

Crop Profile for Tomatoes in West Virginia

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General Production Information

Production Statistics

- There are 21,000 small farms in the state of West Virginia. Approximately, 60 to 100 small farms in the state grow tomato for commercial use (1).
- In year 2001, area planted for fresh tomato production ranges from 0.5 to 10 acres per farm (2).
- The average annual tomato production cost during the year 2001 was estimated to be at US \$2,271 per acre (2).
- The average tomato sale value was estimated to be at US \$5,703 per acre in year 2001 (2).
- Almost all tomatoes planted were harvested for fresh market (2).
- Tomatoes were marketed on a wholesale and retail basis (2).

Production Regions

Tomato production generally occurs on small farms scattered across the state. The majority of the tomato acreage is located on the Western and South Western regions of West Virginia in Jackson, Roane, Putnam, Mason, and Kanawha counties (2). Tomatoes also are produced to a smaller degree in Marion, Mineral, and Taylor counties and others throughout the state.

Fresh market tomatoes in West Virginia are grown on raised beds. Seeds are planted in a greenhouse in plastic trays and then transplanted using a planter or by hand. Transplanting starts around mid April in many parts of the state. Most growers use stakes woven with mesh to support the plants. A 4 feet long by 1-inch square stakes are driven approximately 12 inches into the soil between the plants. Individual staking also is used on small fields. Nearly all large scale fresh market growers use black polyethylene mulch for weed control, with herbicide applied between rows. Tomato variety used in the state include SunRay, Carolina gold, Pink girl, Celebrity, Beef Stake, Mountain Fresh, Pink Ponderosa, Jet Star, Mountain Pride, Prime Time, Mountain Spring, Sunbean, Sunstar, Sunbright, Lelia, Florida 97 and 47, Florina, and Big Boy (2). Trickle irrigation/nutrient delivery systems are employed by most fresh tomato market growers. In addition, the crop is pruned and hand-harvested (2).

Insect Pests

Colorado potato beetle, fruit worms, aphids, stink bugs, flea beetle, and spider mites were reported, by

West Virginia farmers, to be the most damaging insect/mite pests in tomato productions for the year 2001. Other reported insect pests include, cutworms, white flies, thrips, and leafminers (2). Insects and mites are controlled with a combination of non-chemical and chemical controls.

Major Insect Pests

Colorado Potato Beetle *(Leptinotarsa decemlineata)* (3)

The Colorado potato beetle (CPB) is the most severe pest on fresh market tomatoes in the state. Also, it is the most destructive pest of potatoes, eggplant, and tomatoes in the Mid-Atlantic region. This species has developed resistance to every known class of insecticides. CPB adults appear shortly after seedling emergence or transplanting. Early season populations tend to be concentrated in areas where tomatoes were previously grown. Colorado potato beetles are chewing insects. Their damage consists of holes in the leaves and/or consumption of whole leaves and stems. The CPB overwinters as an adult several inches beneath the soil surface. Eggs are deposited in groups of 10 to 30 on the undersides of leaves. The larvae feed for 2 to 3 weeks before entering the soil to pupate. There are 2 generations each year. They will feed on tomatoes, potatoes, and eggplant. **Non-chemical controls:**

Rotation to nonsolanaceous crops (crops other than potato, tomato, eggplant, and pepper) is extremely important in reducing CPB problems. Scouting is used and spraying is only done when necessary. The application of late-season sprays is avoided to prevent the buildup of insecticide-resistant beetles.

Chemical controls: The main chemicals used on the Colorado potato beetle are imidacloprid (Admire 16-24 fl oz 2F/A and Provado 3.75 fl oz 1.6F/A) and thiodan (0.67 qt 3EC/A). Admire has largely replaced oxamyl (Vydate) as the insecticide of choice in soil-applied transplant drenches, whereas Provado has replaced many of the standard foliar insecticides. Imidacloprid is also a valuable chemical for use on aphids and whiteflies. There have been essentially no chemicals that can serve as effective alternatives to imidacloprid; however, Spintor (spinosad 0.023-0.13 lbs ai/A) is proving to be quite effective in other states. This alternative insecticide has not been reported to be used by West Virginia growers. Other chemical options for Colorado potato beetle control include Agi-Mek, cryolite, Bt., azinphos-methyl, azadirachtin, and vydate.

Stakeholders (tomato growers) Input: Imidacloprid is very effective in low dosages against the CPB (95-100% effective). More than 50 percent of tomato production is estimated to be lost if imidacloprid is banned (Comments are based upon Extension agents work with tomato growers) (4).

Tomato Fruitworms *(Vasates lycopersici (Masse), and Apanteles congregatus (Say));*

Corn Earworm (*Heliothis zea*)
Tomato Hornworm (*Protoparce quinque maculata*) (3)

The next highest rated insect in terms of pest severity is the tomato fruitworm, also known as corn earworm. Corn earworm larvae feed on a number of plants, including corn, tomato, and cotton. When feeding on tomatoes, the larvae burrow into the fruit. The corn earworm is one of the most important insects in the United States because it causes serious damage in a wide range of plant hosts.

Chemical controls:

Chemicals reported to be used for treatment of fruitworms include esfenvalerate (Asana 2.9-9.6 fl oz 0.66 EC/A) and lambda-cyhalothrin (Warrior 2.56-3.84 fl. oz. IE/A). Asana is applied every 7-10 days starting after planting. Also labeled for earworm control are azinphos-methyl (Guthion 3-6 pt 2L/A), methomyl (Lannate 1.5-3 pt LV/A), cyfluthrin (Baythroid 1.6-2.8 fl oz 2E/A), cryolite (15-30 lb Kryocide 96WP/A or 25-50 lb Prokil cryolite 96WP/A), and fenpropathrin (Danitol 10.67 oz 2.4ED/A).

Stakeholder (tomato growers) Input: Asana and Warrior are 75% effective in controlling fruitworms. More than 50% of tomato production is estimated to be lost if Asana is banned and more than 30% if Warrior is banned (Comments are based upon Extension agents work with tomato growers) (4).

Aphids (Green Peach Aphid (*Myzus persicae* (Sulzer))
and Potato Aphids (*Macrosiphum euphorbiae*)(3)

Third in terms of insect pest severity are aphids. Aphids are small, soft-bodied, greenish insects, usually found on the undersides of leaves. They suck plant juices, causing leaves to curl and lose color. In addition to the damage caused by their feeding, aphids may transmit a mosaic virus disease. All life stages may occur annually and many generations may occur in a year. Aphids are unusual in that the female may produce young without mating. Also, they can produce live young. During adverse weather conditions, winged aphids may be produced. At certain times male and female aphids are produced, and these mate to produce young. Aphids overwinter in the egg stage.

Chemical controls:

Insecticide application is applied at the time aphids first appear on the leaves. Repeated treatments are sometimes necessary. Thorough spray coverage of the undersides of leaves is important. Imidacloprid (Admire) and Endosulfan (Thiodan) are used by many growers in the state. Admire has low toxicity and is one of the most effective chemicals available. Other labeled chemicals include Lambda-cyhalothrin (Warrior), cyfluthrin (Baythroid) dimethoate, and oxamyl (Vydate).

Stakeholder (tomato growers) Input: Admire and Thiodan are 95% and 75% effective in controlling Aphids, respectively. More than 50% of tomato production is estimated to be lost if Admire is banned

and more than 30% if Thiodan is banned (Comments are based upon Extension agents work with tomato growers) (4).

Stinkbug, green
***Acrosternum hilare* (Say) (3)**

Stinkbug nymphs usually attack tomato fruit when it is small, and damage appears as small pinpricks surrounded by white, corky tissue below the epidermis (Compendium). Adult stinkbugs are about 1.3 cm in length and shield-shaped. Eggs are usually deposited on the underside of leaves and are barrel-shaped, usually multicolored, and laid side by side. Nymphs are not winged, multicolored, and have piercing-sucking mouthparts (5).

Chemical controls:

Endosulfan (Thiodan) and lambda-cyhalothrin (Warrior) have been reported to be the choice for growers in the state. Cyfluthrin (Baythroid) also is labeled but not being used.

Stakeholder (tomato growers) Input: Thiodan and Warrior are 75% effective in controlling stinkbugs. More than 30% of tomato production is estimated to be lost if Thiodan or Warrior is banned (Comments are based upon Extension agents work with tomato growers) (4).

Flea beetle, potato
***Epitrix cucumeris* (3)**

Flea beetles are numerous after mild winters (6).

Chemical Control:

Asana XL (5.8-9.6 fl oz 0.66EC/A), Thiodan (0.67 qt 3EC/A, 1 lb. 50W), and Warrior (2.56-3.84 fl oz 1 E/A) are used for flea beetles control.

Non-chemical:

Use of resistant varieties

Spider Mites (*Tetranychus spp.*)(3)

The two spotted spider mite, *Tetranychus urticae* Koch, is the most common species attacking tomatoes (Compendium). They live on the underside of lower leaves and deposit eggs. First instar larvae have

three pairs of legs, whereas, the nymphal subsequent stages and the adults have four pairs. Feeding damage appears as small, chlorotic spots, or stippling, on the upper surfaces of affected leaves (5).

Chemical controls:

Endosulfan (Thiodan) is used by West Virginia growers. Abamectin (Agri-Mek) also is labeled but has not been reported.

Other Insect/Mite Problems

Cutworms (*Spodopetra exigua* (Hubner)) (3)

Chemical controls:

A broadcast incorporation treatment may be needed, just before planting. The treatment should be worked into the soil immediately after applying and before planting (6). Preplanting: diazinon; postplanting: esfenvalerate (Asana XL), methyl parathion (Lannate), carbaryl (Sevin bait), lambda-cyhalothrin (Warrior).

Whiteflies (*Trialeurodes vaporariorum* (Westwood)) (3)

Chemical controls:

Imidacloprid (Admire), imidacloprid (Provado), and endosulfan (Thiodan).

Thrips (*Heliothrips haemorrhoidalis* (Bouche)) (3)

Several species of thrips spread tomato spotted wilt virus. Some growers scout for thrips and begin treatments when thrips are observed. Sources of thrips or Whiteflies infection may be from the greenhouse.

Chemical controls:

Use of lambda-cyhalothrin (Warrior) for other pests reduces thrips populations. The use of endosulfan (Thiodan) for control of aphids or whiteflies in the greenhouse will suppress thrips. In the field, Imidacloprid (Admire, Provado), and azinphos-methyl (Guthion) are labeled.

Leafminers (*Liriomyza brassicae* (Riley)) (3)

In staked tomatoes, leafminers is a minor problem.

Chemical controls:

Chemicals control options include Abamectin (Agri-Mek), dimethoate, SpinTor, and Trigard (5)

Pesticide Use, Effectiveness and Importance:

Because of the high overhead investment, tomato growers tend to make very conservative decisions regarding the use of pesticides. Insect control is achieved with preventative pesticide treatments. For fresh market tomatoes, depending upon insect economic threshold and weather conditions, insecticides are typically applied less frequently than fungicides. Not more than 7 total insecticide applications per year are applied by the average fresh market grower. The most common insecticides sold to commercial tomato growers in the state include Diazinon, Asana, Sevin, Thiodan, Admire, and Warrior (7). The following table presents percent pesticide effectiveness, and percent tomato production loss, if the following pesticides were banned (2, 4, and 8).

Pesticide	Admire	Asana	Diazinon	Pounce	Sevin	Thiodan	Warrior
% Pesticide Effectiveness	95	75	50	75	30	75	75
% Tomato Production loss if the pesticide is banned	50	50	25	30	15	30	30

Diseases

Diseases are the most important category of pest in West Virginia fresh market tomatoes, where growers need to keep plants healthy over a longer harvest period. Early blight, late blight, Septoria leaf spot, and anthracnose are the most severe diseases in West Virginia, for fresh market tomatoes (2). In addition, Fusarium wilt can be severe on susceptible varieties of fresh market tomatoes, which are harvested ripe. Botrytis fruit rot can be a consistent problem, requiring chemical treatment every year. Late blight and Septoria leaf spot have occurred with growing frequency in the past few years, and often require control measures. Sclerotinia white mold becomes a major control issue once it has infested a field, particularly in the southern areas of the state.

Of the bacterial diseases, bacterial spot, can be more prevalent in given areas of the state. Bacterial speck and bacterial canker are much less of common occurrence on fresh market tomatoes. These bacterial diseases are difficult to control, since few effective products are available. The only effective

controls are the copper products (8).

Some growers in West Virginia maintain a simplified approach to disease control, using a single effective fungicide as their primary control throughout the season. Chlorothalonil (Bravo) is the most popular choice and mancozeb also widely used (8). Most growers, however, rotate fungicides with dissimilar modes of action. This is important for fungicides where the risk of resistance development is high. Azoxystrobin (Quadris) was introduced in West Virginia in 1999 as an important broad-spectrum fungicide for tomatoes. It is very effective against some fungal diseases that are not controlled by chlorothalonil. Many growers alternate azoxystrobin with chlorothalonil for more effective control of fungal diseases.

Major Disease Pests

Early Blight

Caused by the fungus (*Alternaria solani*). Early blight causes necrosis of leaves, stems, and flowers, and occurs during warm rainy or humid weather. The disease overwinters on the residue of previous crops, particularly tomatoes and potatoes. Infection occurs first, and is most severe, on older plant tissue. Early blight is controlled in West Virginia primarily by chemical controls. However, there are some cultural practices which reduce initial disease inoculum or subsequent spread.

Late Blight

Caused by the fungus (*Phytophthora infestans*). Late blight is an increasingly important disease in the state, though it doesn't occur every year. It is favored by cool, wet conditions, and is controlled primarily by chemical controls. The most commonly used chemicals are azoxystrobin (Quadris) and mancozeb. Metalaxyl (Ridomil) has also been used. Several races of *Phytophthora infestans* (the fungus which causes late blight) are now resistant to metalaxyl. Therefore, metalaxyl is effective only on some pathogen populations. Ridomil Gold contains copper, which was added to slow resistance development.

Leaf Spots

In addition to early blight (see above), leaf spot diseases include gray leaf spot and Septoria leaf spot. Gray Leafspot is caused by the fungus (*Stemphylium sp.*), and Septoria Leaf Spot/Blight is caused by the fungus (*Septoria lycopersici*). The leaf spot diseases are recognized by lesions or blotches produced on plant foliage or stems. Septoria leaf spot has become increasingly problematic in West Virginia and is now seen as often as early blight. Crop rotation, proper fertility, and the use of disease-free transplants are important in disease management. Preliminary studies indicate that this disease is reduced in no till tomatoes compared to tomatoes grown on black plastic. Leaf blights are also controlled in the state with chemical controls.

Fruit Rots

Fruit rot results from infection by *Alternaria*, *Colletotrichum*, and other pathogens. Anthracnose, (*Colletotrichum spp.*), the most important fruit rot on tomatoes, overwinters on decayed plant material in the soil. Sunken circular lesions on the fruit, often with dark centers with a concentric ring pattern characterize this disease. To control anthracnose, growers use disease-free seed, practice crop rotation, and plow under crop refuse.

Wilts

Fusarium and *Verticillium* wilts occur in tomatoes grown in West Virginia. Fusarium wilt is caused by the fungus (*Fusarium oxysporum*), whereas Verticillium wilt is caused by both (*Verticillium albo-atrum* and *V. dahliae*). Wilt symptoms begin on older leaves. The leaves of Fusarium infected plants turn yellow, while leaves of Verticillium infected plants will often have brown V-shaped lesions. Vascular system discoloration occurs for both Fusarium wilt (brown or red-brown) and Verticillium wilt (tan). Crop rotation is relatively ineffective for Fusarium wilt, but resistant cultivars are available for both wilt diseases. Rotation in combination with resistant varieties is widely practiced and often successful in controlling disease. Chemical controls are ineffective.

Disease Management

Proper disease management starts with disease-free transplants. Varieties with some resistance or tolerance will reduce fungicide needs, but will not eliminate the need for fungicides on tomatoes entirely. In general, early maturing varieties are more susceptible to early blight than are later maturing ones. Practice crop rotation away from all solanaceous crops for two or more years and control weeds during the rotation. Fall tomatoes are very prone to early blight, especially if early tomatoes or potatoes are planted nearby. Maintain rapid growth through proper fertilization to minimize disease. Crop rotations used for other diseases are an aid to control (9).

Crop rotation is currently the leading non-chemical control practice used by growers (approx. 90%). Fresh tomatoes are rotated to minimize the economically damaging effects of early blight, Septoria leaf spot, and bacterial spot. Resistant varieties also are used to minimize *Fusarium* and *Verticillium* wilts damage.

Chemical controls:

Prior to the recent registration of azoxystrobin (Quadris) on tomatoes, chlorothalonil (Bravo), mancozeb, and maneb were the primary fungicides used on fresh market tomatoes. At that time, chlorothalonil was used on most of West Virginia fresh market tomato crop, and it continues to be used extensively. Chlorothalonil is applied at a rate of 2.25 lb. a.i./acre. Prior to the registration of azoxystrobin, chlorothalonil was applied 8 times per year to control early blight, anthracnose, and Septoria leaf spot. Mancozeb is applied at a rate of 2.4 lb. a.i./acre, four times per year to control early blight and

anthracnose. The recent registration of azoxystrobin has increased grower options. However, azoxystrobin has some systemic activity, and therefore resistance management is a concern. Alternation of chemicals with varying modes of action will reduce the potential for resistance build-up. If chlorothalonil were to be lost from use, the best substitutes would be mancozeb or azoxystrobin. If mancozeb were lost, chlorothalonil or azoxystrobin would be the best substitutes, with no predicted loss of tomato yield; however, this would likely result in increased cost to the grower.

Pesticide Use, Effectiveness and Importance:

Disease control in tomato production is achieved with preventative pesticide treatments. For fresh market tomatoes, fungicides are typically applied every 7 to 14 days, depending upon weather conditions. Not more than 7 total fungicide applications per year are applied by the average fresh market grower.

The most common fungicides sold to commercial tomato growers in the state include maneb, mancozeb, Bravo, Daconil 2787, and Quadris. Availability and Packaging size, too large containers, were essential problems with Quadris sales (7).

Although the dithiocarbamate, maneb or mancozeb, have been used extensively over the years for control of two major diseases, early blight and late blight, the alternative chlorothalonil (Bravo, Daconil 2787) has been more in use. Over the last three years, Quadris has shown to be an excellent alternative for the early blight and late blight diseases (8).

Pesticide	Bravo	Daconil 2787	Mancozeb	Maneb	Quadris
% Pesticide Effectiveness	80	80	80	80	90
% Tomato Production loss if the pesticide is banned	60	60	10	10	60

Nematodes

Nematodes are extremely common, tiny (less than 0.25 inches long), nonsegmented roundworms, many of which are soil-dwelling. Plant parasitic nematodes complete their life cycle by feeding on living plants, most often the roots. They may feed on plant tissues from the inside (endoparasitic) or from the outside (ectoparasitic). Several species of plant pathogenic nematodes occur in West Virginia soils, generally as mixed populations unevenly distributed throughout a field.

Root Knot Nematode

The most important nematode pest of tomatoes in the state is the root knot nematode (*Meloidogyne* spp.). Approximately 100 species of *Meloidogyne* have been described worldwide, and 5 of these are significant pests of vegetable crops. Like most nematodes, they have a broad host range, and feed on a variety of crops and weeds.

Damage and Life Cycle

The life cycle and plant pathogenicity is similar for *Meloidogyne* species on all vegetable crops. Females feed within the root of the plant. They produce eggs in a gelatinous sac attached to their posterior end. Juveniles develop and undergo one molt within the egg before emerging. The second-stage juvenile invades the roots, feeding within the vascular system by piercing cell walls with its stylet. Secretions exuded by nematodes during feeding cause plant cells to swell, producing the diagnostic elongated or rounded "knots" on the roots. The nematodes feed within the plant and undergo 3 more molts before reaching reproductive maturity. Generation time is 25 to 40 days, depending upon host susceptibility, moisture, temperature, and soil type. Above-ground symptoms of root knot nematode infestation include erratic stands, stunted and wilted plants, and chlorosis. In addition to root galls, infected plants usually have reduced secondary roots. Nematode feeding produces the most severe symptoms under drought conditions, when plants are under increased stress. Yield reductions are highly variable, but can be significant. Also, the presence of nematodes has been associated with an increased rate of infection by fungi or bacterial pathogens, which can further reduce yield.

Frequency of Occurrence

Root knot nematodes are present in approximately 20-30% of west Virginia tomato fields, but not always at damaging levels (10). Populations tend to be highest, and outbreaks more likely, in light, sandier soils as opposed to heavier clay soils. Population levels are prone to often drastic fluctuations. Routine soil sampling and crop rotation practices prevent populations from reaching economic levels on most fields most years. No soil samples for nematode diagnosis should be submitted every few years or whenever a nematode problem is suspected.

Detection and Management

Ideally, nematode management should be considered prior to planting, because once above ground symptoms are apparent it may be too late to avoid significant yield loss. Samples are taken from fields after harvest but before tillage, when nematode populations are generally highest, to determine if nematodes are present in a field and to plan the cropping sequence. Most tomato growers in the state don't sample for nematodes routinely, but if nematode damage is suspected after crop emergence, soil and root samples are generally submitted to West Virginia University Nematology laboratory to determine the kind and number of nematodes present. Nematologists estimate the injury potential of a nematode population and use thresholds to determine if a control measure is warranted.

A number of resistant varieties are available for vegetable crops, including tomatoes. These varieties have combined resistance to certain diseases (*Verticillium* and *Fusarium*) and nematodes, however, the VFN tomato varieties tend to be lower-yielding and produce lower quality fruit which is not competitive in the market. For this reason, they are not used by growers. In addition, nematode resistance is only effective against the southern root knot nematode and does not protect against the more common northern root knot nematode. Thus, proper identification of the species present is essential if use of resistant cultivars is being considered for infected sites (10).

Crop rotation into less susceptible vegetable crops or cover crops, such as rye, is the most important strategy for maintaining low populations of root knot and other nematodes. This practice decreases the potential for nematode problems and helps to control a variety of diseases. Growers have found that rotation into sorghum is especially effective for reducing nematode populations. However, because root knot nematode and other nematode species have a broad host range, rotation alone may not always be sufficient to prevent nematodes from reaching economic levels. Also, land limitations and market demands can limit the usefulness of crop rotation as a control measure for nematodes or diseases. Rotation to cereal grasses is more effective for northern root knot than for southern root knot nematodes (10).

Other nonchemical practices that help to prevent the build-up of nematodes include the use of nematode-free transplants, incorporation of green manure or other organic matter into the soil, cleaning of farm equipment (which can spread nematodes from field to field), and maintaining good weed control. Incorporation of certain brassicas varieties e.g., canola, wild mustards or a green manure is being used effectively as a biological fumigant. Compounds in the leaves form, breakdown product toxic to nematode when incorporated into soil (10). Post-harvest disking is a standard practice for growers of fresh market. Most of these, practices are used for reasons other than nematode control, but when combined with crop rotation and soil sampling, usually prevent nematode populations from reaching economic levels.

Chemical Controls for Nematodes:

Crop rotation and other cultural practices generally prevent nematode buildup in tomatoes, but in some cases, chemical control is warranted. Chemical control of nematodes is generally achieved by the use of fumigants or nonvolatile nematicides. Field fumigation is generally done after a nematode problem has been recognized. Since nematodes can be spread mechanically by farm equipment, a grower with a nematode problem in one field is advised to fumigate all fields prior to the next planting.

As much as 5-10% of fresh market tomatoes acreage may be fumigated for nematode, disease, and insect control. Fumigation is rarely done strictly for nematode control. Fumigants in certain situations (not limited to nematode problems), such as when land availability limits the usefulness of rotation, or when rotation isn't feasible due to market demands. The commonly used products are Telone C-17, Telone II, and Metam-sodium (25-100 gal/A of Vapam, Busan, or Nemasol).

Telone C-17 contains chloropicrin (1.7 lbs/gal) + dichloropropene (8.2 lbs/gal), and is applied as a volatile liquid injected into the soil, under plastic. It disperses through the soil as a gas. Telone II is dichloropropene (10.1 lbs/gal), and is used primarily just for nematode for broad spectrum pest management. The Telone products are listed as liquid fumigants with very broad spectrums. They are also used to suppress weeds and certain disease (10).

Metam-sodium (25-100 gal/A of Vapam, Busan, or Nemasol) is a very broad spectrum, water dispersible, crystalline product that is generally applied through irrigation systems. The rate of metam-sodium applied varies considerably, depending on the objective of the grower. It is used well below the labeled rate if the primary concern is weeds, and may be applied at the maximum labeled rate for optimal disease control.

A chemical alternative to fumigation is oxamyl (1-2 qt 2L/A Vydate), which is somewhat effective against nematodes, and can be applied during the growing season. This product is used rarely, on as-needed basis, after a nematode problem has been diagnosed during the growing season. If it is used, 3 applications are typical. Oxamyl can also be applied at far lower rates using drip irrigation, or sprayed at ¼ rate at the base of plants with a cultivator in bare-ground tomatoes, but very few growers use these methods.

All chemical nematicides are restricted use pesticides, and maybe applied only by certified pesticide applicators.

Weeds

Nearly all fresh market growers use black polyethylene mulch for weed control, without additional fumigants applied to beds, although herbicide is applied between rows. Annual broadleaves, annual grasses, and nutsedge are the most severe weed problems on West Virginia tomato crop.

Chemical controls: The main herbicides used for fresh market tomato weed control in the state are metribuzin (Sencor) and trifluralin (Treflan). Metribuzin is 60-90% effective, and is applied at a rate of 0.25 lb. a.i./acre. Trifluralin effectiveness ranges from 60% to 75%, and is applied at a rate of 0.5 lb. a.i./acre. If metribuzin were banned, a possible substitute is cultivation. With this substitute, the predicted impact on yield would be a 30% loss. If trifluralin were banned, the predicted impact on yield would be between 10% to 30% loss (4). Methyl bromide also can be used, but no data was reported.

Non-chemical controls: Currently, weed control methods used on fresh tomatoes are black plastic for all annual weeds, cultivation for all annual weeds, crop rotation for yellow nutsedge and morning glory, transplanting for all annual weeds by crop competition, and hand weeding for all annual and perennial weeds.

Additional Weed Controls Options

Preplant Incorporated - Seeded

Napropamide (Devrinol 50DF) prior to seeding. Primarily controls annual grasses and certain broadleaf weeds. May reduce stand and yield of fall grains if fields are only disked. Moldboard plowing will reduce the risk of injury.

Preplant Incorporated -- Transplants

Napropamide (Devrinol 50DF) prior to transplanting. Primarily controls annual grasses and certain broadleaf weeds. Used in combination with metribuzin 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 (Tillam 6E or other formulations). Primarily controls annual grasses and yellow nutsedge. Used in combination with metribuzin to improve the spectrum of broadleaf weeds controlled. Trifluralin (Treflan 4EC or other formulations). Primarily controls annual grasses and certain broadleaf weeds. Used in combination with metribuzin to improve the spectrum of broadleaf weeds controlled. Will not control ragweed, jimsonweed, or morningglory.

Metribuzin (Lexone/Sencor 75DF or other formulations) before transplanting. Primarily controls broadleaf weeds. Tank-mix with napropamide, pebulate, or trifluralin to control annual grasses at planting, or use sethoxydim 1.5 EC to control grasses postemergence. An additional postemergence application of metribuzin may be necessary to control broadleaf weeds.

Postemergence -- Seeded

Metribuzin(Sencor/Lexone 75DF or other formulations). Primarily controls broadleaf weeds, but does NOT control nightshades. Repeat application to suppress or control yellow nutsedge. Metribuzin is weak on grasses and should follow a preplant or preemergence treatment of another herbicide for grass control. Sethoxydim(Poast 1.5EC) postemergence to control annual grasses and certain perennial grasses. Repeated applications may be necessary to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled. Trifluralin(Treflan 4EC or other formulations) at cultivation. For seeded tomatoes only.

Postemergence -- Transplanted

Metribuzin(Sencor/Lexone 75DF or Sencor/Lexone 4F). Primarily controls broadleaf weeds, but does NOT control nightshades. Use napropamide, pebulate, or trifluralin incorporated or apply sethoxydim 1.5EC postemergence to control annual grasses. Repeat application to suppress or control yellow nutsedge. Paraquat(Gramoxone Extra 2.5SC) as a directed spray between the rows. Pebulate(Tillam 6E

or other formulations) over transplants up to fruit formation. Incorporated into soil immediately after application where nutsedge is a problem. Sethoxydim(Poast 1.5EC)postemergence to control annual grasses and certain perennial grasses. Repeated applications may be necessary to control certain perennial grasses. Yellow nutsedge, wild onion, or broadleaf weeds will not be controlled.

Postharvest

Paraquat(Gramoxone Extra 2.5SC) as a broadcast spray after the last harvest.

Pesticide Use, Effectiveness and Importance:

The most common herbicides sold to commercial tomato growers in the state include Sencor and Treflan. Devrinol also is used by some growers in the state (7). The following table presents percent pesticide effectiveness, and percent tomato production loss, if the following pesticides were banned (2 and 4).

Pesticide	Sencor	Treflan
% Pesticide Effectiveness	60	75
% Tomato Production Loss if Pesticide were banned	30	30

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