Crop Profile for Tomatoes in Maryland

Revised: April, 1999

General Production Information

- Maryland ranks 13th among U.S. states in the production of tomatoes, producing 0.5% of the nation's tomatoes harvested for sale (1).
- Tomato is economically the 2nd most important vegetable crop grown in Maryland (2).
- Cash receipts have averaged $8.6 million for fresh tomatoes and $1.1 million for processing tomatoes from 1992 to 1996 (3).
- 2,500 acres of tomatoes were harvested in 1997 (4).
- 25 to 30 tons of processing tomatoes are produced by Maryland growers annually (5).
- Nearly two-thirds of Maryland tomatoes are produced for fresh market outlets (6).
- Fresh market production averages 20,000 to 25,000 lbs/acre, though the most productive growers may yield up to 50,000 lbs/acre (5).
- To ensure competitive yields and high quality produce, fresh market tomatoes are grown in intensive cultivation systems which require annual expenditures of $1,000 to $3,000 per/acre (2).

Production Regions

The Southern Eastern shore counties (Dorchester, Somerset, Wicomico, and Worcester) harvest 43% of the state's tomatoes by acreage (6).

Western counties (Allegany, Garrett, Baltimore, Carroll, Frederick, Harford, Howard, Montgomery, Washington, Anne Arundel, Calvert, Charles, Prince George's, and St. Mary) harvest 31% of the state's tomatoes by acreage(6).

Northern Eastern shore counties (Caroline, Cecil, Kent, Queen Anne's, and Talbot) harvest 26% of the state's tomatoes by acreage(6).

Cultural Practices

Fresh Market

About 50% of fresh market tomatoes in Maryland are grown on raised beds. The balance of growers use flat beds or 2 inch beds. Less than 2% of Maryland tomatoes produced for the fresh market are grown using no-till (7). Most growers use stakes woven with mesh to support the plants. Individual staking is rare in Maryland. Nearly all fresh market growers use black polyethylene mulch for weed control, with herbicide applied between rows. Less than 5% of growers use red plastic mulch instead of black (8). Fumigants are used some years on about 30% of fresh market acres, but are not applied at all in many counties, and are typically applied at the lowest labeled rates when used for weed suppression. For control of soil pests such as nematodes, and certain diseases, higher rates are used (5, 7). Trickle irrigation/nutrient delivery systems are employed by most fresh market growers. In addition, the crop is transplanted, pruned, tied several times if a trellis system is used, and hand-harvested.

Processing

For the most part, cultural practices for processing tomatoes are similar to those used for fresh market tomatoes (5). Most processing tomatoes are grown on bare ground using overhead irrigation (7).

Pesticide Usage

Because of the high overhead investment, growers of both fresh market and processing tomatoes tend to make very conservative decisions regarding the use of pesticides (2). Insect and disease control is achieved with preventative pesticide treatments. For fresh market tomatoes, fungicides are typically applied every 7 to 14 days, depending upon weather conditions, and insecticides less frequently(5). Not more than 7 total fungicide and insecticide applications were applied in 1998 by the average fresh market grower, and this was likely a typical year (8). Far fewer fungicides and somewhat fewer insecticides are used in processing tomatoes than in fresh market tomatoes (5). Plant growth regulators also are used on processing tomatoes to synchronize the maturation of the fruit for mechanical harvesting. All tomato growers are faced with resistant pest populations, particularly of the Colorado potato beetle. The rising costs of agrochemical inputs is a major constraint to growers which may limit tomato production (2).

Insect Pests

Insects and mites are controlled with a combination of non-chemical and chemical controls. Crop rotation is an important cultural practice for control of Colorado potato beetle and other insect pests (7). Preplant drenches with preventative insecticides have been found to be an effective and inexpensive means of insect control in tomatoes. This new strategy has spread quickly and has been adopted by 25 to

50% of Maryland growers (5, 7, 8). Total insecticide applications may be as low 3 to 4 applications during the growing season (5).

Major Insect Pests

Colorado Potato Beetle (*Leptinotarsa decemlineata*)

The Colorado potato beetle is the most severe pest on both processing and fresh market tomatoes in Maryland. The Colorado potato beetle 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 (9).

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 (10).

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. *Bacillus thurigiensis tenebrionis* is used on some tomato crop acreage (9).

Chemical controls:
The main chemical used on the Colorado potato beetle is the newly registered chemical, imidacloprid (Admire 16-24 fl oz 2F/A and Provado 3.75 fl oz 1.6F/A). Imidacloprid is very effective in low dosages against the CPB. 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. 80 to 90% of the state's tomato acreage is treated with one of these two preferred chemicals (5, 11, 12). 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 (11, 12); however, the newly labelled Spintor (spinosad 0.023-0.13 lbs ai/A (13)) is proving to be quite effective. This alternative insecticide is preferred by some growers hoping to slow imidacloprid resistance in the Colorado potato beetle (5). Other chemicals used on tomatoes for Colorado potato beetle control include abamectin, esfenvalerate, cryolite, azinphos-methyl, azadirachtin, rotenone, endosulfan, and lambda-cyhalothrin (9).

Tomato Fruitworms (corn earworm)

The next highest rated insect in terms of pest severity is the tomato fruitworm, also known as corn earworm (2, 12). 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 (14).

Chemical controls:
Treatment of fruitworms mainly consists of lambda-cyhalothrin (Warrior 2.56-3.84 fl. oz. IE/A) and cyfluthrin (Baythroid 1.6-2.8 fl oz 2E/A). Also used for earworm control are azinphos-methyl (Guthion 3-6 pt 2L/A), esfenvalerate (Asana 2.9-9.6 fl oz 0.66 EC/A), methomyl (Lannate 1.5-3 pt LV/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) (9).

Aphids (Green Peach and Potato)

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. The green peach aphid is the biggest insect pest control issue in Carroll County, where it has developed resistance to all the major insecticides used against it (8). 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 (15).

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 (10). Imidacloprid (Admire) is used by many growers. It has low toxicity and is one of the most effective chemicals available (8). Lambda-cyhalothrin (Warrior) and cyfluthrin (Baythroid) are used, replacing most of the older organophosphates such as dimethoate, carbamates such as oxamyl (Vydate), and cyclodienes such as endosulfan (Thiodan) (9).

Other Insect/Mite problems

Leafminers and pinworms

In staked tomatoes, leafminers and pinworms are a problem. The pinworm is an introduced pest on southern transplants

Chemical controls:
Abamectin (Agri-Mek 8-16 fl oz 1.5 EC/A) is the main chemical used for control. Other chemicals used include dimethoate, esfenvalerate, diazinon, cyromazine, cyfluthrin, azinphos-methyl, tridecan acetate, methyl parathion, and oxamyl.(9).

True Armyworm (TAW), Fall Armyworm (FAW), Beet Armyworm (BAW)

Chemical controls:
Cyfluthrin (Baythroid), methyl parathion (Lannate), lambda-cyhalothrin (Warrior) (9).

Mites

Chemical controls:
Abamectin, dicofol (Kelthane MF). Use of dimethoate for aphids and leafminers may help reduce mite population (9).

Thrips

Several species of thrips spread tomato spotted wilt virus. Some growers scout for thrips and begin treatments when thrips are observed.

Chemical controls:
Use of lambda-cyhalothrin (Warrior) for other pests reduces thrips populations (9). *In the greenhouse*: malathion is used. 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 used (9).

Stinkbug

Chemical controls:
Cyfluthrin (Baythroid), endosulfan (Thiodan), and lambda-cyhalothrin (Warrior) (9).

Whiteflies

Chemical controls:
imidacloprid (Admire), esfenvalerate (Asana XL), azinphos-methyl (Guthion), imidacloprid (Provado), and endosulfan (Thiodan) (9).

Fruit Fly (Vinegar Fly)

Chemical controls:
In the field: diazinon; *basket or bin treatment*: apply a dust containing 0.1% pyrethrum + 1% piperonyl butoxide at the rate of 0.5 to 1 pound of dust per ton of fruit as containers are filled; *processing*: indoors, apply pyrethrum fog when plant is shut down temporarily and before cleanup (9).

Cutworms

Chemical controls:
Preplanting: diazinon; *postplanting*: esfenvalerate (Asana XL), methyl parathion (Lannate), carbaryl (Sevin bait), lambda-cyhalothrin (Warrior) (9).

Spider Mites

Chemical controls:
Abamectin (Agri-Mek) is the main chemical used. Some endosulfan (Thiodan) is also used (12).

Diseases

Diseases are the most important category of pest in Maryland tomatoes, particularly fresh market tomatoes, where growers need to keep plants healthy over a longer harvest period (8). Early blight, Fusarium wilt, and buckeye rot are the most severe diseases in Maryland, both for fresh market and processing tomatoes. In addition, anthracnose can be severe on fresh market tomatoes which are harvested ripe, and on processing tomatoes (19). Early blight, Septoria leaf spot, and Botrytis fruit rot are 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 becomes a major control issue once it has infested a field (8). The bacterial diseases, including bacterial speck, bacterial spot, and bacterial canker, are more problematic than fungal diseases for fresh market tomatoes. They are difficult to control, since few effective products are available. The only effective controls are the copper products. Bacterial diseases are less of an issue for processing tomatoes, except when they occur early in the growing season. Processing varieties are generally more resistant to bacterial diseases, and these bacterial diseases are primarily a cosmetic problem (5, 19). Some growers in Maryland 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 (8). Most growers, however, rotate fungicides with dissimilar modes of action (7). This is important for fungicides where the risk of resistance development is high. Azoxystrobin (Quadris) is an important newly-labeled broad-spectrum fungicide for tomatoes in Maryland. It is very effective against some fungal diseases that are not controlled by chlorothalonil (19). Many growers alternate azoxystrobin with chlorothalonil for very effective control of fungal diseases (5).

Major Disease Pests

Early and Late Blight

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 (19). Early blight is controlled in Maryland primarily by chemical controls (20). However, there are some cultural practices which reduce initial disease inoculum or subsequent spread. (19).

Late blight is an increasingly important disease in Maryland (8), though it doesn't occur every year (19). It is favored by cool, wet conditions, and is controlled primarily by chemical controls. The most commonly used chemicals are azoxystrobin (Quadris), mancozeb, or Tattoo C (chlorothalonil and propamocarb hydrochloride) (8). Tattoo C was available in 1998 under section 18 registration in Maryland. It does not yet have a section 3 registration (19). Metalaxyl (Ridomil) has also been used (7). 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 (19). Ridomil Gold contains copper, which was added to slow resistance development (7).

Leaf Spots and Fruit Rots

The leaf spot diseases are recognized by lesions or blotches produced on plant foliage or stems. In addition to early blight (see above), leaf spot diseases include gray leaf spot and Septoria leaf spot (19).

Septoria leaf spot has become increasingly problematic in Maryland and is now seen as often as early blight (8). 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 Maryland with chemical controls

(19). Fruit rot results from infection by *Alternaria, Colletotrichum*, and other pathogens.

Anthracnose, the most important fruit rot on processing 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. Protectant fungicide sprays are necessary on processing tomatoes (19).

Buckeye rot infects tomato fruit when severe rain or high humidity occur (19). It is not an issue in fresh market tomatoes, but is of economic importance to growers of processing tomatoes (5). Buckeye rot is controlled in Maryland with a combination of non-chemical (water and fertilizer management) and chemical treatments (10).

Wilts

Fusarium and Verticillium wilts occur in Maryland. 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 (19).

Disease Management

Non-chemical controls:
Crop rotation is currently the leading non-chemical control practice used (90% of tomato crop). Fresh tomatoes are rotated to minimize the economically damaging effects of early blight, bacterial speck and spot, canker, and Septoria leaf spot. Processing tomatoes are rotated to reduce damage resulting from root knot nematodes, bacterial speck and spot, canker, early blight, buckeye rot, and anthracnose. On fresh market tomatoes, resistant varieties are used to control Fusarium wilt and Verticillium wilt. For processing tomatoes, resistant varieties are selected to control root knot nematodes, Fusarium wilt, and Verticillium wilt (17, 19).

Chemical controls:
Prior to the recent registration of azoxystrobin (Quadris) on tomatoes, chlorothalonil (Bravo) was the primary fungicide used on *fresh market tomatoes*. At that time, chlorothalonil was used on 95% of Maryland's fresh market tomato crop, and it continues to be used extensively. The fungicide 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 used on 35% of Maryland's fresh market tomato crop. This fungicide 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 or gain of tomato yield; however, this would likely result in increased cost to the grower. Other chemicals used on fresh market tomatoes include copper (on bacterial speck and spot, 5% of the crop), benomyl (for timber rot, 1% of the crop), and methyl bromide (for nematodes, 15% of the crop) (17, 19).

Chlorothalonil, azoxystrobin, and mancozeb are the key fungicides used on *processing tomatoes*. Chlorothalonil has historically been used on 98% of Maryland's crop. The fungicide is applied at a rate of 2.25 lb. a.i./acre 4 times per year to control early blight, anthracnose, Septoria leaf spot, grey leaf spot, anthracnose and buckeye rot. If chlorothalonil were lost from use, a combination of mancozeb, azoxystrobin, and copper could be used. Mancozeb has historically been used on 50% of Maryland's processing tomatoes. The fungicide is applied at a rate of 2.4 lb. a.i./acre twice a year to control early blight, anthracnose, Septoria leaf spot, gray leaf spot, and buckeye rot. If mancozeb were lost, a combination of chlorothalonil, azoxystrobin, and copper could be used (19).

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) (21). Several species of plant pathogenic nematodes occur in Maryland soils (9), generally as mixed populations unevenly distributed throughout a field (21).

Root knot nematode

The most important nematode pest of tomatoes in Maryland is the root knot nematode (*Meloidogyne spp.*) (22). 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 (23).

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 (23).

Secretions exuded by nematodes during feeding cause plant cells to swell, producing the diagnostic elongated or rounded "knots" on the roots (23, 24). The nematodes feed within the plant and undergo 3 more molts before reaching reproductive maturity (23). Generation time is 25 to 40 days, depending upon host susceptiblity, moisture, temperature, and soil type (22, 25).

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 (23). Nematode feeding produces the most severe symptoms under drought conditions, when plants are under increased stress (22). 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 (26).

Frequency of Occurrence

Root knot nematode is a potentially serious pest of tomatoes in Maryland, but routine soil sampling and crop rotation practices prevent populations from reaching economic levels on most fields most years (5, 7). 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 (22).

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 (26). On the Eastern Shore, 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 (5, 21). Most tomato growers west of the Chesapeake Bay don't sample for nematodes routinely (7). If nematode damage is suspected after crop emergence, soil and root samples are generally submitted for laboratory analysis to determine the kind and number of nematodes present (9). Nematologists estimate the injury potential of a nematode population and use thresholds to determine if a control measure is warranted (21).

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 (22), 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 (5).

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. On the Eastern Shore, a 5-year rotation is common. 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 (5). Also, land limitations and market demands can limit the usefulness of crop rotation as a control measure for nematodes or diseases (7).

Other nonchemical practices that help to prevent the build-up of nematodes include the use of nematode-free transplants (26), incorporation of green manure or other organic matter into the soil (9), cleaning of farm equipment (which can spread nematodes from field to field), and maintaining good weed control (28). Post-harvest discing is a standard practice for growers of fresh market and processing tomatoes. 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 (5).

Chemical Controls for Nematodes:
Crop rotation and other cultural practices generally prevent nematode buildup in tomatoes, but in some cases, chemical control is warranted (5). Chemical control of nematodes is generally achieved by the use of fumigants (such as methyl bromide) or nonvolatile nematicides (28). 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 (5).

<u>Eastern Shore</u>
As much as 30% of fresh market tomatoes on the Eastern Shore may be fumigated for nematode, disease, and insect control. Fumigation is rarely done strictly for nematode control. On the Eastern Shore, methyl bromide (225 lbs/A of Terr-O-Gas 67 or MC-33), applied as an injected soil gas under plastic, accounts for about a third of the acres fumigated. Metam-sodium (25-100 gal/A of Vapam, Busan, or Nemasol) makes up the rest. It 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. Fumigation is not used in production of processing tomatoes. 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 1/4 rate at the base of plants with a cultivator in bare-ground tomatoes, but very few growers use these methods (5).

<u>West of the Chesapeake Bay</u>
Up to 20% of growers west of the Chesapeake Bay may use 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. Approximately 5% of acres are treated with fumigants in a typical year. The cheapest and most commonly used product is methyl bromide (225-350 lbs/A of Terr-O-Gas 67 or MC-33). Chloropicrin (50 gal/A) is also used by some growers. 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). The Telone products are listed as liquid fumigants with very broad spectrums. The other soil fumigant used is metam-sodium (75-100 gal/A of Vapam, Busan, or Nemasol) (7).

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 (8). Annual broadleaves, annual grasses, and nutsedge are the most severe weed problems on Maryland's tomato crop.

Major Weed Pests

Eastern black nightshade

This weed is problematic since it is also solanaceous and the herbicides usually used in tomatoes (napropamide, trifluralin, pebulate, metribuzin, and metolachlor) fail to control it. Chloramben was effective on black nightshade, but it was discontinued by the manufacturer because the costs of reregistration exceeded the economic potential of the product (16).

Non-chemical controls:
Currently, non-chemical components of IPM are being used to control weeds on 95% of Maryland tomatoes. For processing tomatoes, non-chemical weed control methods include cultivation for annual weeds, transplanting by early competition for all annual weeds and perennials, crop rotation for annual weeds, hand weeding for annual weeds and yellow nutsedge, and cereal cover crop mulch for annual weeds. For fresh tomatoes, methods used 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 (17).

Chemical controls:
Metolachlor (Dual) was granted an emergency exemption under section 18 for use against eastern black nightshade and yellow nutsedge in tomatoes in 1998. Maryland has requested section 18 registration for a new formulation of this product (Dual Magnum) for the same use in 1999, and national registration for this use is currently pending. The rate is 0.80-1.0 pt/A on coarse soils if organic matter is less than 3% or 1.33-1.67 pt/A on fine soils (16).

Morning glory (tall morning glory and ivy leaf morning glory)

These summer annual weeds can become pests in beans, cucurbits, sweet corn, and tomatoes. They are vining weeds that grow very slowly in late-planted vegetables, but seeds are produced before frost (10). Morning glories are very competitive and generally difficult to control in most crops (18). Most vegetable herbicides do not control morning glory. Timely cultivation when the morning glory has just emerged is required (10). Morning glory is the most severe weed pest on both fresh market and processing tomatoes in Maryland (12).

Chemical controls:
For processing tomatoes, the main herbicides used to control morning glory are metribuzin (Sencor) and napropamide (Devrinol). Metribuzin is applied to 90% of planted acres once per year at a rate of 0.25 lb. a.i./acre. Napropamide is applied to 5% of planted acres once per year at a rate of 1.0 lb. a.i./ acre. If the use of metribuzin were to be restricted, substitutes used would include cultivation and the herbicide paraquat. The predicted impact on tomato yield would be a 20% loss. If napropamide were restricted, substitutes would include cultivation and the herbicide trifluralin. The predicted impact on tomato yield would be a 10% loss (17).

For fresh market tomatoes, metribuzin is the main herbicide control. The chemical is used on 90% of planted acres once per year at a rate of 0.66 lb. a.i./acre. If the use of metribuzin were restricted, substitutes would be cultivation and the herbicide paraquat. The predicted impact on tomato yield would be a 25% loss (17).

Nutsedge, *Cyperus sp.*

Yellow nutsedge is the next most severe weed problem, and is prevalent on both fresh market and processing tomatoes. This perennial weed forms rhizomes and nutlets in August. It may be a pest in cucurbits, beans, and sweet corn, as well as tomatoes. Nutsedge usually is controlled in vegetable crops with herbicides. For a high level of infestation, the nutsedge population should be reduced by growing corn in crop rotation, since corn herbicides are available for effective control of nutsedge. In the spring, nutsedge-infested areas are disked frequently to prevent the development of large plants, because nutsedge plants over 5 inches tall are difficult to kill by tillage, and herbicides also are less effective on large plants (10, 12)

Chemical controls:
For processing tomatoes, the main herbicides used to control yellow nutsedge are metribuzin (Sencor) and pebulate (Tillam). Metribuzin is applied to 45% of planted acres once per year at a rate of 0.35 lb. a. i./acre. Pebulate is applied to 13% of planted acres once per year at a rate of 2.5 lb. a.i./ acre. If metribuzin were restricted, substitutes would include cultivation, handweeding, and the herbicide paraquat. With these substitutes, a 20% loss is the predicted impact on yield. If the use of pebulate were to be restricted, one substitute that could be used would be cultivation. All of the acres currently treated with pebulate could be cultivated with no predicted impact on yield (17).

For fresh market tomatoes, the main herbicides used to control yellow nutsedge are metribuzin (Sencor), methyl bromide, and pebulate (Tillam). Metribuzin is applied to 90% of planted acres once per year at a rate of 0.66 lb. a.i./acre. Methyl bromide is applied to less than 30% of planted acres once per year at a rate of 225 lb. a.i./acre, for weed, disease, and nematode control. Lower rates may be used for weed control alone. Pebulate is applied to 10% of planted acres an average of 2.3 times per year at a rate of 0.5 lb. a.i./ acre. If metribuzin were restricted, two possible substitutes are cultivation and the herbicide paraquat. With these substitutes, the predicted impact on yield would be a 25% loss. If methyl bromide were restricted, hand weeding could be done as a substitute, with a predicted 25% loss of yield. If pebulate were restricted, substitutes would include methyl bromide and paraquat. No impact on yield is predicted (17).

Additional Weed Controls Being Used

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 (9).

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 (9).

- 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 (9).

- 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 morning glory (9).

- 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 (9).

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 (9).

- **Sethoxydim**(Poast 1.5EC) posteemergence 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 (9).

- **Trifluralin**(Treflan 4EC or other formulations) at cultivation. For seeded tomatoes only (9).

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 (9).

- **Paraquat**(Gramoxone Extra 2.5SC) as a directed spray between the rows (9).

- **Pebulate**(Tillam 6E or other formulations) over transplants up to fruit formation. Incorporated into soil immediately after application where nutsedge is a problem (9).

- **Sethoxydim**(Poast 1.5EC)posteemergence 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 (9).

Postharvest

- **Paraquat**(Gramoxone Extra 2.5SC) as a broadcast spray after the last harvest. A special local-needs 24(c) label has been approved for the use of Gramoxone Extra 2.5SC for postharvest desiccation of the crop in Maryland and Virginia (9).

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