Crop Profile for Tomatoes in Virginia

Prepared June, 2001

General Production Information

- Tomato production in Virginia averaged 380 cwt./acre in 1999.
- A total of 148 million pounds of tomatoes were produced within Virginia in 1999, valued at $41.5 million or roughly $0.28/lb.
- The value of production of tomatoes increased from 40.3 million in 1998 to 41.5 million in 1999.
- The majority of the acreage reported in 1999 was grown for the fresh market.
- Virginia ranks third in the nation, accounting for 4.2% of the U.S. tomato production.
- Additional tomato acreage is grown within Virginia and contracted to large processing companies located out-of-state. The exact acreage cannot be released as a result of disclosure laws.

Production Regions:
The majority of the tomato acreage is located on the Eastern Shore of Virginia in Accomack and Northampton counties. Tomatoes are also produced to a smaller degree on the Northern Neck of Virginia within Lancaster, Richmond, and Westmoreland counties.

Cultural Practices

Tomato varieties recommended for growth in Virginia include *SunStart**, *Sunbrite*, *Mountain Spring**, *Sunbeam**, *Mountain Fresh**, *Sunbrite**, *Florida 47**, *Plum Dandy**, *Mountain Bell**, *Carolina Gold**, *Sunray*, and *Husky Gold**. These are produced on a variety of soil types within Virginia, but predominantly on sandy loam soils. Soil target pH for tomatoes is 6.5 with lime being recommended below 6.0. Nitrogen is recommended at a rate of 40-45 lb./acre prior to planting and again at the same

rate when fruits are first set. In addition, phosphorus and potassium are recommended at planting at a rate of 100-200 and 100-300 lb./acre, respectively, depending on soil test results. Other micronutrients may also be needed as indicated by soil test results. Calcium is one of the more important micronutrients, especially for the prevention of a physiological disorder known as blossom end rot.

Tomato seedlings are typically planted in the spring beginning in mid-April and continuing through May for a mid-July harvest. Producers often stagger plantings throughout the season and in some cases may harvest until the first killing frost. Prior to planting, tomato seedlings are typically hardened to improve their success rate when placed in the field. It is recommended that this procedure be accomplished by withholding nitrogen and water or by allowing plants to wilt slightly between light waterings. Rows are typically spaced 5 feet apart and plants are placed 18 inches apart in the row. Mostly all of the tomatoes grown on the Eastern Shore are grown on black plastic mulch under some type of irrigation, either overhead or drip. These tomatoes are staked, pruned, and tied with string to increase productivity. Tomatoes in other regions of Virginia are grown mostly on black plastic with irrigation and staking, although some bare-ground, non-irrigated and non-staked fields are in production. All tomatoes in Virginia are hand harvested approximately 3-6 times depending on the variety of tomato and the habits of the producer.

Tomato varieties differ in their resistance to certain diseases. *SunStart* is resistant to *Verticillium*, *Fusarium*, and *Stemphylium* wilt, *Sunbrite*, *Mountain Spring*, *Sunbeam*, *Mountain Fresh*, *Plum Dandy*, *Mountain Bell*, and *Mountain Gold* are resistant to *Verticillium* and *Fusarium* wilt, and *Sunray* is resistant to *Fusarium* wilt.

**Indicates hybrid varieties.*

Special Use Labels:
Section 18 Emergency Use Exemptions and Special Local-Need (24c) labels are used to supplement the chemical tools available to producers for pest control. Once the problem or gap in pest control has been identified specialists submit the proper documentation for the emergency/special label. Thus far, Extension Specialists have been successful in obtaining these labels, which must be applied for annually and are usually only valid for limited time intervals. Given the temporary nature of the emergency/ special labels, compounds labeled in this manner were not included in chemical pest sections found below. Local Extension offices will usually have the most current emergency/special label information. Without these, pest control in tomatoes as well as other vegetable crops would be extremely difficult for producers.

Insect Pests

Control recommendations were taken from the 2000 Commercial Vegetable Production Recommendations--Virginia.

Stink bugs and thrips are the most common problem pests of tomatoes planted early in Virginia, whereas tomato fruitworms and aphids may be very damaging later in the season. More detailed descriptions of these insects are found below. The Colorado potato beetle has been a problem in the Northern Neck region as a result of the adaptation of these beetles to tomato. In contrast, potato beetles are not well adapted to tomato on the Eastern Shore and therefore have not been a problem. In part this may be due to the large acreage of potatoes on the Shore, which are the preferred host of this insect, but may also be due to the widespread use of *Admire*, which has considerably reduced the population of this insect, at least for the time being. In addition, spider mites (*Tetranychus urticae*), beet armyworms (*Spodoptera exigua*), fall armyworms (*Spodoptera frugiperda*), cabbage loopers (*Trichoplusia ni*) and fruit flies (*Drosophila melanogaster*) may cause problems under unusual conditions, resulting from weather or seasonal variations throughout the state. Spider mites, for example, are particularly devastating in dry years. Tomato pinworms (*Keiferia lycopersicella*) and vegetable leafminers (*Liriomyza sativae*), which were once serious problems due to insecticide resistance, may show up during dry years. Recent chemical developments have made several good insecticides available for control of these pests. Changes in cultural practices, such as growing transplants locally instead of bringing them up from Florida, and the discontinuation of cull piles, have also played a role in the reduction of these two pests. European corn borers (*Ostrinia nubilalis*), flea beetles, tomato hornworms (*Manduca quinquemaculata*), tobacco hornworms (*Manduca sexta*), true armyworms (*Pseudaletia unipuncta*) and whiteflies also occur in Virginia tomato fields, but are not difficult to control given currently labeled insecticides.

Aphids
Green Peach Aphid, *Myzus persicae*
Potato Aphid, *Macrosiphum euphorbiae*

Aphids attack a number of economically valuable crops. Both species listed above are common pests of tomatoes in Virginia, although the potato aphid is more prevalent than the green peach aphid. Typically aphids feed on the underside of leaves causing severe curling and reduced photosynthate potential. Feeding of large aphid populations' results in excretion of large amounts of honeydew that supports the growth of secondary fungal diseases. Aphids may also function as vectors of certain virus diseases of tomato. Populations in Virginia begin increasing in May through June and again in mid-September through October.

Monitoring: Tomato plants should be scouted and an insecticide application should be made if one or more aphids is observed on 25% or more of the fully expanded compound leaves.

Chemical Control: The potato aphid is easily controlled with broad-spectrum insecticides, such as those used for other insect pests and supplemental sprays are rarely warranted.

Biological Control: Natural aphid predators, such as lady beetles and parasitic wasps will help to control population size. These predators should be considered when making chemical control decisions.

Cultural Control: No commercially effective controls are available.

Lepidoptera Pests
Tomato Fruitworm, *Helicoverpa zea*

The tomato fruitworm, also known as the corn earworm, soybean podworm, and the cotton bollworm is generally a problem in late-planted tomatoes around mid- to late-August. Fruitworms feed on leaf tissue causing tomatoes to look ragged, but also feed directly on the fruit, rendering them completely unmarketable. Given the high value of tomatoes, such damage is not tolerated by producers in Virginia.

Monitoring: Blacklight and pheromone traps can be used to monitor moth flight and alert producers of peak moth activity. Treatment is recommended if fruitworm moth catches in local blacklight traps average 20 or more per night and most corn in the area is mature.

Chemical Control: Insecticides for fruitworms should be applied every 5-7 days following the initial spray at the threshold recommended above.

Biological Control: No commercially effective controls are available for either pest.

Cultural Control: Later plantings of tomatoes are at a higher risk of fruitworm infestation than early plantings given that populations are often generated from infestations in nearby corn.

Stink Bugs
Green Stink Bug, *Acrosternum hilare*
Brown Stink Bug, *Euschistus servus*

Both the green and brown stink bugs are problem pests in tomato fields in Virginia, particularly of developing fruit. Feeding by these insects results in minute puncture marks in the fruit, surrounded by a yellow halo, which greatly reduces market value. Their ability to hide and move quickly makes them hard to monitor and thus treat.

Monitoring: Scouting for stink bugs is difficult, but spotted in the field, an insecticide application should be made.

Chemical Control: Insecticides provide the only effective form of stink bug control.

Biological Control: No commercially effective controls are available.

Cultural Control: No commercially effective controls are available.

Thrips, various spp.

Thrips are tiny, spindle-shaped insects that feed on leaves of seedling tomato plants and in the blossoms and developing fruit. This feeding may result in leaf crinkling, reduced photosynthetic potential, plant stunting, or may result in the transmission of virus. *Frankliniella fusca*, in particular, has the ability to transmit the tomato spotted wilt tospovirus (TSWV). As this type of thrips feeds, the virus is injected from the bodies through the mouthparts and into the plant. Once initiated, this virus can be very devastating. An additional type of thrips damage results from the placement of eggs into small developing fruit, which leaves scars and also reduces the marketability of the tomatoes. Thrips may complete several generations per season in Virginia under favorable conditions.

Monitoring: Scouting should begin at plant emergence and continue for approximately 6 weeks after planting. If thrips are found, insecticides should be applied.

Chemical Control: Insecticides may be applied at planting to help prevent thrips infestation in fields or areas with a history of their presence. Insecticides may also be used for control when the thrips are first observed in the field.

Biological Control: No commercially effective controls are available.

Cultural Control: Later planting often helps to reduce thrips pressure in tomatoes. Thrips are not generally a problem late in the growing season.

Chemical Insect Control

The most recent pesticide use survey for tomatoes grown in Virginia was completed in 1992. According to this report, insecticides were used by 75.8% of tomato producers on 20,854 of the treatment acres. However this information is rather dated. Currently, tomato producers in Virginia average 1-2 insecticide applications per week from the time seedlings are transplanted until harvest. It is estimated that 100% of the tomato acreage in the state is treated with insecticides, even organically grown tomatoes, which are treated with *Bacillus thuringiensis* for worm control. The list of chemicals below is representative of the 2000 insecticide recommendations for tomatoes grown commercially. However, the most frequently used insecticides include *Baythroid 2E*, *Warrior T*, *Danitol 2.4EC*, *Admire 2F*, *Provado 1.6F* and *SpinTor 2SC*.

- **azinphos-methyl (**Guthion**)**-PHI-0 days (<0.75 lb. a.i./acre)-14 days (0.75-1.50 lb. a.i./acre). Organophosphate. Apply at a rate of 0.75-1.50 lb. a.i./acre for control of the tomato fruitworm. A lower rate of 0.50-0.75 lb. a.i./acre should be applied for thrips control. REI-5 days.
- **cryolite (**Kryocide 96WP**) (**Prokil 96WP**)**-PHI-0 days. Inorganic fluorine. Apply *Kryocide* at a rate of 14.40-28.80 lb. a.i./acre and *Prokil* at a rate of 24-48 lb. a.i./acre for control of tomato fruitworm. REI-12 hours.
- **cyfluthrin (**Baythroid 2E**)**-PHI-0 days. Synthetic pyrethroid. Apply at a rate of 0.04 lb. a.i./acre for control of fall armyworm and stink bug and 0.025-0.04 lb. a.i./acre for control of tomato fruitworm. Do not exceed 0.26 lb. a.i./acre/season. REI-24 hours.

- **l -cyhalothrin (**Warrior T**)**-PHI-5 days. Synthetic pyrethroid. Apply at a rate of 0.02-0.03 lb. a.i./ acre for control of fall armyworm, stink bug and tomato fruitworm. Do not exceed 0.36 lb. a.i./ acre/season. REI-24 hours.
- **dimethoate (**Dimethoate 4EC**)**-PHI-7 days. Apply at a rate of 0.25-0.50 lb. a.i./acre for control of aphids. REI-48 hours.
- **endosulfan (**Thiodan**)**-PHI-2 days. Sulfurous acid ester of a chlorinated cyclic diol. Apply at a rate of 0.50-1.00 lb. a.i./acre for control of aphids and stink bugs (higher rate). REI-48 hours.
- **esfenvalerate (**Asana XL**)**-PHI-1 day. Apply at a rate of 0.01-0.05 lb. a.i./acre for control of tomato fruitworm. Do not exceed 0.50 lb. a.i./acre/season. REI-12 hours.
- **fenpropathrin (**Danitol 2.4EC**)**-PHI-3 days. Pyrethroid. Apply at a rate of 0.20 lb. a.i./acre for control of tomato fruitworm. Do not exceed 0.80 lb. a.i./acre/season. REI-24 hours.
- **imidacloprid (**Admire 2F**) (**Provado 1.6 F**)**-PHI-21 days (Admire 2F) and 0 days (Provado 1.6F). Chloronicotinoid. Apply *Admire* at a rate of 0.25-0.38 lb. a.i./acre and *Provado* at a rate of 0.05 lb. a.i./acre for control of thrips, and aphids. *Admire* is a soil insecticide, whereas *Provado* is a foliar insecticide. See label for specific instructions and application methods. Do not exceed 0.50 lb. a.i./acre/season, regardless of application method or formulation. REI-12 hours.
- **methamidophos (**Monitor 4EC**)**-PHI-7 days. Apply at a rate of 0.75-1.00 lb. a.i./acre for control of aphids, stink bug, thrips, and tomato fruitworm. REI-48 hours.
- **methomyl (**Lannate LV**)**-PHI-1 day. Carbamate. Apply at a rate of 0.45 lb. a.i./acre for control of aphids, 0.60 lb. a.i./acre for control of fall armyworm and a rate of 0.45-0.90 for control of tomato fruitworm. REI-48 hours.
- **oxamyl (**Vydate 2L**)**-PHI-1 day. Carbamate. Apply at a rate of 0.50-1.00 lb. a.i./acre for control of aphids. REI-48 hours.
- **spinosad (**SpinTor 2SC**)**-PHI-1 day. Apply at a rate of 0.06-0.13 lb. a.i./acre for control of fall armyworm, thrips and tomato fruitworm. Do not exceed 0.45 lb. a.i./acre/season. REI-48 hours.
- **tebufenazide (**Confirm 2F**)**-PHI-7 days. Apply at a rate of 0.13-0.25 lb. a.i./acre for control of fall armyworm. Do not apply more than 1.00 lb. a.i./acre/season. REI-12 hours.

Diseases

Control recommendations were taken from the 2000 Commercial Vegetable Production Recommendations--Virginia.

Disease control is often the most important yet challenging part of tomato production in Virginia. Primarily this is due to the large number of diseases that infect tomatoes, but is also due to the limited control options available for these diseases. In particular, early blight, Septoria leaf spot, and late blight are usually problems in Virginia. In addition, bacterial diseases and fungal wilts can also cause problems, although they occur less frequently. Other diseases of a more sporadic nature include gray mold, powdery mildew, Southern blight (Sclerotium), timber rot (Sclerotinia), and post-harvest rots. These diseases often show up under unusual conditions such as weather or result from poor cultural

practices. Fruit rots caused by the fungi, Pythium and Phytophthora may also appear from time to time, but are usually of more concern in processing tomatoes.

Bacterial Diseases

Bacterial Canker, *Clavibacter michiganensis* subspecies *michiganensis*
Bacterial Speck, *Pseudomonas syringae* pv. *tomato*
Bacterial Spot, *Xanthomonas campestris* pv. *vesicatoria*
Bacterial Wilt, *Pseudomonas solanacearum*

The causal agents of bacterial canker, speck and spot are seedborne making them difficult to avoid in cases of contaminated seed. Once present, these diseases are very devastating and hard to control. The types of damage they cause are reflected in their individual names. Bacterial canker causes plant necrotic cankers, blighting, and wilt during wet conditions. Bacterial speck develops under cool temperatures early in the season and results in leaf and fruit spotting. Bacterial spot also produces spots on leaves and fruit, eventually resulting in extreme blighting and defoliation. Bacterial wilt, on the other hand, is soilborne and infects plant roots resulting in wilting and eventual collapse of the tomato plant. Warm, moist soil conditions are highly favorable for this disease.

Monitoring: Field monitoring by scouts is important to identify emerging bacterial diseases before they become wide spread. However, no economic thresholds have been established at present. Treatment is recommended immediately after a disease has been detected.

Chemical Control: *Actigard* is the most effective product for controlling bacterial spot and speck diseases on tomato. *Maneb* plus products containing fixed copper are effective when disease levels are relatively low. These should be applied shortly after transplanting and be repeated every 7 days where bacterial diseases are a threat. Generally these diseases are difficult to control with the limited chemicals available. Control is not possible once the disease becomes established.

Biological Control: No commercially effective controls are available.

Cultural Control: The use of certified plants is critical for control of bacterial diseases, especially in areas where the disease is not yet established. Where disease is present or anticipated, do not work in fields when plant surfaces are wet. A crop rotation of 2-3 years between tomato plantings may help manage infestations of the causal agents of bacterial canker, speck, and spot. However, rotation is not effective in controlling bacterial wilt, especially given the persistence of this organism in the soil. In this case, producers should avoid infested sites.

Late Blight, *Phytophthora infestans*

Late blight caused by the fungus, *Phytophthora infestans*, may result in early-season leaf blighting and also late-season fruit rot. This disease prevails in cool, wet conditions and can be very devastating if not controlled preventatively. To further the difficulty, new metalaxyl resistant strains of this fungus are

present in the mid-Atlantic region. These strains are particularly aggressive on tomatoes.

Monitoring: Blight forecasting systems (i.e. Blitecast) can be very effective in identifying proper timing of fungicide sprays.

Chemical Control: If cool, wet conditions prevail, a preventative fungicide application is recommended every 7 days. Given the known resistance of late blight to metalaxyl (Ridomil), care should be taken to slow the spread. *Ridomil Gold*, which contains copper in addition to the metalaxyl, may be used to help in this process. However, the use of additional chemistries is recommended.

Biological Control: No commercially effective controls are available.

Cultural Control: No commercially effective controls are available.

Leaf Spots
Early Blight, *Alternaria solani*
Septoria Leaf Spot, *Septoria lycopersici*
Gray Leaf Spot, *Stemphylium solani*

Leaf spots can be very devastating, especially during periods of wet weather. They first appear as lesions or blotches on lower plant leaves and/or stems and progress up the plant as the disease develops. Leaf spot fungi are seedborne and can also become established on tomato stakes and overwintering crop debris. Of the leaf spot diseases, early blight is by far the most detrimental in Virginia, particularly in fields with continuous tomato production.

Monitoring: No economic thresholds have been established at present.

Chemical Control: Preventative fungicide applications are the best means of control for leaf spot diseases. An additional fungicide application will provide further control of leaf spot after the application of a fruit-ripening agent.

Biological Control: No commercially effective controls are available.

Cultural Control: Good sanitation practices, such as using certified seed along with proper timing of field operations will help to prevent leaf spot diseases. Also, fields where these diseases were present the previous season should be avoided and planted with rotation crops for 2-3 years.

Wilts
Fusarium Wilt, *Fusarium oxysporium*
Verticillium Wilt, *Verticillium dahliae*

Both Fusarium and Verticillium wilt are soilborne diseases that may infest tomato fields within Virginia. Symptoms of Fusarium wilt include chlorotic, stunted plants while brown, V-shaped lesions are characteristic of Verticillium wilt. Infected plants often have discolored vascular systems, appear wilted and eventually die. These diseases can be transmitted by seed, transplants, soil, tomato stakes, and equipment.

Monitoring: No economic thresholds have been established at present.

Chemical Control: Currently, no effective chemical controls are available.

Biological Control: No commercially effective controls are available.

Cultural Control: Given the persistence of the fungi in the soil, crop rotations are not usually very effective. However, resistant tomato cultivars for both Fusarium and Verticillium wilt are available and should be utilized in areas where these diseases are troublesome. Good sanitation practices are also important in controlling the spread of wilt diseases.

Chemical Disease Control*

The most recent pesticide use survey for tomatoes grown in Virginia was completed in 1992. According to this report, fungicides were used by 63.6% of tomato producers on 10,600 of the treatment acres. The insecticides reported at the time of the survey included mancozeb by 12.1% of producers on 10,027 treatment acres, chlorothalonil by 48.5% on 348 acres, metalaxyl by 18.2% on 213 acres, copper sulfate by 3% on 9 acres, benomyl by 3% on 3 acres, maneb by 3% on 0.5 acres and copper hydroxide by 3% on an unspecified number of acres. As mentioned in the *Chemical Insect Control* section, this survey information is rather dated and may not be representative of current fungicide usage patterns. Anecdotal data was used in the case of the more commonly applied fungicides to provide a better idea of present practices. The list of chemicals below is representative of the 2000 fungicide recommendations for tomatoes grown commercially.

- **acibenzolar-S-methyl (**Actigard 50WG**)**-PHI-14 days. Apply at a rate of 0.01-0.02 lb. a.i./acre at 7-day intervals following the initial spray for control of bacterial spot and speck. Do not apply more than 6 times per crop per season. REI-12 hours.
- **azoxystrobin (**Quadris 2F**)**-PHI-0 days. Apply at a rate of 0.78-0.97 lb. a.i./acre for excellent control of leaf spot diseases, fruit rots, and late blight. The highest rate should be used for optimum late blight control. Azoxystrobin controls some of the diseases missed by chlorothalonil and is therefore a highly effective tool. Resistance management is important when using this chemical, given the recent introduction of *Quadris 2F*. Following two sequential applications of *Quadris 2F*, rotation should be made to a chemical with a mode of action unlike azoxystrobin. REI-12 hours.
- **benomyl (**Benlate 50WP**)**-PHI-1 day. Apply in 7-14 day intervals once disease has been detected

at a rate of 0.25-0.50 lb. a.i./acre for control of gray mold and timber rot (Sclerotinia). Should not be used alone, but rather in combination or in an alternating spray program with a labeled nonbenzimidazole fungicide. REI-24 hours.

- **chlorothalonil (**Bravo**) (**Terranil**)**-PHI-0 days. Apply at a rate of 0.75-2.25 lb. a.i./acre for control of leaf spot diseases, fruit rots and late blight (lower rate). If applied later in the season, chlorothalonil works will on the fruit rot phase of late blight. REI-48 hours.
- **copper, fixed (**various formulations**)**-Apply at a rate of 1.00 lb. a.i./acre in combination with a half rate of mancozeb for control of bacterial speck and bacterial spot shortly after transplanting and repeat every 7 days. REI-24 hours.
- **manganese EBDC (**Maneb 75DF**)**-PHI-5 days. Apply at a rate of 1.13-2.25 lb. a.i./acre at 7-10 day intervals for control of bacterial diseases. Do not exceed 16.8 lb. a.i./acre/crop. REI-24 hours.
- **mefenoxam (**Ridomil Gold**)**-PHI-30 days. Recommended at a rate of 1.30 lb. a.i/acre for control of fruit rots caused by Pythium and Phytophthora. May be used in place of Ridomil to help slow late blight resistance, but neither of these chemicals is highly recommended for late blight control. REI-48 hours.
- **mancozeb (**Dithane Rainshield NT**) (**Manex II**) (**Penncozeb 80WP**)**-PHI-5 days. Apply at a rate of 2.4 lb. a.i./acre for control of leaf spot diseases and late blight. If applied early in the season, mancozeb works well against the foliar blighting phase of late blight. REI-24 hours.
- **mancozeb + copper hydroxide (**ManKocide**)**-PHI-5 days. Apply at a rate of 1.59-3.23 lb. a.i./ acre for control of bacterial speck and bacterial spot. REI-48 hours.

*Additional fungicides may be available under the Section 18 Emergency Use Exemption label.

Nematodes

Control recommendations were taken from 2000 Commercial Vegetable Production Recommendations--Virginia.

The root knot (*Meloidogyne hapla*) and lesion (*Pratylenchus penetrans*) nematodes are the most common species found in tomato fields and often pose the greatest threat to Virginia producers. Nematode infestations, in general, reduce plant productivity by inhibiting the plant's ability to uptake water and nutrients. Populations are especially high in fields where tomatoes are consistently being rotated with other host crops, such as melons or peppers. However, irrigation capabilities and land restrictions usually limit rotations to non-host crops.

Monitoring: Both diagnostic and predictive nematode assay programs in Virginia provide data to producers on the numbers and kinds of nematodes in soil along with recommendations for control. Soil samples for diagnostic assays are processed without charge to determine the cause of production problems during the growing season. Predictive nematode assays are done on samples collected after harvest. These samples are processed at a cost of $11 per sample, and must be collected in the fall no

later than November 20.

Chemical Control: See *Chemical Nematode Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Crop rotation with non-host crops to lower their population size is highly recommended in the event of nematode activity.

Chemical Nematode Control

Several chemicals are currently available for nematode control, although this may change in the next few years. Currently the soil fumigants chloropicrin, dichloropropene (Telone C-17), metam sodium (Busan), (Nemasol), (Vapam HL), and methyl bromide (Terr-O-Gas 67) (MC-33) are recommended for use in Virginia. In addition, the nematicides aldicarb (Temik 15G), ethoprop (Mocap 10G or 6EC) and oxamyl (Vydate L) are also recommended. Typically, chemical controls are used only when cultural practices are unable to provide adequate control. However, these chemicals are still important tools with other methods of control have failed.

Weeds

Control recommendations were taken from 2000 Commercial Vegetable Production Recommendations--Virginia.

In the past, the majority of tomato producers fumigated plant beds with methyl bromide for weed control. Typically, this chemical was applied to the row beds that were covered immediately with black plastic mulch. Given the current legislation to reduce and soon restrict methyl bromide use along with the rising costs of the chemical, producers are looking for alternative ways to manage weed problems in tomatoes. At present, many producers are continuing to use the black plastic mulch with methyl bromide in lieu of effective alternatives. Yellow nutsedge is becoming an increasingly difficult weed for tomato producers in Virginia to control, especially given the limited herbicide options. If not controlled, all types of weeds compete with the tomato plants for the necessary nutrients, light and water.

Monitoring: Proper weed identification is an important part of effective weed control. Weeds observed in previous crops within a given field should be noted to aid in future herbicide decisions.

Chemical Control: See *Chemical Weed Control* section below.

Biological Control: No commercially effective controls are available.

Cultural Control: Black plastic is used by producers for control of fall annual weeds, which would normally grow directly around the plant.

Chemical Weed Control*

The list below contains all of the fully labeled products available to producers for weed control in tomatoes. Table 1 lists the effectiveness of these herbicides on a variety of weed species. Use estimates are also included based on anecdotal data.

- **clethodim (**Select 2EC**)**-PHI-20 days. Apply at a rate of 0.094-0.125 lb. a.i./acre for postemergence control of annual grasses and certain perennial grasses. Repeated applications may be needed to control certain perennial grasses. Yellow nutsedge, wild onion, and broadleaf weeds will not be controlled. Not used on more than 5% of the tomato acreage in Virginia. REI-24 hours.
- **metribuzin (**Lexone/Sencor**)**-PHI-7 days. Incorporate at a rate of 0.25 lb. a.i./acre prior to transplanting. Application will provide control of broadleaf weeds. An additional postemergence application of metribuzin may be necessary. Do not apply within 24 hours of treatment with other pesticides. Used on approximately 90-100% of the tomato acreage for control of weeds in the row middles (not under plastic). REI-12 hours
- **napropamide (**Devrinol 50 DF**)**-Apply at a rate of 1.0-2.0 lb. a.i./acre prior to seeding or transplanting and incorporate the same day as application. Controls annual grasses and certain annual broadleaf weeds. Use of napropamide may reduce the stand and yield of fall planted small grains. Moldboard plowing will reduce the injury to small grain cover crops. Applied to roughly 5-10% of the tomato acreage in Virginia. REI-12 hours.
- **paraquat (**Gramoxone Extra 2.5SC**)**-PHI-30 days. Apply as a directed spray at a rate of 0.5 lb. a. i./acre for postemergence control of weeds growing between beds. Injury could result if paraquat contacts crop plants. Used on approximately 50% of the tomato acreage for weed control in the row middles. Paraquat also has a Special-Local Needs Label-24(c) in Virginia for post-harvest vine desiccation for plants grown under plastic. Application of paraquat in this manner allows for burn-down of weeds and crop debris and also aids in disease prevention. In this respect the chemical is probably used on all of the tomato acres under plastic. REI-12 hours.
- **pebulate (**Tillam 6E**)**-PHI-8 days. Incorporated into the soil immediately after application at a rate of 3.0-4.0 lb. a.i./acre for control of annual grasses and yellow nutsedge. If used in combination with metribuzin, the spectrum of broadleaf weed control may be improved. Also recommended for postemergence control the same type of weeds when applied over transplants (up to fruit formation) at the same rate. Currently used on only 1-2% of the tomato acreage. Research is being completed at present to assess this chemical as a methyl bromide alternative. REI-12 hours.
- **sethoxydim (**Poast**)**-PHI-30 days. Postemergence herbicide used at a rate of 0.2-0.4 lbs. a.i./acre for control of annual grasses and certain perennial grasses. Repeat applications may be necessary for additional control of tough perennial grasses. Do not apply more than 5.0 pints of product per acre in one season. Used on less than 10% of the tomato acreage in Virginia. REI-12 hours.

- **trifluralin (**Treflan 4EC**)**-Incorporate into the soil 8 hours after application at a rate of 0.5-1.0 lb. a.i./acre. Primarily controls annual grasses and certain broadleaf weeds. Will not control ragweed, jimsonweed or morningglory. Typically used only by those producers not using black plastic mulch on 2-3% of the non-mulched acres. REI-12 hours.

*Section 18 Emergency Use Exemption and 24(c) Special Local-Need labels requests may be submitted to supplement the list above.

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

On-line Resources

C&P Press Online Crop Protection Reference
http://www.greenbook.net/free.asp

Crop-Net Crop Protection Website
http://www.crop-net.com/index.html

Insects and Related Pests of Vegetables
http://ipmwww.ncsu.edu/AG295/html

Pests of Vegetables and Fruit Trees
http://everest.ento.vt.edu/~idlab/vegpests/vegfact.html

Virginia Tech Pesticide Programs
http://www.vtpp.ext.vt.edu

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