	150 ³	100 ³	250 ³	150 ³	100 ³
	70-100 ⁴	0	0	0	0	0	0

¹Total amount nutrient recommended.
²Incorporate into the plant bed area only, at bed formation, immediately before installation of polyethylene mulch.
³Broadcast and plow down.
⁴Fertigate 0.5 to 2.5 lbs/day; increasing N rates as the growing season progresses. See Drip/Trickle Fertilization section
 Apply 1 - 2 pounds of boron (B) per acre with broadcast fertilizer. See Table B-10 for more specific boron recommendations.

Suggested Fertigation Schedule – Fresh Market Tomatoes

Days After Planting	Daily		Cumulative	
	Nitrogen ¹	Potash ^{1,2}	Nitrogen ¹	Potash ^{1,2}
	-----lbs/A-----			
Preplant ³	---	---	50	125
0-14	0.5	0.5	57	132
15-28	0.7	0.7	67	142
29-42	1.0	1.0	81	156
43-56	1.5	1.5	102	177
57-77	2.2	2.2	148	223
78-98	2.5	2.5	201	276

¹Adjust rates accordingly if you apply more or less preplant nitrogen and potash.
²Base overall application rate on soil test recommendations.
³Applied under plastic mulch to effective bed area using modified broadcast method. Adjust as needed.

Seed Treatment

Hot water treatment is administered to eradicate bacterial pathogens from seeds. Check with your seed company to determine if seed is hot water treated. Purchase hot water treated seed if possible or request hot water seed treatment. For more information to prevent disease see the Disease Section.

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

For any nutrient management program, begin by obtaining an accurate soil test from a certified laboratory. Choose a nutrient program as necessary to meet your individual production system requirements based on soil and production history.

Before laying plastic mulch, adjust soil pH to 6.5 and apply enough farm-grade fertilizer to supply 50 to 85 pounds per acre of N, depending on soil and yield potential. You should also apply the balance of your needed K₂O that you do not plan to apply via fertigation as a modified broadcast application that treats only the mulched area. Nitrogen fertilizer should be incorporated into the bed or split between incorporated and a surface band bed treatment immediately before laying plastic mulch.

After laying plastic mulch and installing the trickle irrigation system, apply completely soluble fertilizer through the drip system to supply additional nitrogen and potash throughout the season, depending on soil texture and yield potential (see table for suggested schedule). Nitrogen and potassium fertigation should be increased over the growing season as plants mature (see table for example). Adjust rates as necessary based on soil and tissue tests.

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 string 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, Virginia, or West Virginia)

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 not overwinter, 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 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 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 transplanted 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. 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. Plant spacing appears to affect fruit size and yield, but research is not yet complete.

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. Use varieties that feature a dense canopy and resistance to foliar diseases.

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.

Find the herbicides you plan to use in the Herbicide Resistance Action Committee's (HRAC) **Herbicide Site of Action Table E-7** and follow the recommended good management practices to minimize the risk of herbicide resistance development by weeds in your fields.

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 tubing 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 tubing 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 below), 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).

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 90 days of harvest except in VA, where a 60 day PHI may be observed when 1.67 pints or less Dual Magnum is used per year. **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. Moldboard 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 lambsquarters 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 or OLF 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).
- 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 90 days of harvest except in VA, where a 60 day PHI may be observed when 1.67 pints or less Dual Magnum is used per year. **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 lambsquarters 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 or OLF 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 lambsquarters, common ragweed, jimsonweed, morninglory 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 90 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 or OLF 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 Field Tomatoes (Fresh Market and Processing Tomatoes)

NOTE: Copies of specific insecticide product labels can be downloaded by visiting the websites www.CDMS.net or www.Greenbook.org. Also, specific labels can be obtained via web search engines.

Cutworms (Also see Chapter E 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 (Diazinon 4E or OLF)

Postplanting Treatment

If control is required after seedling emergence or after transplanting, treat soil thoroughly beneath plants with the following:

beta-cyfluthrin (**variegated cutworm**) (Baythroid XL)

bifenthrin (Brigade EC, Sniper, Empower² or OLF)

carbaryl (Sevin 80S, Sevin 5% Bait or OLF)

cyfluthrin (Renounce 20WP, Tombstone or OLF)

esfenvalerate (Asana XL)

gamma-cyhalothrin (Proaxis)

lambda-cyhalothrin (Lambda-Cy, LambdaT, Silencer, Warrior II or OLF)

lambda-cyhalothrin + chlorantraniliprole (Voliam express)

methomyl (Lannate LV or OLF)

zeta-cypermethrin+bifenthrin(HeroEC)

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 EC, Abba EC, Temprano or OLF)
acetamiprid (Assail 30SG or OLF)

azadirachtin (Azatin, Ecozin, Neemix). Apply when pests first appear and are in their early larval stages, or

Bacillus thuringiensis tenebrionis (**Small CPB larvae only**) (Novodor, Raven). 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

bifenthrin + imidacloprid (Brigadier, Swagger or OLF))

chlorantraniliprole (soil/drip/fo liar - Coragen 1.67SC)

clothianidin (soil/fo liar--Belay 2.13SC)

cryolite (not cherry types) (Kryocide 96W, Prokil cryolite 96)

endosulfan (Thionex 3EC or OLF)

dinotefuran (soil/fo liar-Scorpion 35SL, Venom 70SG or OLF)

imidacloprid (soil/drip--Admire PRO; fo liar--Nuprid 1.6F, Provado 1.6F or OLF)

imidacloprid + cyfluthrin (Leverage 2.7)

lambda-cyhalothrin + chlorantraniliprole (Voliam express)

oxamyl (Vydate L).

Note: Oxamyl L is most effective when plants have adequate foliage and are actively growing. Applications under other conditions may be ineffective.

spinetoram (Radiant 2SC)

spinosad (Entrust 80W, SpinTor 2SC, or OLF)

thiamethoxam (soil/drip--Platinum 75SG; fo liar--Actara 25WDG, or OLF)

thiamethoxam+chlorantraniliprole (soil/drip--Durivo; fo liar--Voliam flexi)

Flea Beetles (FB)

beta-cyfluthrin (Baythroid XL)

bifenthrin (Brigade EC, Sniper or OLF)

bifenthrin + imidacloprid (Brigadier, Swagger or OLF))

clothianidin(soil/fo liar- Belay 2.13SC)

cryolite (Kryocide 96W, Prokil Cryolite 96)

cyfluthrin (Renounce 20WP, Tombstone or OLF)

dinotefuran (soil/fo liar--Scorpion 35SL, Venom 70SG or OLF)

endosulfan (Thionex 3EC or OLF)

esfenvalerate (Asana XL)

gamma-cyhalothrin (Proaxis)

imidacloprid (soil,drip--Admire PRO; fo liar--Nuprid 1.6F, Provado 1.6F or OLF)

imidacloprid + cyfluthrin (Leverage 2.7)

lambda-cyhalothrin (Lambda-Cy, LambdaT, Silencer,

Warrior II or OLF)

lambda-cyhalothrin + chlorantraniliprole (Voliam express)

thiamethoxam (soil, drip--Platinum 75SG; fo liar--Actara 30WDG or OLF)

thiamethoxam + chlorantraniliprole (soil, drip--Durivo; fo liar--Voliam flexi)

zeta-cypermethrin (Mustang MAX, Respect, or OLF)

zeta-cypermethrin+bifenthrin(HeroEC)

Aphids (Green Peach and Potato)

Note: Thorough spray coverage beneath leaves is important.

acetamiprid (Assail 30SG or OLF)
 bifenthrin + imidacloprid (Brigadier Swagger or OLF)
 clothianidin (soil/foliar–Belay 2.13SC)
Chenopodium extract (Requiem)
 dimethoate (Dimate 4EC or OLF)
 endosulfan (Thionex 3EC or OLF)
 flonicamid (Beleaf 50 SG)
 imidacloprid (soil/drip–Admire PRO; foliar–Nuprid 1.6F, Provado 1.6F or OLF)
 imidacloprid + cyfluthrin (Leverage 2.7)
 methomyl (Lannate LV or OLF)
 oxamyl (Vydate L)
 pymetrozine (Fulfill 50WDG)
 pyriproxyfen (**use only in combination with acephate**) (Knack 0.86E)
 spirotetramat (Movento)
 thiamethoxam (soil/drip–Platinum 75SG; foliar–Actara 25WDG or OLF)
 thiamethoxam + chlorantraniliprole (soil, drip–Durivo; foliar–Voliam flexi)

Caterpillars (Tomato Fruitworm [also called Corn Earworm] [CEW], Hornworm [HW], European Corn Borer [ECB], Cabbage Looper [CL])

Bacillus thuringiensis (**CL, HW only**) (Biobit, Dipel, Dipel 2X, Javelin, XenTari or OLF)
 beta-cyfluthrin (Baythroid XL)
 bifenthrin (Brigade EC, Sniper, or OLF)
 bifenthrin + imidacloprid (Brigadier)
 chlorantraniliprole (soil, drip, foliar) (Coragen 1.67SC)
 cyfluthrin (Renounce 20WP, Tombstone or OLF)
 emamectin benzoate (**except ECB**) (Proclaim 5 WDG)
 esfenvalerate (**except ECB**) (Asana XL)
 fenpropathrin (**except ECB**) (Danitol 2.4EC)
 flubendiamide (Synapse WG)
 flubendiamide + buprofezin (Vetica)
 gamma-cyhalothrin (Proaxis)
 imidacloprid + cyfluthrin (Leverage 2.7)
 indoxacarb (**except ECB**) (Avaunt 30WDG)
 lambda-cyhalothrin (Lambda-Cy, LambdaT, Silencer, Warrior II or OLF)
 lambda-cyhalothrin + chlorantraniliprole (Voliam express)
 methomyl (**except ECB**) (Lannate LV or OLF)
 methoxyfenozide (**except CEW**) (Intrepid 2F)
 novaluron (Rimon 0.83EC)
 spinetoram (Radiant 2SC)
 spinosad (Entrust 80W, SpinTor 2SC or OLF)
 thiamethoxam + chlorantraniliprole (soil/ drip–Durivo; foliar–Voliam flexi)
 tebufenozide (**except CEW**) (Confirm 2F)
 zeta-cypermethrin (Mustang MAX, Respect or OLF)
 zeta-cypermethrin+bifenthrin(HeroEC)

Leafminers

Treat when first mines appear and repeat every 7 days or as needed.

abamectin (Agri-Mek EC, Abba EC, Temprano or OLF)
 chlorantraniliprole (soil, drip, foliar) (Coragen 1.67SC)

cyromazine (Trigard 75WP)
 dimethoate (Dimate 4EC or OLF)
 dinotefuran (soil/foliar–Scorpion 35SL, Venom 70SG or OLF)
 lambda-cyhalothrin + chlorantraniliprole (Voliam express)
 spinetoram (Radiant 2SC)
 spinosad (Entrust 80W, SpinTor 2SC or OLF)
 oxamyl (Vydate L)

True Armyworm (TAW), Fall Armyworm (FAW)

bifenthrin (Brigade EC, Sniper, or OLF)
 bifenthrin + imidacloprid (Brigadier)
 chlorantraniliprole (soil, drip, foliar) (Coragen 1.67SC)
 emamectin benzoate (**FAW only**) (Proclaim 5 WDG)
 flubendiamide (Synapse WG)
 flubendiamide + buprofezin (Vetica)
 gamma-cyhalothrin (Proaxis)
 lambda-cyhalothrin (FAW) (Lambda-Cy, LambdaT, Silencer, Warrior II or OLF)
 lambda-cyhalothrin + chlorantraniliprole (Voliam express)
 methomyl (Lannate LV or OLF)
 methoxyfenozide (Intrepid 2F)
 novoluron (Rimon 0.83EC)
 spinetoram (Radiant 2SC)
 spinosad (Entrust 80W, SpinTor 2SC or OLF)
 tebufenozide (Confirm 2F)
 thiamethoxam + chlorantraniliprole (soil, drip– Durivo; foliar– Voliam flexi)
 zeta-cypermethrin (Mustang MAX, Respect)
 zeta-cypermethrin+bifenthrin(HeroEC)

Beet Armyworm

bifenthrin (Brigade EC, Sniper, or OLF)
 bifenthrin + imidacloprid (Brigadier)
 chlorantraniliprole (soil, drip, foliar) (Coragen 1.67SC)
 emamectin benzoate (**FAW only**) (Proclaim 5 WDG)
 flubendiamide (Synapse WG)
 flubendiamide + buprofezin (Vetica)
 gamma-cyhalothrin (Proaxis)
 lambda-cyhalothrin (FAW) (Lambda-Cy, LambdaT, Silencer, Warrior II or OLF)
 lambda-cyhalothrin + chlorantraniliprole (Voliam express)
 methomyl (Lannate LV or OLF)
 methoxyfenozide (Intrepid 2F)
 novoluron (Rimon 0.83EC)
 spinetoram (Radiant 2SC)
 spinosad (Entrust 80W, SpinTor 2SC or OLF)
 tebufenozide (Confirm 2F) TOMATOES
 thiamethoxam + chlorantraniliprole (soil, drip–Durivo; foliar–Voliam flexi)
 zeta-cypermethrin (Mustang MAX, Respect)

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 will reduce spider mite populations.

abamectin (Agri-Mek EC, Abba EC, Temprano or OLF)
 bifenthrin (Brigade EC, Sniper, or OLF)
 bifenazate (Acramite 50WS)

fenpropathrin (Danitol 2.4EC)
 fenpyroximate (Portal)
 spiromesifen (Oberon 2SC)
 zeta-cypermethrin+bifenthrin(HeroEC)

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 EC, Abba EC, Temprano or OLF)
 beta-cyfluthrin (Baythroid XL)
 chlorantraniliprole (soil/drip, foliar) (Coragen 1.67SC)
 cyfluthrin (Renounce 20WP, Tombstone or OLF)
 emamectin benzoate (Proclaim 5WDG)
 flubendiamide (Synapse WG)
 flubendiamide + buprofezin (Vetica)
 gamma-cyhalothrin (Proaxis)
 imidacloprid + cyfluthrin (Leverage 2.7)
 indoxacarb (Avaunt 25WDG)
 lambda-cyhalothrin (Lambda-Cy, LambdaT, Silencer, Warrior II OLF)
 lambda-cyhalothrin + chlorantraniliprole (soil, drip- Durivo; foliar- Voliam express)
 methomyl (Lannate LV or OLF)
 novoluron (Rimon 0.83EC)
 NoMate TPW--200 spirals/A

Note. NoMate is a technique using a mating disruption pheromone useful for preventing mating of emerging adults from young transplants. The pheromone is applied to a hard plastic matrix formed into a hanging “spiral” for dispersal into the air. Apply at first sign of pinworm larvae in leaves.

spinetoram (Radiant 2SC)
 spinosad (Entrust 80W, SpinTor 2SC or OLF)
 thiamethoxam + chlorantraniliprole (Voliam flexi)
 zeta-cypermethrin (Mustang MAX, Respect or OLF)

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.

acetamiprid (Assail 30SG or OLF)
 cyfluthrin (Renounce 20WP, Tombstone or OLF)
 dinotefuran (soil/foliar-Scorpion 35SL, Venom 70 SG or OLF)
 gamma-cyhalothrin (Proaxis) (**except Western Flower Thrips**)
 imidacloprid (soil-Admire PRO; foliar-Nuprid 1.6F, Provado 1.6F or OLF)
 lambda-cyhalothrin (**except Western Flower Thrips**) (Lambda-Cy, LambdaT, Silencer, Warrior II OLF)
 spinetoram (Radiant SC)
 spinosad (Entrust 80W, SpinTor 2SC or OLF)
 thiamethoxam + chlorantraniliprole (soil, drip- Durivo)

Stink bug

beta-cyfluthrin (Baythroid XL)
 bifenthrin (Brigade EC, Sniper or OLF)
 bifenthrin + imidacloprid (Brigadier, Swagger or OLF)
 clothianidin (foliar-Belay 2.13 SC)
 cyfluthrin (Renounce 20WP, Tombstone or OLF)

cyhalothrin (Lambda-Cy, LambdaT, Silencer, Warrior II or OLF)
 dinotefuran (soil/foliar-Scorpion35SL, Venom 70SG or OLF)
 endosulfan (Thionex 3EC)
 fenpropathrin (**green stinkbug only**) (Danitol 2.4 EC),
 gamma-cyhalothrin (Proaxis)
 imidacloprid + cyfluthrin (Leverage 2.7)
 lambda-cyhalothrin + chlorantraniliprole (Voliam express)
 thiamethoxam + chlorantraniliprole (Voliam flexi)
 zeta-cypermethrin (Mustang MAX, Respect)
 zeta-cypermethrin+bifenthrin(HeroEC)

Whiteflies

acetamiprid (Assail 30SG or OLF)
 bifenthrin + imidacloprid (Brigadier)
 buprofezin (Courier 40SC or OLF)
Chenopodium extract (Requiem)
 dinotefuran (soil/foliar-Scorpion 35SL, Venom 70SG or OLF)
 endosulfan (Thionex 3EC or OLF)
 imidacloprid (soil/drip-Admire PRO; foliar-Nuprid 1.6F, Provado 1.6F or OLF)
 imidacloprid + cyfluthrin (Leverage 2.7)
 pymetrozine (Fulfill 50W)
 pyriproxyfen (Knack 0.86EC)
 spiromesifen (Oberon 2SC)
 spirotetramat (Movento)
 thiamethoxam (soil-Platinum 75SG; foliar-Acatara 25WDG, or OLF)
 thiamethoxam + chlorantraniliprole (soil, drip-Durivo; foliar-Voliam flexi)

Greenhouse Tomatoes

Aphids (Green Peach and Potato)

Note: Thorough spray coverage beneath leaves is important.

acetamiprid (for transplants only) (TriStar 30SG)
 endosulfan (Thionex 50WP or OLF)
 imidacloprid (soil, drip-Admire PRO, Marathon II; foliar-Marathion II or OLF)
 malathion (Malathion 57EC or OLF)
 pyrethrins (Pyrethrum TR)
 rosemary oil + peppermint oil (Ecotec)

Worms (armyworm, cabbage looper, pinworm)

acetamiprid (for transplants only) (TriStar 30SG)
Bacillus thuringiensis (Biobit, Dipel, Dipel 2X, Javelin, XenTari or OLF)
 chlorfenapyr (Pylon)
 pyrethrins (Pyrethrum TR)

Fungus Gnats (larvae)

Sanitation and drainage are the best methods of fungus gnat management.

acetamiprid (for transplants only) (TriStar 30SG)
Bacillus thuringiensis var. *israeliensis* (soil-Gnatrol)
 imidacloprid (soil, drip-Marathon II or OLF)
 pyriproxyfen (soil/sprench) (Distance)

Note: Use of chlorfenapyr for worms or mites will also reduce fungus gnat populations.

Mites

bifenazate (Floramite)
chenopodium extract (Requiem)
 chlorfenapyr (Pylon)
 endosulfan (Thionex 50W or OLF)
 rosemary oil + peppermint oil (Ecotec)

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.

acetamiprid (for transplants only) (TriStar 30SG)
 chlorfenapyr (Pylon)
 imidacloprid (soil, drip, foliar—Marathon II or OLF)
 malathion (Malathion 57EC or OLF)
 pyrethrins (Pyrethrum TR)
 rosemary oil + peppermint oil (Ecotec)
 spinosad (Entrust 80W, SpinTor 2SC) (**not for greenhouse transplant tomatoes**)

Note: Use of endosulfan for control of aphids or whiteflies will reduce thrips populations.

Whiteflies

acetamiprid (for transplants only) (TriStar 30SG)
 buprofenzin (Talus or OLF)
 endosulfan (Thionex 50WP or OLF)
 imidacloprid (soil, drip—Admire PRO, Marathon II; foliar—Marathon II or OLF)
 pyrethrins (Pyrethrum TR)
 pyriproxyfen (Distance)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest
INSECTICIDE			
abamectin	R	12	7
acetamiprid	G	12	7
azadirachtin	G	4	0
<i>Bacillus thuringiensis</i>	G	4	0
bifenthrin	R	12	1
bifenthrin + imidacloprid	R	12	1
bifenazate	G	12	3
buprofezin	G	12	7
carbaryl	G	12	3
<i>Chenopodium</i> extract	G	4	0
chlorantraniliprole (soil, drip, foliar)	G	4	1
chlorfenapyr	G	12	0
clothianidin (soil/foliar)	G	12	AP/21
cyfluthrin	R	12	0
cyromazine	G	12	0
diazinon	R	24	1
dimethoate	R	48	7
dinotefuran (soil/foliar)	G	12	21/1
emamectin benzoate	R	48	7
endosulfan	R	48	2
esfenvalerate	R	12	1
fenpropathrin	R	24	3
fenpyroximate	G	12	1
fonicamid	G	12	0
flubendiamide	G	12	1
flubendiamide + buprofezin	G	12	1
gamma-cyhalothrin	R	24	5
imidacloprid (soil, drip/foliar)	G	12	21/0
imidacloprid + cyfluthrin	R	12	0
indoxacarb	G	12	3

(table continued in next column)

Pesticide	Use Category ¹	Hours to Reentry ²	Days to Harvest ³
INSECTICIDE (continued)			
lambda-cyhalothrin	R	24	5
lambda-cyhalothrin + chlorantraniliprole	R	24	5
malathion	G	12	5
methamidaphos	R	48	7
methomyl	R	48	1
methoxyfenozide	G	4	1
novoluron	R	12	1
oxamyl	R	48	3
pymetrozine	G	12	0
pyrethrins	G	12	1
pyriproxyfen	G	12	14
rosemary oil + peppermint oil	G	0	0
spinetoram	G	4	1
spinosad	G	4	1
spiromesifen	G	12	1
spirotetramat	G	24	1
tebufenozide	G	4	7
thiamethoxam (soil, drip/foliar)	G	12	30/0
thiamethoxam + chlorantraniliprole (soil, drip/foliar)	G	12	30/1
zeta-cypermethrin	R	12	1
zeta-cypermethrin	R	12	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
Curzate (Group 27)	G	12	3
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
Previcur Flex (Group 28)	G	12	5
Presidio (Group 43)	G	12	2
Quadris (Group 11)	G	4	0
Rally (Group 3)	G	12	0
Ranman (Group 21)	G	12	0
Revus Top (Groups 3 + 40)	G	12	1
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
Scala (Group 9)	G	12	1
Switch (Groups 9 + 12)	G	12	0
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.

¹ G = general, R = restricted,

² Chemicals with multiple designations are based on product and/or formulation differences. CONSULT LABEL.

³ AP=At Plant

Nematode Control

See Chapter E "Nematodes" section of Soil Pests--Their Detection and Control. Use fumigants listed in the "Soil Fumigation" section.

Disease Control

Seed Treatment

Check with your seed company to determine if seed is hot water treated. Purchase hot water treated seed if possible or request hot water seed treatment. Heat treatment of seeds is a non-chemical alternative to conventional chlorine treatments that only kill pathogens on the surface of the seed coat. Heat treatment has the additional benefit of killing pathogens that may be found within the seed coat. Heat treatment is particularly useful for crops, such as tomato and pepper, that are prone to seed-borne bacterial infections. Seed heat-treatment follows a strict time and temperature protocol, and is best done with thermostatically controlled water baths. Two baths are required; one for pre-heating, and a second for the effective (pathogen killing) temperature. The initial pre-heat cycle is for 10 minutes at 100°F (37°C) followed by the effective temperature. Soak tomato seed at 122°F (50°) for 25 minutes. Immediately after removal from the second bath, seeds should be rinsed with cool water to stop the heating process. Afterward, seeds should be dried on screen or paper. Pelleted seed is not recommended for heat treatment. Heat treat only seed that will be used during the current production season.

An alternative to hot water seed treatment is to use 1 part Alcid (sodium chlorite), 1 part lactic acid, and 18 parts water as a seed soak. Treat seed for 1 to 2 minutes under constant agitation 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).

Damping-Off

Greenhouse: Use seed treatment and plant in a disease-free mix.

Field: At planting apply:

Aliette--2.5-5.0 lb 80WDG/A, or
mefenoxam (Ridomil Gold--1.0-2.0 pt 4SL/A or 2.0-4.0 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.

metalaxyl (MetaStar)--2.0-4.0 pt 2EC/A

Additional field applications may be made as needed, see label for specific instructions.

Fumigants will also offer some suppression of in-field damping-off.

Bacterial Wilt

Use certified transplants. 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, such as BHN669, are also available. Soil fumigation with a fumigant that contains either methyl bromide/iodide or chloropicrin may reduce disease occurrence. Ponds that are adjacent to previously diseased fields may be contaminated with the causal agent. Avoid irrigating with pond water when possible, especially avoiding those ponds that may be contaminated.

Bacterial Canker

Use certified transplants. Rotate to allow 3 years between tomato plantings. When producing transplants, be sure to chlorox or heat-treat seed as described under the "Seed Treatment" section in Chapter E to help prevent bacterial canker. When producing transplants, in addition to using seed treatment, be sure to treat used transplant growing flats with chlorine. See the "Treatment of Flats and Trays" section of Plant Growing in Chapter A. For staked tomatoes, stakes from bacterial canker infested fields should be power washed to remove excess debris and soil, soaked into a 20% chlorine solution for at least 30 minutes, and powerwashed a second time prior to use. Pruning and stringing will promote spread of disease in infested fields. 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 chlorox- 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 (1.0 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--1.0 lb ai/A *plus* mancozeb--1.5 lb 75DF/A or OLF, or

ManKocide--2.5-5.0 lb 61WP/A or
Cuprofix MZ--1.75-7.25 lb 52.5DF/A, or
Tanos--8.0 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 by not allowing 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 on methods for reducing postharvest losses see the website: <http://edis.ifas.ufl.edu/HS131>.

Powdery Mildew

For more control options on selected tomato diseases in greenhouses and high tunnels see Table E-14. "Selected Fungicides and Bactericides Labeled for Greenhouse Use".

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--8.0-12.0 20EG/A, or
Rally--2.5-4.0 oz 40WSP/A

Timber Rot (*Sclerotinia*)

Rotate away from fields where snap or lima beans, peas, peanuts, lettuce or cucurbits have been grown. 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.

Control of white mold in the field:

Endura labeled for Botrytis Gray Mold control (9.0-12.5 oz 70W/A), will also help control Sclerotinia Timber Rot.

Contans--2.0-4.0 lb 5.3 WG/A

Applying Contans in areas within 300 ft of structure because the fungus that produces apothecia can. Do not discard plant material within 300 ft.....

Southern Blight (*Sclerotium rolfsii*)

Southern blight is more commonly seen in the southern portion of the Mid-Atlantic region. 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--3.0 lb 75WP/100 gal of water or OLF and apply 0.5 pt/plant.

Fusarium and Verticillium Wilts

Be certain that you select a variety with resistance to Fusarium wilt. Soil fumigation and crop rotation are essential components of a successful management program for these wilts. For Fusarium wilt, select cultivars that are resistant to Races 1, 2, and 3 as all are prevalent on in the Mid-Atlantic region.

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. 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®.

Rotate the following fungicides to help delay the development of resistant pathogen strains:

Alternate:

chlorothalonil--2.0-3.0 pt 6F/A or OLF (also for gray leaf spot, black mold and soil rot), or
mancozeb--3.0 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 2.08SC/A (Also for buckeye rot and black mold. Do not apply near apples: see label for details), or
Cabrio--8.0-12.0 oz 20EG/A, or
Endura--2.5-3.5 oz 70W/A (also for Botrytis at 9.0-12.5 oz/A), or
Flint--4.0 oz 50WDG/A, (Do not apply near Concord grapes), or
Revus Top--5.5-7.0 fl oz 4.16SC/A, or
Tanos--8.0 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 pathogen that cause Late blight are present in the mid-Atlantic region. These strains are aggressive on tomato and most are mefenoxam-insensitive.

Transplants that are disease free should be used for plantings. 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--1.0-3.0 pt 6F/A or OLF, or
Gavel--1.5-2.0 lb 75DF/A, or
mancozeb--3.0 lb 75DF/A or OLF.

Once late blight is detected in your area, switch to one of the following translaminar fungicides which can move into and through leaves. Rotate between the following tank mixtures:

Curzate--3.2-5.0 oz 60DF/A *plus* a protectant fungicide, or
Forum--6.0 fl oz 4.18SC/A *plus* a protectant fungicide, or
Presidio--3.0--4.0 fl oz 4SC/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
Reason--5.5-8.2 fl oz 500SC/A *plus* a protectant fungicide, or
Revus Top--5.5-7.0 fl oz 4.16SC/A *plus* a protectant fungicide, or
Tanos--8.0 oz 50WG/A *plus* a protectant fungicide.

Fruit Rot caused by *Pythium* and Buckeye Rot caused by *Phytophthora*

Apply mefenoxam (Ridomil Gold at 1.0 pint 4SL per acre

or Ultra Flourish at 1.0 quart 2E per acre) as a soil surface application under the vines 4 to 8 weeks before harvest. Apply broadcast or banded (see Chapter E 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)--2.0 lb 76WP/A, or
Ridomil Gold Copper--2.0 lb 65WP/A

If weather and soil conditions continue to favor disease development apply one of the following between applications of the above listed fungicides:

Gavel--1.5-2.0 lb 75DF/A, or
Tanos--8.0 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--2.0-2.75 pt 6F/A or OLF (also very good for late blight), or
Endura--9.0-12.5 oz 70WG/A (also very good for early blight; not for use in greenhouses), or
Switch--11.0-14.0 oz 62.5WG/A

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.

Greenhouse Tomatoes

Powdery Mildew

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--1.0-2.0 gal/100 gal, or
Scala--7.0 fl oz 5SC/A
Sun Spray Ultra-Fine Spray Oil--1.0-2.0 gal/100 gal

For more control options on selected tomato diseases in greenhouses and high tunnels see Table E-14. "Selected Fungicides and Bactericides Labeled for Greenhouse Use".

Late Blight

Late blight can be particularly damaging in a greenhouse setting. A strong preventative program and microclimate management is recommended to suppress levels of this disease in the greenhouse. The following materials permit greenhouse applications targeting this disease:

Heritage--1.6-3.2 oz 50WG/A or
Catamaran--5.5-7.0 pt 5.3F/A

WATERMELONS

Varieties

Varieties¹

Seeded

Crimson Sweet (AR,FR1,OS)	These varieties are
Royal Majesty* (FR1,2)	recommended for
Sangria*	DE, MD, NJ
Jamboree*(AT,FT)	PA, VA, WV
Royal Star (FR1)	
Mardi Gras* (FR 1, AR)	
StarBrite (AR, FR1,OS)	
Top Gun*	

Seedless (all seedless varieties are triploid hybrids)

Imagination (Sugarbaby Type)	These varieties are
Gypsy	recommended for
Crisp N Sweet	DE, MD, NJ,
Millionaire	PA, VA, WV
Sugarheart	
SS5244 (OT)	
Tri-X 212	
Tri-X-313 (OT)	
Tri-X Palomar	
Premier	
Super Crisp	
5244	
Matrix (oblong)	
Revolution (oblong) (OT)	
Amarillo (yellow)	
Crunchy Red	
SS7187	

Seedless Personal (3-7 lbs) (all seedless varieties are hybrids)

Solitaire	These varieties are
Vanessa	recommended for
Pixie	DE, MD, NJ,
Petite Envy	PA, VA, WV

Pollenizers

SP-4	
Jenny	These varieties are
Patron	recommended for
Pinnacle	DE, MD, NJ,
Sidekick	PA, VA, WV

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