Crop Profile for Tomatoes in Arkansas

Prepared: August, 2003

General Production Information

- **State Rank**: 18th
- **Percentage of U.S. Production**: Less than 2%
- **Total acres grown**: 1,200 acres (estimated)
- **Cash Value**: $12 to 16 million (estimated)
- **Production Regions**: Tomato production is distributed throughout Arkansas with the greatest concentration of growers in Bradley, Drew, and Ashley Counties.

Cultural Practices

The tomato, *Lycopersicon esculentum*, is a tender, warm season crop belonging to the Solanaceae or nightshade family. Tomatoes prefer a well-drained, loam soil with a soil pH of 5.8-7.2.

Crop rotation is commonly practiced to aid in the reduction of several disease, insect and weed problems. Most growers in Arkansas now produce tomatoes using the plasticulture production system. Use of methyl bromide aids in reduction of soil-borne pests that include weeds, insects and several wilt diseases. Transplants are planted in early spring from March 25 to May 1, and for fall production, during July depending on soil temperature and location in the state. The transplants are planted in single rows at densities of approximately 4000 plants per acre on methyl bromide fumigated, raised beds that are covered with black plastic mulch at 18-24 inches apart and 48-72 inches between rows.

Methyl bromide (67%) + chloropicrin (33%) is currently applied prior to planting (minimum of two weeks between application and planting) transplants for management of soil borne diseases, nematodes, insects, and weeds. A single application of approximately 200 lb. of product per acre is injected into the soil during construction of the plastic covered raised beds. Row middles are not treated. Standard production practices include use of methyl bromide fumigation, raised beds, black polyethylene mulch, and drip-irrigation. Rows are usually spaced five feet apart and plants are usually 18-24 inches apart in the row. Most producers grow their own transplants. Tomatoes are staked, pruned, and tied using the Florida string-weave system. Tomatoes are hand-harvested and often field packed.

Worker Activities

Tomato plants are normally planted in the spring (March 25 to May 5) into plastic covered beds that are normally fumigated before planting (80 – 90% of the tomato acreage in Arkansas is fumigated with methyl bromide). Approximately 95% of the planting is by hand means. The fumigation normally is done at least 14 days prior to planting (30 days prior to planting is nearer the norm).

Preemergent herbicide applications are applied to the middles beds of mulched tomatoes. These applications are made in early spring, primarily with tractor mounted spray equipment. Postemergence herbicide applications are made to the beds of traditionally grown tomatoes and the row middles of plastic covered beds in early summer and occasionally after harvest primarily with tractor mounted sprayers although backpack sprayers are occasionally used. Hand labor is used to tie and prune the plants above the plastic beginning (May to June).

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Insecticides and fungicides are applied from early spring up to harvest primarily with airblast sprayers or boom sprayers.

Virtually the entire tomato crop is hand-harvested (June -July). The tomato plants are normally removed after harvest as well as the plastic mulch. This is all done by hand. The beds are renovated in preparation for fumigation before replanting in the spring.

**Insect Pests**

**Aphids**

*Macrosiphum euphorbiae*

Aphids or plant lice are among the smallest most preyed on of all insects, yet because of their immense vitality and extraordinary fecundity resulting from a short life cycle and an ability to reproduce parthenogenetically, they affect nearly every kind of green plant, including tomatoes.

Aphids, generally about 1/16 to 1/8 inch long, are usually green, although some species are brown, yellow, pink or black. They can usually be distinguished by the pair of oil- or wax-secreting tubes on the upper side of the fifth or sixth abdominal segment and by their two-segmented tarsi. They feed by thrusting sharp, hollow stylets from their beaks in among the plant cells and sucking out the sap. During the feeding process, they may inject toxic saliva into the plant. The result is a blighting of buds, dimpling of fruits, curling of leaves and the appearance of discolored spots on the foliage.

On tomatoes, the most noticeable injury is the devitalizing of the blossom clusters so that the blossoms fall and no tomatoes set. When large numbers of aphids are present, the plants may gradually wilt, turn yellowish or brown and die. Aphids are among the most important agents in the dissemination of plant virus diseases; a brief period of feeding by a single infected aphid may infect and eventually kill a plant.

Aphids typically winter as fertilized eggs on some perennial plant (particularly roses) or on refuse from annual vegetable crops. The spring hatching nymphs, functioning as stem-mothers, become the start for a great colony of aphids over the growing season. Greenish or pinkish, winged or wingless aphids cluster in shaded places on the leaves, stems and blossoms. Winged migrants spread from field to field so that the epidemic may sweep over a district in an alarming manner. Following such an outbreak, the insect may not visit a community in conspicuous numbers again for many years.

**Controls**

**Biological:** Aphids are preyed upon by lady beetles and green lacewing and syrphid larvae, but these cannot usually control the rapid spring increase in aphid populations. Wasp parasites are also enemies of aphids but provide limited control.

**Insecticides for Aphid Control:**

**Abamectin** (Agri-Mek 0.15 EC) 8-16 fl oz. Applied as a foliar spray at 8-16 fl oz product per acre. PHI: 7 days. REI: 12 hours

**Dimethoate** (Dimethoate 400) - Applied as a foliar spray at 1/2 to 1 pint product per acre per season. PHI: 7 days. REI: 48 hours.

**Diazinon** (Diazinon 50 WP) - Applied as a foliar spray at 1/2 lb product per acre per season. PHI: 1 day. REI: 24 hours.
**Endosulfan 3 EC** (Thiodan, Phaser)- Applied as a foliar spray at 2/3 to 1-1/3 qt product per acre to a limit of 6 applications or 4 qt per acre per season. PHI: 1 day. REI: 48 hours.

**Malathion** (Malathion 57 EC) - Applied as a foliar spray at 1 to 3 pt product per acre. PHI: 3 days. REI: 12 hours.

**Imidacloprid** (Provado 1.6 F) - Applied as a foliar spray at 3.75 fl oz per acre to a limit of 18.75 fl oz product per acre per season. (cannot be used following a soil application of Admire.) PHI: 0 days. REI: 12 hours.

**Colorado Potato Beetle**  
*Leptinotarsa decemlineata*

The Colorado potato beetle is notorious for its ability to rapidly develop resistance to insecticides that are used repeatedly for control. This has been a serious problem on the east coast for some time, and is becoming more of a problem in Arkansas. With a limited number of insecticides available, some growers feel they have exhausted their control options when it becomes resistant to one or more insecticides.

In tomatoes Colorado potato beetle is an infrequent pest of newly set tomato plants. The adult and larva feed on the leaves and terminal growth of tomato plants, but typically only cause serious damage to young plants. Once plants reach eight inches, adult or larval feeding, regardless of the apparent severity of damage, does not reduce fruit yield.

Colorado potato beetles overwinter in the soil as adults. They become active in the spring as temperatures rise and begin to feed on weeds and volunteer or early planted potatoes, even entering the soil to attack emerging foliage. Female beetles lay orange-yellow eggs in batches of approximately two dozen on the underside of the leaves. Each female can lay 500 or more eggs over a four to five week period. Eggs hatch in four to nine days and the larvae begin to feed on potato foliage. The larvae are humpbacked with two rows of black spots on each side. They usually feed in groups and damage can be severe. The larval stage lasts two to three weeks.

Full grown larvae burrow in the ground to pupate. In five to 10 days, the adult beetle emerges. This insect can go from egg to adult in as little as 21 days. The newly emerged adult female feeds for a few days before egg laying begins. There are two full and occasionally a partial third generation each year. If foliar sprays are used, an effort should be made to treat just after most eggs have hatched but before serious plant damage occurs.

**Controls**

**Biological:** The Colorado potato beetle has several important natural enemies in Arkansas including the pentatomids, *Perillus bioculatus* and *Podisus maculiventris*. *Bacillus thuringiensis* var *tenebrionis* (Bt) is effective against small larvae (less than 1/4 inch) and is applied at egg hatch or when larvae are first seen. A premature treatment may lose much of its effectiveness before the eggs hatch. Larger larvae are more difficult to control with Bt.

**Monitoring:** Recommendations are to treat for Colorado potato beetle if an average of 1 adult larva or egg mass per plant is found and plants are less than 12 inches tall when staked.

**Chemical:** Insecticides in the same chemical class usually have the same mode of action, the same method of killing the insect. Resistance develops more rapidly to an insecticide when that insecticide is used repeatedly as the only control measure. Repeated use of one insecticide, or insecticides with similar modes of action, kills susceptible beetles, leaving those that are resistant. Overuse of one insecticide may favor the development of resistance to other insecticides in the same chemical class. Consequently, to delay or prevent resistance
it is important to avoid repeated usage of one particular insecticide by rotating the insecticides used.

**Insecticides used for Colorado potato beetle control:**

**Abamectin** (Agri-Mek 0.15 EC) - Applied as a foliar spray at 8 to 16 fl oz product per acre. Limit 48 fl oz per acre per season. Allow 7 days between applications. PHI: 7 days. REI: 12 hours

**Permethrin** (Ambush 2 E) - Applied as a foliar spray at 3.2 to 12.8 fl oz product per acre to a limit of 76.8 fl oz per acre per season. PHI: 0 days. REI: 12 hours.

**Esfenvalerate** (Asana XL) - Applied as a foliar spray at 5.8 to 9.6 fl oz product per acre to a limit of 96 fl oz per acre per season. PHI: 1 day. REI: 12 hours.

**Endosulfan 3 EC** (Thiodan, Phaser) - Applied as a foliar spray at 2/3 to 1-1/3 qt product per acre to a limit of 4 qt per acre or 6 applications per season. PHI: 1 day. REI: 48 hours.

**Imidacloprid** (Provado 1.6 F) - Applied as a foliar spray at 3.75 fl oz product per acre to a limit 18.75 fl oz per acre per season. Do not use following a soil application of Admire. PHI: 0 days. REI: 12 hours.

**Spinosad** (Spintor 2SC) - Applied as a foliar spray at 2.25 to 4.5 fl oz product per acre to a limit of 0.45 lb ai per acre per season. PHI: 1 day. REI: 4 hours

**Lambda-cyhalothrin** (Warrior 1EC) - Applied as a foliar spray at 2.56 to 3.84 fl oz product per acre to a limit of 2.88 pts per acre per season. Not for use on cherry tomatoes. PHI: 5 days. REI: 24 hours.

**Cutworms**  
(Various species)

Several species of cutworms can occasionally be serious pests of newly set tomatoes in Arkansas. As in other crops, the seedling losses caused by cutworms result in reduced stands.

**Controls**

**Biological:** Ground beetles and other generalist predators readily prey upon several cutworm species but provide limited control.

**Cultural:** Rotation of crops and summer plowing can be effective in limiting the impact of some cutworms. The elimination of weeds from field margins and plowing fields at least two weeks prior to planting, helps to destroy cutworm food sources and egg laying sites.

**Monitoring:** Tomato producers often treat for cutworms and flea beetles preventively just after the plants have been set into the field.

**Insecticides for cutworm control:**

**Esfenvalerate** (Asana XL) - Applied as a foliar spray at 5.8 to 9.6 fl oz product per acre to a limit of 96 fl oz per acre per season. PHI: 1 day. REI: 12 hours.

**Tebufenozide** (Confirm 2F) – Applied as a foliar spray at 6-8 fl oz per acre. PHI: 7 days. REI: 4 hours.

**Carbaryl** (Sevin 80S) – Applied as a foliar spray at 2-1/2 lbs product per acre to a limit of 7 applications per season (must allow at least 7 days between sprays). PHI: 3 days. REI: 12 hours.
Tomato Fruitworm
(*Heliothis zea*)

The tomato fruitworm is potentially the most damaging insect pest of tomato. The larvae are variable in color, ranging from pale yellow, to red, to green, to brown with pale stripes running lengthwise. The larvae have four pairs of prolegs and are densely covered with microscopic spines that makes the larvae feel rough.

The moths lay eggs at night on leaves near green fruit at the outer edges of the plant. The dome shaped eggs are white when first laid and develop a reddish brown band before hatching. After the egg hatches, the larva feed for a short period of time on the foliage before attacking the fruit. They prefer to feed on green fruit and usually do not enter ripe fruit. Damage consists of deep watery cavities frequently in the stem end of the fruit. During its development, one larva may injure several fruit.

The tomato fruitworm has a wide host range and the attractiveness of tomatoes for egg laying vary with the time of year. Early fruitworm generations attack corn, particularly when it is silking. Tomatoes are preferred for egg laying over corn when the silks turn brown and dry.

**Controls**

**Biological:** The egg parasite, *Trichogramma* ssp., is the most important natural enemy and provides some control, but growers often must resort to insecticide applications to control large infestations by the insect.

**Monitoring:** Plants must be carefully monitored plants for eggs on undersides of leaves, often near flower clusters. Recommendations are to treat only when the plants have green fruit and an average of 1 infested plant (larvae or fresh feeding damage) per 40 plants or when any eggs are present on foliage. When trap catches exceed 7 moths per trap per week the plants should be monitored carefully.

**Insecticides for tomato fruitworm control:**

**Permethrin** (Ambush 2 E) - Applied as a foliar spray at 3.2 to 12.8 fl oz product per acre to a limit of 76.8 fl oz per acre per season. PHI: 0 days. REI: 12 hours.

**Esfenvalerate** (Asana XL) - Applied as a foliar spray at 5.8 to 9.6 fl oz product per acre to a limit of 96 fl oz per acre per season. PHI: 1 day. REI: 12 hours.

**Endosulfan 3 EC** (Thiodan, Phaser) - Applied as a foliar spray at 1-1/3 qt product per acre to a limit of 4 qt per acre per season. PHI: 1 day. REI: 48 hours.

**Carbaryl** (Sevin 80S) - Applied as a foliar spray at 1-1/4 to 2-1/2 lb product per acre to a limit of 7 applications per acre per season. Allow at least 7 days between sprays. PHI: 3 days. REI: 12 hours.

**Spinosad** (Spintor 2SC) - Applied as a foliar spray at 3 to 6 fl oz product per acre to a limit of 0.45 lb ai per acre per season. PHI: 1 day. REI: 4 hours.

**Lambda-cyhalothrin** (Warrior 1EC) - Applied as a foliar spray at 2.56 to 3.84 fl oz product per acre to a limit of 2.88 pts per acre per season. Not for use on cherry tomatoes. PHI: 5 days. REI: 24 hours.
Flea Beetles
(*Epitrix cucumeris* and *Epitrix hirtipennis*)

Flea beetles attack the foliage leaving small round holes in the leaves and large numbers may destroy entire leaves. Potentially they can be serious pests early in the season when the plants are less than 4 to 6 inches tall. As they grow, larger plants can withstand substantial flea beetle damage without loss of yield.

As soon as the plants are set, they are vulnerable to attack by two species of flea beetles, the tobacco and potato flea beetles. The tobacco flea beetle is about the same size, but is yellowish brown with a dark band across its wings. The potato flea beetle is about 1/10 inch and brownish black in color. These beetles infest solanaceous crops such as tobacco, potato, tomato, and pepper.

**Controls**

**Biological:** No effective biological controls against flea beetles on tomatoes are recognized in Arkansas.

**Cultural:** Weed control in and around the fields is often the most important method of holding these pests in check, since the adults often feed on weeds harbor flea beetles early spring and late in fall.

**Monitoring:** Plants should be monitored through flowering. Treatments are recommended only when the plants are less than 6 inches and an average of 40 beetles per 10 plants or 30% defoliation.

**Insecticides for flea beetle control:**

- **Endosulfan 3 EC** (Thiodan, Phaser) - Applied as a foliar spray at 2/3 to 1-1/3 qt product per acre to a limit of 4 qt per acre or 6 applications per season. PHI: 1 day. REI: 48 hours.

- **Azinphos-methyl** (Guthion 50 WP) - Applied as a foliar spray at 3/4 to 1 1/2 lb product per acre. PHI: 4-14 days. REI: 48 hours.

- **Carbaryl** (Sevin 80WSP) - Applied as a foliar spray at 1-1/4 to 2-1/2 lb product per acre with a limit of 7 applications per acre per season. Allow at least 7 days between sprays. PHI: 3 days. REI: 12 hours.

Two Spotted Spider Mite
(*Tetranychus urticae*)

Two-spotted spider mites are occasional pests that can cause serious damage to some vegetable crops during hot dry weather. Mites can injure tomatoes, beans, muskmelons, watermelons, and sweet corn. Extended periods of hot, dry weather favors mite buildups. Infestations usually first occur at the edge of a field, typically near rank weed growth or dirt roads. Mites can also be easily moved from infested plants to non-infested plants on clothing.

Generally mites feed on the undersides of leaves. They use their sucking mouthparts to remove sap from plants, giving the upper leaf surface a speckled or mottled appearance. Leaves of mite infested plants may turn yellow and dry up, and plants may lose vigor and die when infestations are severe. The underside of affected leaves appear tan or yellow and have a crusty texture. Heavy infestations of the two-spotted spider mite produce fine webbing which may cover the entire plant.

**Controls**
**Biological:** Natural enemies of mites are present in and around fields and can keep mite populations low. Many insecticides used for control of insect pests severely reduce numbers of beneficial insects that keep mite populations in check. Insecticides are applied only as needed, rather than at regularly scheduled intervals.

**Cultural:** It is recommended that destruction of weeds adjacent to and in fields should be done in the fall or early spring and most growers utilize this practice. Weeds are often controlled by mowing around fields regularly during the season, although spraying or mowing of weeds after growth has become rank may increase the movement of mites to cultivated plants. Use of overhead-sprinkler irrigation may provide some short-term relief of mite infestations.

**Monitoring:** Mites can be identified by shaking symptomatic leaves onto a sheet of white paper or by observing infected leaf areas with a hand lens.

**Insecticides for mite control:**

When possible, select pesticides for other pests which will have the least impact on beneficial insects.

- **Abamectin** (Agri-Mek 0.15 EC) - Applied as a foliar spray 8 to 16 fl oz product per acre. Limit 48 fl oz per acre. Allow 7 days between applications. PHI: 7 days. REI: 12 hours

- **Dicofol** (Kelthane MF) - Applied as a foliar spray at 3/4 to 1-1/2 pt product per acre. Limit 2 applications per season. Allow 7 days between applications. PHI: 2 days. REI: 12 hours

- **Malathion** (Malathion 57 EC) - Applied as a foliar spray at a rate of 1 1/2 pt product per acre per season. PHI: 3 days. REI: 12 hours

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**Stink Bugs**  
*(Acrosternum hilare, Euschistus servus)*

Green stink bug (*Acrosternum hilare*) and brown stink bug (*Euschistus servus*) attack vegetable crops including tomatoes. Stink bugs have a distinctive shield shape and produce an odor when handled. There are several species of stink bugs that feed on tomato fruit, but the brown stink bug is the most serious. Stink bugs feed with piercing sucking mouthparts which cause whitish-yellow corky spots underneath the skin of the fruit. This damage is serious for fresh market tomatoes and whole-pack processing tomatoes because they render the fruit unmarketable.

Adult stink bugs migrate from weedy areas into tomato fields, particularly when the plants begin to decline. On green fruit, stink bug damage appears as a pin prick, surrounded by a light discolored area. This may turn yellow or remain green on ripe fruit and the tissue below these spots corky.

**Controls**

- **Biological:** There are no recognized effective natural enemies of stink bugs on tomatoes in Arkansas.

- **Cultural:** Growers avoid mowing or chopping weeds, pastures, or hay fields near tomato plantings because this practice can drive adult stink bugs into tomato fields. Weeds near tomato fields should not be allowed to become rank before mowing.

- **Monitoring:** Recommendations are to treat if an average of more than one stink bug per 40 plants is found.

**Insecticides for stinkbug control:**
**Endosulfan 3 EC** (Thiodan, Phaser) - Applied as a foliar spray at 2/3 to 1-1/3 qt product per acre to a limit of 4 qt per acre or 6 applications per season. PHI: 1 day. REI: 48 hours.

**Azinphos-methyl** (Guthion 50 WP) – Applied as a foliar spray at 3/4 to 1 1/2 lb product per acre. PHI: 4-14 days. REI: 48 hours.

**Carbaryl** (Sevin 80WSP) - Applied as a foliar spray at 1-1/4 to 2-1/2 lb product per acre to a limit of 7 applications per acre per season. Allow at least 7 days between sprays. PHI: 3 days. REI: 12 hours.

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**Whiteflies**

*(Bemisia tabaci and Trialeurodes vaporariorum)*

The sweet potato whitefly has flat, oval, greenish nymphs which suck sap from plants, excreting copious amounts of sticky honeydew and are the vectors of a complex of virus diseases including lettuce infectious yellows and squash silver leaf. More than 420 plant species are hosts. The whitefly is a very destructive pest of vegetable crops. The adults are typical four-winged whiteflies about 1/16 inch long. In greenhouses, breeding is continuous. The greenhouse whitefly leaves plants covered, especially on the undersides, with small, snow-white, four-winged flies and very small, oval, flat, pale-green nymphs, less that 1/30 inch in length, which suck the sap. Infested plants are lacking in vigor, wilt, turn yellow and die. The leaves are covered with a coating of glazed, sticky material on which a sooty-colored fungus often grows, completely covering the foliage. Tomatoes are significantly impacted by this pest. They suck the sap from the leaves, feeding greedily on the plant juices for about 4 weeks. In the course of this time, they pass through four instars. The average duration of the nymphal periods is about 28 to 30 days. The adult whitefly is about 1/16 inch in length, very active, four-winged, with a yellowish body and has the appearance of having been thoroughly dusted with some very fine white material. Both males and females fly, and they feed, like the nymphs, on the undersides of the leaves, living from 30 to 40 days. Under greenhouse conditions, the generations overlap, and all the stages of the insect may be found on infested plants at any time.

**Controls**

**Biological:** Release of the eulophid parasite, *Encarsia formosa*, at 1 to 5 wasps per square foot of plant area or 1 to 8 per plant to control greenhouse whitefly infestations is recommended, but only occasionally used by growers.

**Cultural:** Because the green house and sweet potato whiteflies cannot overwinter in Arkansas, field infestations are often the result of carrying greenhouse infestations into the field. Growers inspect transplants for whiteflies before moving them to the field.

**Insecticides for whitefly control:**

**Esfenvalerate** (Asana XL) - Applied as a foliar spray at 5.8 to 9.6 fl oz product per acre to a limit of 96 fl oz per acre per season. PHI: 1 day. REI: 12 hours.

**Endosulfan 3 EC** (Thiodan, Phaser) - Applied as a foliar spray at 2/3 qt product per 100-200 gallons of water per acre to a limit of 4 qt per acre or 6 applications per season. PHI: 1 day. REI: 48 hours.
Weeds

Weeds that infest tomatoes in Arkansas include annual grasses: Broadleaf signalgrass (Brachiaria platyphylla), Crabgrass (Digitaria spp.), Goosegrass (Eleusine indica), and Fall panicum (Panicum dichotomiflorum); perennial grasses: Johnsongrass (Sorghum halepense); and broadleaf weeds; Common cocklebur (Xanthium strumarium), Groundcherry (Physalis angulata), Jimsonweed (Datura stramonium), Common lambsquarters (Chenopodium album), Morningglory (Ipomea spp.), Nutsedge (Cyperus spp.), Smooth pigweed (Amaranthus hybridus), Common ragweed (Ambrosia artemisiifolia), Pennsylvania smartweed (Polygonum pensylvanicum), Sicklepod (Cassia obtusifolia), and Velvetleaf (Abutilon theophrasti). Weeds, if uncontrolled, can cause as much as 50 to 70 percent reduction in tomato yield. Tomatoes must be nearly weed-free from transplanting to flowering for optimum yield and quality.

In bareground (no plastic) tomatoes, weeds must be managed with preplant or preemergence herbicides. Preplant herbicides are applied before transplanting. Certain preplant herbicides (paraquat) kill emerged weeds and do not suppress weed germination, while others (metribuzin, pebulate, or napropamide) are incorporated to suppress weed emergence. Preemergence herbicides (metribuzin, napropamide) are applied after tomato transplanting and before weed emergence. Postemergence weed control is achieved by using either postemergence herbicides (metribuzin, paraquat, sethoxydim) or hand removal and early cultivation.

In tomatoes grown using black plastic, preemergence and postemergence herbicides are used to control weeds in middles between the plastic rows. Cultivation (between plastic rows) is not used because the cultivators may damage the plastic and increase erosion.

**Mechanical control:**
Tomatoes grown on bare ground are cultivated twice during the season. Weeds that emerge near the tomato plants are generally hand-removed although the widespread use of methyl bromide fumigation has greatly reduced the amount of hand weeding.

**Chemical Control:**

**Preplant herbicides**

- **Methyl bromide**
  This material (240 lb a.i./acre) is injected into the soil under plastic for disease control. An additional benefit is that it prevents weeds from emerging through the same hole that the tomato plant uses to grow through the plastic. It is used on approximately 25 percent of the tomato acreage. See specific label for PHI and REI.

- **Paraquat**
  This non-selective herbicide (Gramoxone Extra 2.5L at 0.6-0.9 lb a.i./acre) is applied to control emerged annual weeds before tomato transplanting. It is used on approximately 25 percent of the acreage. PHI: N/A. REI: 12 hours

- **Metribuzin**
  Applied preplant incorporated, this material (Lexone or Sencor 75DF at 0.25-0.5 lb a.i./acre) targets annual grasses and broadleaf weeds. It gives excellent control of common lambsquarters, common ragweed, hairy galinsoga, jimsonweed, most pigweeds, purslane, sicklepod, and certain annual grasses. It is used on approximately 20 percent of the tomato acreage. PHI: 7 days. REI: 12 hours.

- **Napropamide**
  Applied preplant incorporated, this material (Devrinol 50DF at 1-2 lbs a.i./acre) is used to control annual grasses and broadleaf weeds, including common purslane, pigweeds, and hairy galinsoga. It is applied to approximately 7 percent of the tomato acreage. PHI: N/A. REI: 12 hours.
Preemergence herbicides

- **Metribuzin**
  This material (Lexone or Sencor 75DF at 0.33-0.67 lb a.i./acre) is applied preemergence for controlling annual grasses and broadleaf weeds. It gives excellent control of common lambsquarters, common ragweed, hairy galinsoga, jimsonweed, most pigweeds, purslane, sicklepod, and certain annual grasses. It is used on approximately 45 percent of the tomato acreage. PHI: 7 days. REI: 12 hours

- **Napropamide**
  Applied preemergence, this material (Devrinol 50DF at 1-2 lbs a.i./acre) controls annual grasses and broadleaf weeds, including common purslane, pigweeds, and hairy galinsoga. It is applied to approximately 5 percent of the tomato acreage. PHI: N/A. REI: 12 hours.

Postemergence herbicides

- **Paraquat**
  This material (Gramoxone Extra 2.5L at 0.5 lb a.i./acre) is applied as a shielded, postdirected application to emerged weeds. It is most effective on small, actively growing broadleaf weeds. It is applied to approximately 70 percent of the acreage an average of three times per season. PHI: N/A. REI: 12 hours

- **Metribuzin**
  This postemergence material (Lexone or Sencor 75DF at 0.33-1.33 lbs a.i./acre) is used to control small weeds. It is most effective for controlling broadleaf weeds. It is applied to approximately 60 percent of the tomato acreage. Lexone or Sencor are sometimes applied with sethoxydim (Poast) to broaden their control. PHI: 7 days. REI: 12 hours.

- **Sethoxydim**
  Applied postemergence, this material (Poast 1.53EC at 0.2-0.3 lb a.i./acre) controls annual and perennial grasses. It is used on approximately 40 percent of the tomato acreage. PHI: 20 days. REI: 12 hours

Diseases

**Anthracnose**
*(Colletotrichum spp.)*

Control of anthracnose is especially important for processing tomatoes because quality standards include mold counts. In fresh market operations it will be a serious concern only if fully ripe fruit are involved, such as with roadside markets. The recommendations for anthracnose are written for processing crops. With fresh market tomatoes the program used for early blight should be sufficient to control anthracnose. Anthracnose occurs mainly as sunken circular spots on ripe fruits with the sporulating fungus appearing as a dark mass in the center of the lesion. It is particularly troublesome on fruit that is overripe and in contact with the soil. Although infections can occur early (when fruits are green and small), this is primarily a disease of ripe fruit.

**Controls**

**Cultural:** It is recommended that growers follow a two to four year rotation to crops not related to tomatoes with good weed control during the rotation to avoid a buildup of the pathogen. Hot water seed treatment will reduce the potential for anthracnose and this
practice is often utilized by growers. It is recommended to avoid having overmature fruit in the field, especially after Ethrel applications (or other fruit ripening agents) when susceptibility increases rapidly.

**Chemical:** Fungicide sprays are needed on a 7 to 10 day schedule from fruit set through harvest using any of the following:

**Fungicides for anthracnose control:**

**Chlorothalonil-containing fungicide** (Various formulations) - Applied at 2 to 3 pts product per acre for flowable formulations or 1.5 to 2.5 lbs per acre for dry formulations (DF, DG or WP). See specific labels for PHI and REI.

**Mancozeb/Maneb** (Various formulations) - Applied at 1.5 to 2 lb product per acre for dry formulations (WP, DF, DG) or 2 to 3 pts per acre for flowables. See specific labels for PHI and REI.

**Azoxystrobin** (Quadris) - Applied at 5 to 6 fl oz product per acre. PHI: 0 days. REI: 4 hours.

**Bacterial Canker**  
*(Clavibacter michiganensis michiganenese)*

Bacterial Canker is an increasingly important disease in Arkansas which can cause serious losses during cool summers and in fall crops. It occurs in many forms as a fruit spot, leaf blight, stem canker or vascular wilt, depending on whether the pathogen is localized or systemic. Under Arkansas weather conditions, the bacterium becomes established on the foliage of healthy plants and invades the plant through wounds and natural openings. Prevention is the only recommended strategy for control.

The canker pathogen is seed and transplant-borne; it overwinters on tomato debris (on roots and large stems) plus stakes and other field and greenhouse items. Once present, the bacterium is easily spread during wet conditions by splashing rain, irrigation water, machinery and workers.

**Controls**

**Cultural:**

It is recommended to start with disease-free material (i.e., certified disease-free), but to also use proper seed treatments for bacterial diseases (see seed treatments section below) and most growers utilize these practices. All items contacting tomatoes are often sanitized with a 10% bleach solution to reduce introduction. In fresh market operations, plants detected with canker in the field are rogued out, avoided or at a minimum worked last. The canker pathogen is easily spread during pruning and staking operations, and less disease develops in fields where suckers are removed when very small or where plants are not pruned at all.

Working in fields while foliage is wet, especially early in the season, is avoided to prevent the spreading of the pathogen. Some observations strongly suggest that air blast-type sprays enhance the spread of pathogens by creating airborne mist.

Rotating to non-host crops for 3 to 4 years is highly effective in reducing the pathogen at site, but there are many hosts, including tomatoes, peppers, potatoes, eggplant and other solanaceous weeds such as black nightshade, so long term planning is important. Preliminary evidence suggests that tobacco is a symptomless host.

At the end of season for any susceptible crops, burning or properly composting the above ground residue is used to reduce the pathogen; the fields are often plowed so that all residue is turned under the soil.
**Pesticides used for bacterial canker control:**

Seedbeds should be sprayed on a 5-day schedule with Streptomycin at 1.25 teaspoons/gallon of water starting with first true leaf until transplanting is complete (not for use on the plants after transplanting to the field).

**Copper**- Applied as a foliar spray on staked tomatoes on a weekly basis immediately after transplanting at a rate of 1 lb ai per acre. (Early spraying of copper on processing tomatoes has generally been ineffective in controlling bacterial canker early, but its use for other bacterial diseases may slow the spread of the foliar phases of canker.)

**Mancozeb** (Various formulations) - Applied as a foliar spray on staked tomatoes on a weekly basis immediately after transplanting at a rate of 1.5 lb product per acre. See specific labels for PHI and REI.

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**Bacterial Speck and Bacterial Spot**

*(Pseudomonas syringae pv. tomato and Xanthomonas campestris pv. vesicatoria)*

Bacterial Spot mainly occurs on the foliage as dark, angular spotting with yellow halos and scabby lesions of the fruit. Bacterial Speck causes similar spots on the foliage but black specks on the fruit. Spot is favored by warm wet weather while bacterial speck is more likely in cool, wet conditions. The incidence and severity of spot and speck have markedly increased recently, probably due to the production of hybrid seed in tropical climates.

**Controls**

**Cultural:** It is recommended to use western-grown seed, certified as disease-free and use a hot-water or bleach seed treatment (most growers utilize at least one of these practices). Bacterial Speck and Spot can "explode" under protracted wet conditions due to very rapid reproduction of the bacteria. Most growers institute a spray program once first symptoms are present or advisories are issued.

**Monitoring:** Plants should be monitored for any spotting or specks due to the potential for rapid spreading. Where possible, a fixed copper plus mancozeb or maneb (these two products make copper more effective) should be used. Premixed material is now marketed.

**Pesticides for bacterial speck and bacterial spot control:**

**Fixed copper + mancozeb 80WP** - Applied as a foliar spray at 1.8 lbs. per acre fixed copper and 1.2 lbs. per acre of mancozeb. No more than 16.8 lbs active ingredient can be applied per season.

**Fixed copper + maneb 80WP** - Applied as a foliar spray at 1.8 lbs. per acre of fixed copper and 1.2 lbs. per acre of maneb. No more than 16.8 lbs active ingredient can be applied per season. See specific label for PHI and REI.

**Bravo C/M** - Applied as a foliar spray at 1.08 to 1.62 lbs. per acre of chlorothalonil and 1.83 to 2.74 lbs. per acre of copper and 0.21 to 0.32 lbs. per acre of mancozeb. See specific label for PHI and REI.

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**Blossom End Rot**

Blossom End Rot is not an infectious disease, rather a physiological disorder related to calcium movement or calcium deficiency promoted by variances in water availability and growth flushes. Blossom End Rot is aggravated by improper fertility programs (e.g. high levels of ammonium...
Cultural: Growers usually take soil tests to insure adequate calcium levels in the soil. Applications of calcium nitrate can help minimize the problem. Mulching of tomatoes reduces blossom end rot (most growers use plasticulture). Uniform soil moisture is important in controlling the disorder. Growers try to avoid sudden injury to healthy roots by close cultivation as well as sites subject to standing water or flooding because they can increase the incidence of blossom end rot.

Application Alternatives used in Arkansas:

Calcium sprays are not considered effective in reducing Blossom End Rot in field plantings.

Buckeye Fruit Rot
*(Phytophthora parasitica)*

Pythium Stem Rot and Fruit Rot
*(Pythium spp.)*

Buckeye Rot occurs as circular, zonate lesions on the fruits while Pythium causes a water rot of the fruit. In stake tomatoes, these are problems mainly on the lower fruits which receive soil splash. Both cause dark watery rots of the stem near the soil line, mainly of young plants.

Controls

**Cultural:** Fields with poor drainage or heavy soils are avoided. The majority of growers plant on raised beds with mulch to reduce surface moisture and stake to reduce contact with soil.

Phytophthora Stem Blight has been of minor importance in Arkansas, but is common in the Midwest. The chemical controls listed below are effective with Phytophthora Blight, but rotation of other susceptible crops would need to be seriously considered should this blight become a problem here. Pythium stem rot has been more common, especially with growers using the float system to produce transplants.

Fungicides for buckeye fruit rot, Pythium stem rot and fruit rot control:

**Mefenoxam** (Ridomil Gold 4E) - Applied as a soil spray at 0.5 lbs per acre no later than 28 days prior to harvest. PHI: 0 days. REI: 48 hours.

**Mefenoxam + chlorothalonil** (Ridomil Gold Bravo/Ridomil Gold 4EC) - Applied as a foliar spray at a rate of 1.5 to 2 lb per acre starting with fruit set and continuing until fruit are full size. PHI: 0 days. REI: 48 hours.

Early Blight
*(Alternaria solani)*

Gray Leaf Mold
*(Cladosporium sp.)*

Gray Leaf Spot
*(Stemphylium sp.)*

Septoria Leaf Spot/Blight
*(Septoria lycopersici)*

Early Blight (the most common foliage disease of tomatoes in Arkansas) mainly affects older foliage causing dark brown, target-like spots and general blighting of the foliage, stem cankers and
fruit rot.

Gray Leaf Mold is more common in the greenhouse than field but can be severe under low light situations in the field, occurring as a yellow spot on foliage with gray fungus growth on the bottom side of the leaf.

Gray Leaf Spot is often found on transplants upon arrival from southern areas and/or from hot, humid greenhouses. Spots are irregular in shape, brown with extensive yellowing. In the field, it has been mainly a problem with late crops.

Septoria Leaf Spot/Blight occurs frequently and dominates in some seasons, as small gray/tan spots with dark borders, usually with dark fruiting bodies of the fungus evident in the center of each spot.

Controls

Cultural: Control starts with disease-free transplants which most growers use. Varieties with some resistance or tolerance will reduce fungicide needs, but do 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. When possible, growers 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. Maintaining rapid growth through proper fertilization to minimize disease is one control strategy utilized by growers. Crop rotations used for other diseases are an aid to control.

Pesticides used for early blight, gray leaf mold, gray leaf spot and septoria leaf spot/blight control in Arkansas:

**Bravo C/M 78 WP** - Applied as a foliar spray at a rate of 4 to 6 pints per acre. See specific label for PHI and REI.

**Chlorothalonil** (Bravo) - Applied as a foliar spray at a rate of 2 to 3 pts per acre for flowable formulations; 1.5 to 2.5 lb per acre for dry formulations. PHI: 0 days. REI: 48 hours.

**Mancozeb/Maneb 80 W** - Applied at 2 to 3 lb per acre for dry formulations. See specific label for PHI and REI.

**Azoxystrobin** (Quadris 2.08 SC) - Applied as a foliar spray at a rate of 5 to 6 fl oz product per acre. Applied on a 7 to 14 day schedule, this is rapidly becoming the treatment of choice. PHI: 0 days. REI: 4 hours.

**Mefenoxam + chlorothalonil** (Ridomil Gold/Bravo) - Applied at 2 to 3 lbs product per acre. PHI: 0 days. REI: 48 hours.

**Late Blight** *(Phytophthora infestans)*

Late blight can very quickly destroy a commercial tomato crop under cool, wet weather. This disease causes dark, irregular spots (often worse on the youngest foliage) giving a scalded appearance to the foliage. Fruit appear as if rolled on a hot plate. Late blight appears erratically in Arkansas; it is more common in the mountains and during fall plantings. The disease has been observed more frequently nation-wide in recent years with new strains and increased disease levels. Significant epidemics are much more likely in the future, so it is important to keep controls in place when the threat of late blight exists.

The control program listed for early blight is adequate for most cases of late blight in Arkansas.
Close spray intervals, obtaining good coverage, and keeping the fixed coppers together with the chlorothalonil or mancozeb/maneb are all recommended and utilized by growers. Under very strong late blight pressure, chlorothalonil usually provides superior control. Quadris at 6.2 fl oz/A is a new option, but no more than two sequential applications can be made before switching back to the other fungicides to help manage resistance. All outbreaks in Arkansas investigated since 1992 have involved the mefenoxam/metalaxyl-resistant (tolerant) strains of the fungus. Therefore, these fungicides are no longer recommended for this disease.

**Controls**

**Cultural:** Arkansas outbreaks are often connected with either potatoes or greenhouse infections.

**Pesticides used for late blight control in Arkansas:**

**Bravo C/M 78 WP** - Applied as a foliar spray at a rate of 4 to 6 oz product per acre. See specific label for PHI and REI.

**Chlorothalonil** (Bravo) - Applied as a foliar spray at a rate of 2 to 3 pts per acre for flowable formulations; 1.5 to 2.5 lb per acre for dry formulations. PHI: 0 days. REI: 48 hours.

**Mancozeb/Maneb 80 W** - Applied at 2 to 3 lb product per acre for dry formulations. See specific label for PHI and REI.

**Azoxystrobin** (Quadris 2.08 SC) - Applied as a foliar spray at a rate of 5 to 6 fl oz per acre. PHI: 0 days. REI: 4 hours.

**Sclerotinia Stem Rot**

*(Sclerotinia sp.)*

**Botrytis Fruit and Stem Rot**

*(Botrytis cinerea)*

These diseases occur as girdling cankers on the main stems, usually resulting from transplanting infected plants or occasionally from high populations of the pathogens that can naturally occur in the soil. Botrytis gray mold occurs mainly as a rot of the leaf and fruit under prolonged cool, wet conditions and is becoming more common in fall plantings of tomatoes in Arkansas. It also occurs in the spring along with Sclerotinia as stem lesions on young plants. Adding Benlate to the spray program will aid in control if the strain is sensitive to benomyl.

**Controls**

**Cultural:** Growers avoid setting infected transplants into the field. They also avoid fields with a history of Sclerotinia. Spores can move into tomato fields from adjacent weedy fields or from fields of tobacco, canola, cabbage, or beans were infected in the previous season. Improving air movement in the planting can help reduce disease levels.

**Powdery Mildew**

*(Oidium lycopersicum)*

Several serious cases of powdery mildew of tomatoes were diagnosed in 1998/99. This disease causes a white mildew and can lead to defoliation of the plants. Most cases have been in the greenhouse although some have been in the field. In all field outbreaks, the spray program being used for other foliar diseases was inadequate.
Controls

**Cultural:** Growers generally try to make sure they do not set powdery mildew infected transplants into the field.

**Pesticides used for sclerotinia stem rot and botrytis fruit/stem rot control in Arkansas:**

**Chlorothalonil** (Bravo) - Applied as a foliar spray at a rate of 2 to 3 pts per acre for flowable formulations; 1.5 to 2.5 lb per acre for dry formulations. PHI: 0 days. REI: 48 hours.

**Azoxystrobin** (Quadris 2.08 SC) - Applied as a foliar spray at a rate of 5 to 6 fl oz per acre. PHI: 0 days. REI: 4 hours.

**Southern Stem Blight or Southern Blight**

*(Sclerotium rolfsii)*

Plants wilt and die from girdling of the roots and stem at the soil line. The white fungus and its fruiting bodies (resembling mustard seeds) are normally present at the soil line. Traditionally, this has been a southern disease, but it has been on the increase during the past decade. Avoid fields with a history of this disease on any crop. This disease is often introduced on field grown transplants from the south. The pathogen has a wide host range and can colonize almost any plant material as the tissue dies. The pathogen moves onto tomato plants from colonized debris.

**Controls**

**Cultural:** Deep plowing sods, cover crops, and crop debris may reduce the disease potential and these practices are used by a majority of growers. Preplant control of weeds and grass is very important and growers are urged to use this practice. Some very serious cases have occurred following grass control after transplanting because the fungus "eats" the dead weeds and then moves onto tomatoes.

**Pesticides used for southern stem blight control in Arkansas:**

**PCNB** (Terrachlor 75 WP) - Applied at 10 lb/100 gallon using 0.5 pt/plant sprayed in the planting trench and on soil at transplanting may be warranted for serious cases. This is not a transplant water treatment although some areas report good success when using it in the setter water. PHI: N/A. REI: 12 hours.

**Viruses**

Virus diseases cause a range of conditions including mosaic and mottling, stunting, poor fruit quality and even plant death. Tomato spotted wilt (TSWV) is a relatively new problem which is arriving mainly on infected transplants.

**Controls**

**Cultural:** Most growers try to ensure that southern grown transplants are from sources specifically certified to be free of this virus. Transplants produced in greenhouses where ornamentals are also being produced will often be infected with TSWV. Transplants should be produced in isolation from thrips and ornamental hosts. Several other virus diseases are common or troublesome in tomatoes: Tobacco Etch (TEV), Tobacco Mosaic (TMV), Cucumber Mosaic (CMV), Potato Virus Y (PVY), and Beet Curly Top Virus.

The use of TMV resistant varieties and minimizing contact with infected plants in the field is
recommended and most growers follow the recommendation. Several serious outbreaks of TMV have occurred in recent years, usually as a result of using infected transplants that had been grown in greenhouses with either heirloom tomato varieties or TMV-susceptible tobaccos.

To avoid Potato Virus X in greenhouses, potatoes are not handled before working tomatoes. Rinsing hands with milk (whole, dried, or skim) when planting is occasionally used to reduce spread of these viruses. Most of these viruses are weedborne and moved from weeds to tomatoes by insect vectors (mainly aphids). Weeds should be controlled around fields or plant into sites surrounded by small grains or corn. It is recommended to not plant adjacent to tobacco, potatoes, or peppers. Greater disease reduction can be achieved by planting at least 200 yards away from these other crops. The risk of TEV, PVY, and CMV is higher for fall plantings. Most growers follow these recommendations when possible.

Nematodes

Due to heavy soils, nematodes have not caused the level of crop damage often present in the south. Root knot nematode is the most common in Arkansas; it deforms the root system resulting in stunting, early firing of foliage, and low yields.

Controls

**Cultural:** Some root knot resistant varieties are available and growers plant them when nematodes are a problem. Rotating away from tomatoes frequently; i.e., every two years (tall fescue, as a rotational crop, provides excellent control of root knot) is utilized when possible. It is recommended that dicot plants should be avoided in the rotation once nematodes are detected in the field.

**Monitoring:** If rotation to grass is not being used, fields should be carefully checked every year for root knot. Roots should be examined for symptoms on plants with symptoms at the end of harvest. Soil samples should be sent to a diagnostic lab to determine the population if the field will be used for any vegetable crop the next season.

**Application Alternatives Used in Arkansas:**

Use preplant soil fumigation (see fumigation) if the nematode population is moderate to high.

**Oxamyl** (Vydate 2L) - Applied at 2-4 pts product per acre at 7-14 day intervals after plants are established. PHI: 3 days. REI: 48 hours.

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References


