

Managing Tomato Diseases in Arkansas

Sherrie Smith
Plant Pathologist/
Instructor

Introduction

Tomatoes are grown by most home gardeners in Arkansas and are commercially produced primarily in the southeastern and other parts of the state. Tomatoes suffer from numerous diseases and are regarded as among the most sensitive plants to herbicide drift injury.

Serious tomato diseases in Arkansas are caused by viruses, bacteria, fungi and nematodes. Plant viruses are somewhat similar to viruses that attack humans and animals, in that they must use infected host cells to reproduce and cannot survive independently. Plant viruses are too small to see with even the most powerful light microscopes but can be detected with antibody-based or molecular tests using plant material. These tests can be done by our Plant Health Clinic on samples sent in by the local county extension agent. In some years, plant viruses may be the most important diseases of tomatoes in Arkansas, resulting in near total loss for some growers.

Bacterial diseases are also widespread in the state and are often favored by the warm, wet spring or early summer weather in Arkansas. Bacteria are single-celled organisms visible only by high-powered microscopes and are among the most common microorganisms on earth. Most bacteria are beneficial, but a few species can cause diseases in plants or animals.

Fungi are very diverse microorganisms that can be seen with either low-powered or high-powered microscopes, depending on the species.



Although single-celled, most fungi form filaments (hyphae) or other structures composed of many cells. Mushrooms are commonly observed fungal structures, for example. Most fungi are also considered beneficial, but some species can cause disease, primarily in plants.

Nematodes are microscopic roundworms and live almost everywhere. Nematodes can be parasites of both plants and animals; plant nematodes are generally associated with the soil and roots of plants. Nematode problems can be difficult to diagnose, and suspect soil must be sent to the Nematode Diagnostic Laboratory for identification of a particular nematode. Because of the difficulty involved in analyzing soil samples, a small fee is charged for this service.

The viruses, bacteria, fungi and nematodes that attack tomatoes cannot infect humans or animals – they have adapted to live only on plants.

*Arkansas Is
Our Campus*

Visit our web site at:
<http://www.uaex.edu>

Virus Diseases

Cucumber Mosaic Virus (CMV)

This is a common virus disease of tomatoes in Arkansas, still it only causes sporadic damage. It can infect many plants besides tomato, including cucumbers, melons, lettuce, peppers, ornamentals, weeds, etc., and is transmitted by more than 90 aphid species.

Symptoms – Early symptoms include yellowing, stunting, mosaics (light and dark green pattern within infected leaves) and bushiness. Only parts of the plant may have symptoms, such as only the bottom or top leaves. A later characteristic symptom is called shoe-string, which can also be caused by tobacco mosaic virus (Figure 1) or tomato mosaic virus, where infected leaves become very narrow and string-like. This symptom may also resemble some types of herbicide injury. Severely CMV-infected plants produce little or no fruit.

Management –

1. Eliminate nearby weeds to reduce the amount of virus for aphids to transmit.
2. Destroy infected plants immediately.
3. Insecticides and certain mineral oil sprays may be effective in preventing virus transmission. Resistant tomato varieties are not available.

Tobacco Mosaic/ Tomato Mosaic Virus (TMV/ToMV)

These are highly related viruses, but ToMV is more commonly found on tomato whereas TMV is more common on tobacco. However, they both can infect tomatoes. Both viruses can survive with seeds or plant debris and may survive multiple seasons in infected debris in the soil. They are most often transmitted by people who handle infected seed or plants then touch uninfected plants.

Symptoms – The most common symptom is a mottling of infected leaves (mottling or mosaic consists of light and dark green areas in the infected leaf), and young infected plants are also often stunted with a yellowish cast. Infected leaves may be small and curl upward or otherwise appear deformed. A shoe-string symptom similar to CMV may also be present (Figure 1). High temperatures reduce symptoms; cool temperatures increase them. Infected green fruit may develop a brown color inside (brownwall), usually on the first two clusters and often before leaf symptoms are noticed.



Figure 1. Tobacco Mosaic Virus in tomato leaves. Note the “shoe-stringed” narrowed leaves.

Management –

1. Use only uninfected transplants or seed.
2. Growers should never use any tobacco products before handling tomato seed or plants – or they should at least wash their

hands thoroughly with pumice soap and water or non-fat milk to inactivate any virus on their hands before touching plants.

3. Use resistant varieties, if available. Varieties with more than one resistance gene are better.
4. Rotate tomatoes to different soil areas at least every two years – continuous tomato cropping on the same soil year after year is a bad idea for many reasons, including these viruses.

Tomato Spotted Wilt Virus (TSWV)

This is the most serious virus disease of Arkansas tomatoes in recent years, causing widespread damage to both commercial and home garden plantings. Infected fruit are unmarketable. The virus is spread between plants by at least nine species of thrips (a tiny winged insect). The virus infects more than 1,000 plant species, including many weeds and ornamentals, so it is usually present in most areas. Weather patterns such as warm winters that favor survival of thrips probably are responsible for severe outbreaks of the disease.

Symptoms – Young infected leaves usually turn bronze with many dark, irregular spots (Figure 2). Tops of plants may suddenly die back (snuff-top) and some plants may wilt on one side, suggesting a wilt disease. Early-infected plants produce little or no fruit while later-infected plants produce fruit that is discolored. Infected green fruit may have slightly raised bumps with faint, light green to whitish circles. The circles and rings are more obvious as the fruit ripens, staying yellowish while the fruit turns red (Figure 3). These symptoms are usually not noticed at the breaker (picking) stage. As the tomatoes ripen, symptoms intensify.

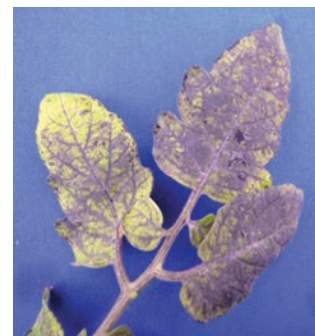


Figure 2. Tomato Spotted Wilt Virus (TSWV) in tomato leaf. Note dark irregular spots.



Figure 3. Tomato Spotted Wilt Virus (TSWV) in tomato fruit. Note mottling and circles.

Management –

1. Plant varieties resistant to TSWV.
2. For commercial tomatoes, controlling thrips early in the season with systemic insecticides may reduce TSWV incidence but may not be effective in severe years. Spraying of vegetation and weeds around the tomato field or garden is also recommended. Read and follow all label directions for products.
3. Plant as early as possible.
4. Reflective mulch under tomatoes may reduce infection by discouraging thrips feeding.
5. Pull and destroy infected plants immediately.

Bacterial Diseases

Bacterial Canker (*Clavibacter michiganensis ssp. michiganensis*)

This is an infrequent problem but may be very serious in some fields or gardens. The bacterium is spread by seed, infected soil or crop debris, contaminated stakes, etc., and by splashing water, workers or machinery. It may be favored by wounding, especially on staked and tied tomatoes.

Symptoms – Margins of lower leaves start turning brown and one side of the leaf may wilt. Entire leaves and branches start to die. Yellowish streaks may develop along stems and sunken, brown spots (cankers) may develop. The inside of infected stems turns yellow then brown, and the pith may collapse. Yellow ooze may appear on the cut ends of infected stem sections.

Management –

1. Use only clean seed and transplants.
2. Suspect seed should be treated with 1% bleach for 10 minutes to disinfect.
3. Pruning tools and stakes should be disinfected with 10% bleach, if the disease is a routine concern.
4. Infected plants should be destroyed immediately.
5. Rotate to soil that has been free of tomatoes for two years and grow corn or beans in infested soil for one to two years to eliminate the bacterium in the soil.

Pith Necrosis (*Pseudomonas sp.*)

This disease is sometimes confused with bacterial canker and is an occasional problem in Arkansas. It is favored by excessive nitrogen fertilization, pruning or suckering wounds and high humidity.

Symptoms – Dark streaks may be observed on the stems, plants may wilt and the pith hollows out (Figure 4).

Management –

1. Do not overfertilize.
2. Rotate but not with alfalfa, another host.
3. Avoid using contaminated pruning tools or disinfect tools frequently in 1% bleach.
4. Remove suckers only when plants are young so wounds heal quickly.

Bacterial Speck (*Pseudomonas syringae pv. tomato*)

This disease is favored by cool, wet weather and is more common during the spring months in

Arkansas. It is spread primarily on seed or infected transplants and is moved about by splashing water, workers or machinery. It can survive in infected crop debris for several months and can live on various weeds.

Symptoms – The disease causes small, round, dark spots on leaves (Figure 5). Young spots do not have a halo (light border) but older spots can. Spots may grow together, killing larger areas of leaf tissue. Spots can also form on stems, branches and fruit. Fruit spots are very tiny dark specks and can be slightly raised or sunken, depending on the age of the spot (Figure 6). A dark green halo may surround some fruit spots.

Management –

1. Use only bacterial speck-free seeds or transplants.
2. Seed disinfestation with 1% bleach for 10 minutes should be used when the seed source is suspect.
3. Eliminate all nearby weeds or volunteer tomato plants.
4. Rotate tomatoes to new soil areas every two years and plant rotation crops like corn or beans in old production areas.
5. Bactericides containing copper can be used but should be applied following label directions at the first sign of disease. These materials will wash off periodically and must be reapplied every one to two weeks.

Bacterial Spot (*Xanthomonas campestris pv. vesicatoria*)

This disease is common in Arkansas and can be severe under warm, wet conditions. It has usually been more of a problem on fall-grown tomatoes in home gardens. It is spread on infected seed and transplants and may survive in diseased plant debris or on volunteer tomatoes. It is moved about by splashing water, people, machinery or wind-driven rain.

Symptoms – Brown, circular spots form on leaves (Figure 7), stems and branches and may appear grayish (water-soaked) around the edges during rainy or dew periods. Spots are usually small, about 1/8 inch across. Spots may combine as long streaks under wet, warm



Figure 5. Bacterial Speck on young tomato leaves.



Figure 6. Bacterial Speck on tomato fruit.



Figure 4. Pith Necrosis of tomato stem.



Figure 7. Bacterial Spot on tomato leaves.

conditions, but no halo is present around them. Under severe conditions, entire branches may turn brown and die. Spots on the fruit look like tiny, raised blisters (Figure 8) which grow to become a larger, brown, scab-like spot with a sunken center). Fruit lesions may have a halo that disappears in time.



Figure 8. Bacterial Spot on tomato fruit.

Management –

1. Use disease-free seed or transplants.
2. Disinfect suspect seed with 1% bleach for 10 minutes.
3. Destroy volunteer tomatoes in the area.
4. Rotate to new soil areas every two years – avoid continuous cropping.
5. Apply approved, labeled bactericides as needed at the first sign of disease.

Bacterial Wilt (*Ralstonia solanacearum*)

This disease can cause rapid death of infected plants but usually only attacks a few plants within a planting. It can infect many other plants, including potato, tobacco, eggplant and others. The bacterium can survive in the soil for months, especially in well-drained soils. It is spread by soil and water movement or by diseased plants or infected debris.

Symptoms – Early symptoms are a slight wilt of the youngest leaves, followed by a rapid wilt within two to three days (Figure 9). New aboveground roots may appear just above the soil surface growing out of the stem. The inside of the stem becomes brown (Figure 10), and stems cut cross-wise may ooze a thick, off-white to yellowish liquid. Sticking the cut end of an infected stem partially into a glass of water reveals a milky-white stream of bacteria in the water within three to five minutes. The root system may also develop a brownish rot as the plant dies. Symptom development is favored by hot, dry weather.

Management –

1. Use only disease-free transplants from a reliable supplier.

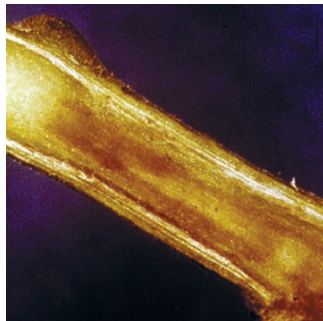


Figure 9. Bacterial Wilt of tomato.



Figure 10. Bacterial Wilt of tomato. Note general browning of inside of infected stem when split.

2. Rotate to clean areas as soon as possible. Do not use peppers, eggplant, Irish potatoes, sunflowers or cosmos in the rotation areas.
3. Grow resistant varieties, if available.
4. Rotation soils should be fallowed one to two years between crops, with frequent tillage.
5. Remove infected plants and destroy immediately.
6. Grow on raised beds to promote drainage.

Fungal Diseases

Buckeye Rot/Phytophthora Root Rot (*Phytophthora parasitica*, *P. capsici*, *P. drechsleri*)

This disease is favored by warm, wet conditions and poorly drained soil. The fungi are common in many soils.

Symptoms – Buckeye rot occurs on the fruit and first appears as a brown spot on the skin, usually where the fruit has contacted soil. Green or ripe fruit may become infected. As the spot grows, it forms rings of narrow dark brown and wider light brown bands (Figure 11). Infected fruit remains firm for a time, then rots rapidly, sometimes with a white, cottony growth in the center of the brown area. Root rot symptoms include dark brown discoloration of the roots and lower stem, resulting in death of the plant.



Figure 11. Buckeye Rot of tomato fruit.

Management –

1. Plant only in well-drained soils.
2. Use deep tillage to reduce soil compaction and improve internal soil drainage.
3. Rotate with corn or other grass crops.
4. Mulch beneath plants to reduce soil contact with fruit.
5. Fungicides – see current MP154, *Arkansas Plant Disease Control Products Guide* (under Publications at www.uaex.edu).

Late Blight (*Phytophthora infestans*)

Late blight is one of the most devastating diseases of tomato. This disease can cause 100 percent losses when environmental conditions are favorable for disease.

Symptoms – Leaves, flowers, stems and fruit may all be infected. Lesions first appear on the leaves, petioles or stems as small water-soaked spots which grow rapidly into large pale green to brown lesions. A grayish-white fuzzy mold grows on the lesions (Figure 12). Initially, the mold can be observed on both sides of the leaf but later is found on the underside. Affected tissues become brown and

shriveled and die. The lesions on the fruit begin as olive-colored greasy spots. These may enlarge to engulf the entire fruit. Whitish-gray fuzzy mold can also occur on the fruit, followed by fruit rot. Rotted fruit and tomato vines let off a nasty odor.



Figure 12. Late Blight of tomato on leaves.

Management –

1. Tomatoes should be grown on raised beds in well-drained soil.
2. Fruit should be prevented from touching the ground by staking or mulching.
3. Avoid overwatering.
4. There are now some very good resistant cultivars.
5. Fungicides – see current MP154, *Arkansas Plant Disease Control Products Guide* (under Publications at www.uaex.edu).

Early Blight (*Alternaria solani*)

This is a very common disease of Arkansas tomatoes and is favored by warm, rainy weather. The fungus survives on seed, infected plant debris, volunteer tomatoes or certain other plants like potatoes, eggplants, horse nettles or black nightshade. Poor fertilization favors the disease as well.



Figure 13. Early Blight of tomato leaves.

Symptoms – Spots form

on leaves, stems and fruit. Leaf spots start as small, dark brown areas, sometimes with a yellow border (Figure 13). Leaf spots grow rapidly under favorable conditions, forming lighter brown bands with a dark center. Stem spots have even more noticeable rings (Figure 14) than leaf spots and may cause plant death if the stem is girdled. Fruit spots start at or near the stem attachment and also develop a dark, ringed



Figure 14. Early Blight of tomato stems. Note concentric rings of infected tissue.



Figure 15. Early Blight of tomato fruit.

appearance (Figure 15). Spots are leathery-feeling and may be covered by a blackish “dust,” consisting of numerous microscopic spores of the fungus. Infected fruit often drops off soon after infection.

Management –

1. Grow resistant varieties.
2. Avoid diseased transplants, if possible.
3. Eliminate weeds and volunteer tomatoes and rotate to other areas every two years.
4. Use proper fertilization.
5. Fungicides – see current MP154, *Arkansas Plant Disease Control Products Guide* (under Publications at www.uaex.edu).

Fusarium Root Rot (*Fusarium oxysporum f.sp. radicis-lycopersici*)

This is a sporadic problem in Arkansas, associated with long-term tomato production on the same fields. It is spread with infested soil, moving water or infested crop debris.

Symptoms – Older (lower) leaves turn yellow along the edges as the fruit starts to ripen, followed by browning and collapse of the leaf petiole. Symptoms progress upward to the younger leaves. Some plants may wilt and die quickly, while others wilt more slowly and live through harvest. Roots have a dry, brown rot of the outer tissue, and a sunken, dark area may develop in the stem just above the soil. Pinkish spore masses of the fungus may form on this dark area during wet weather or under frequent irrigation.

Management –

1. Use only disease-free transplants in soil free of the fungus.
2. Grow resistant varieties, if available.
3. Rotate to disease-free soil, if possible.

Fusarium Wilt (*Fusarium oxysporum f.sp. lycopersici*)

This is one of the most common and important wilt diseases of tomatoes around the world and has been significant in Arkansas production as well. It is favored by hot weather and sandy, acid soils. The fungus survives in infested soil for several years and can be spread by anything that moves soil about, including irrigation.



Figure 16. Fusarium Wilt of tomato. Note brownish discoloration along outer edges of stem; pith is healthy.

Symptoms – Young, infected plants may be severely stunted. Older leaves may droop downward, turning yellow. When

the lower stem of affected plants is split, a brown discoloration is evident on each side of the stem, just beneath the outer skin (Figure 16). The pith (center of stem) remains white and healthy. Leaves may turn yellow on only one side of the plant. Eventually, infected plants start wilting during the hot afternoon, recovering at night and early morning. Finally, infected plants collapse and die.

Management –

1. Grow resistant varieties. Since the fungus has different races that can attack some resistant varieties, choose varieties with resistance to the most races possible.
2. Lime acid soils to raise the pH to 6.5-7; however, do not over-lime as alkaline soils can cause other problems.
3. Use nitrate forms of nitrogen fertilizer and avoid ammonium forms.
4. Prevent introduction of the fungus into your field or garden by using known disease-free transplants and soil.
5. Do not use flood irrigation and avoid pond or other surface-water irrigation because these water supplies can be contaminated with the fungus.
6. Long-term rotations (five to seven years out of tomato) may help.

Septoria Leaf Spot (*Septoria lycopersici*)

This fungal disease is very common in Arkansas, especially under warm, splashing rain or overhead irrigation. The fungus survives in infected tomato debris or weed hosts like horse nettle. It may also be introduced on seed.

Symptoms –

Spots on lower leaves usually show up about first fruit set and may also occur on stems and branches. Spots are round, about 1/8 inch across, with dark brown borders and light gray centers (Figure 17). The centers may contain tiny black spots called pycnidia that contain spores of the fungus. Young spots may be surrounded by a yellow halo as well. The disease progresses up the plant, from the older to younger leaves, spread by splashing rain or overhead irrigation. Fruit infection is very rare.



Figure 17. *Septoria* Leaf Spot of tomato.

Management –

1. Fungicides – see current MP154, *Arkansas Plant Disease Control Products Guide* (under Publications at www.uaex.edu).

2. Rotate out of tomato for two years if the problem is persistent. Do not use Irish potatoes in the rotation.
3. Control horse nettle around or in the crop.
4. Thoroughly bury or destroy tomato debris after harvest.
5. Use overhead irrigation as infrequently as possible and during late morning so plants can dry off before nightfall.
6. Do not work fields while foliage is wet to avoid spreading the fungus to uninfected leaves or plants.

Southern Blight (*Sclerotium rolfsii*)

This is a common problem in Arkansas on soils that have grown tomatoes for several years. The fungus survives as hard, brown “sclerotia” that look like tiny BBs in the soil or on infected tomato debris. It is spread by anything that moves soil or debris in the field. Sclerotia can survive for several years without a host.

Symptoms –

A large, brown to dark brown rot appears on the stem at the soil line which spreads up and around the stem, causing a rapid wilt of the plant. Usually a white, cottony growth develops over the surface of the rot area, and sclerotia form on the white growth over a period of a few days (Figure 18). The sclerotia are spherical, starting out as whitish balls which turn red, then brown, and are about 1/16 inch across. Many sclerotia form on the infected stem. If young plants are infected, they may fall over at the soil line.



Figure 18. Southern Blight of tomato. Note white mycelium and numerous brown sclerotia on surface.

Management –

1. Rotate with corn or wheat for one to two years. Avoid beans or eggplants in the rotation.
2. Deep plow the soil to bury infected plants.
3. Use only disease-free transplants and soil.
4. Plastic mulch may help somewhat.
5. Fertilize to minimize disease.
6. Fungicides – see current MP154, *Arkansas Plant Disease Control Products Guide* (under Publications at www.uaex.edu).

Verticillium Wilt (*Verticillium albo-atrum, V. dahliae*)

This is a sporadic disease in Arkansas, favored by long-term tomato production, cool weather and high pH soils. The fungus survives as micro-sclerotia in infected crop debris and can attack many other plants.

Verticillium wilt is increased by root wounding from cultivators or root-knot nematode feeding.

Symptoms – The wilt symptoms can be confused with Fusarium or bacterial wilt. Infected plants may wilt only slightly at first, usually during the hottest part of the day, and recover at night. Later, lower leaves may show whitening or yellowing between the veins. This discoloration may become fan-shaped and more yellow over time. Like Fusarium wilt, a brownish discoloration forms under the outer skin of the lower stem and can be observed if split length-wise. The pith remains white and healthy.

Management –

1. Grow resistant varieties with resistance to as many races of the fungus as possible.
2. Rotate out of tomatoes for two years.
3. Destroy all weeds on a regular basis as they may be hosts for the fungus.
4. Destroy all infected plants immediately.

White Mold (Timber Rot) (*Sclerotinia sclerotiorum*)

Similar to southern blight, this disease is associated with long-term tomato production. The fungus attacks many other crop plants and weeds as well. It survives as large black sclerotia in the soil and is spread by anything that moves soil around. Infection is favored by wet weather or overhead irrigation.

Symptoms –

Infected areas of the stem become soft and watery and usually form around branch joints. Unlike southern blight, infection may occur above the soil line. Infected areas grow up and down the stem, turning the infected area a bleached, bone color. A white cottony growth appears on the infected areas under wet conditions, and black sclerotia up to ¼ inch long form inside the stem (Figure 19). Eventually, infected plants wilt and die. The fungus can spread to nearby plants, resulting in patches of dying, wilted tomatoes. Fruit may be infected where they join the plant, developing a gray rot sometimes with a ring of black sclerotia around the calyx.



Figure 19. White Mold of tomato. Note large black sclerotium inside split stem.

Management –

1. Rotate to uninfested areas, if possible.
2. Do not rotate with sunflowers or snap beans since they are very susceptible and may increase this disease.
3. Destroy infected plants by removal and burning.

Root-Knot Nematodes (RKN)

Root-knot nematodes are primarily associated with long-term tomato production on sandy soils. Root-knot nematodes persist in the soil, building up during the summer months while feeding on roots of tomatoes or other susceptible plants. Many other plants are susceptible.

Symptoms –

Roots develop galls (swollen areas) caused by feeding of the nematodes (Figure 20). Swellings vary in shape and size. Affected plants may wilt during the day and recover at night and may be stunted or grow poorly.



Figure 20. Root-Knot Nematode.

Management –

1. Grow resistant varieties.
2. Rotate with grass crops or fallow – do not use corn as it is susceptible.
3. Plant nematode-suppressive crops such as marigolds or canola and till debris into the soil prior to tomato production.

Physiological Disorders

Blossom-End Rot

This is caused by a deficiency of calcium in developing tomato fruit. This may be due to a lack of calcium in the soil or extreme fluctuations in watering, which can decrease calcium uptake. Overfertilization with nitrogen can increase the problem.

Symptoms –

Early symptoms include a slight water-soaked or sunken area at the blossom end of the fruit. This area soon develops into a large brown to blackish spot that constantly increases in size until the fruit ripens (Figure 21). Affected tissue may shrink inward and have a dry, leathery feel.

Management –

1. Have the soil tested. Apply lime if pH is low. Agricultural lime or gypsum may be used but should be applied several months in advance of planting. A soil pH of 6.5-6.8 is ideal for tomatoes.



Figure 21. Blossom-End Rot of tomato.

2. Apply a calcium chloride product such as Stop-Rot, Tomato Saver or Blossom-End Rot Preventer to plants beginning at early fruiting (first green fruits should be about 1½ inches in diameter). Rates of different products vary, but 4 pounds actual calcium chloride in 100 gallons of water per acre is a standard recommendation. This spray should be applied every seven days for four weeks and only applied in the early morning when temperatures are cool to avoid burning the plants.
3. Mulch plants and irrigate regularly to avoid extremes in water supply. Tomato plants should receive about one to two inches of water per week during the summer for proper growth.
4. Remove affected fruit when first observed to encourage formation of new, healthy fruit.

Catfacing

This is caused by cold nights during early fruit set and development.

Symptoms – Fruit is grossly deformed at the blossom end during growth (Figure 22).

Management –

1. Spread out planting dates. Avoid planting too early.
2. Protecting the plants during cool nights with cloth or plastic covers may help.

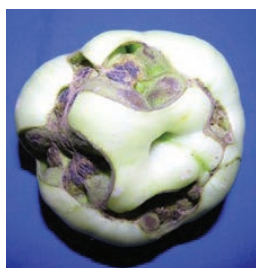


Figure 22. Catfacing of tomato.

Fruit Cracking

Cracking is usually caused by rapid fruit development, too frequent watering or overfertilization. Some varieties appear to be more susceptible, especially tomato types with high sugar content.

Symptoms – Affected fruit becomes callused or cracks, usually vertically (Figure 23).

Management –

1. Avoid overwatering and excessive fertilization.



Figure 23. Fruit cracking of tomato.

Lack of Fruit Set

This is sometimes caused in Arkansas by hot (>75°F) temperatures at night during flowering to early fruit development and may also be caused by drift injury from various herbicides.

Management –

1. Space plantings at two- to four-week intervals to avoid high temperature injury to all plants.
2. Use hot-set tomato varieties like Heatwave or Solar Set, if available, in at least some of the plantings.
3. Follow herbicide label directions carefully if using around tomatoes.

Photo Acknowledgments: Figure 1, Dr. James Correll, Arkansas Department of Plant Pathology; Figure 17, Rachel Bearden, University of Arkansas Cooperative Extension Service; Figure 23, Keith Gresham, University of Arkansas Cooperative Extension Service; Figures 3, 9, 13 and 14, Dr. Stephen Vann (retired), University of Arkansas Cooperative Extension Service. Other figures, Sherrie Smith, University of Arkansas Cooperative Extension Service.

Printed by University of Arkansas Cooperative Extension Service Printing Services.

SHERRIE SMITH is a plant pathologist/instructor with the University of Arkansas System Division of Agriculture and is located at the Plant Health Clinic, 2601 N. Young Avenue, Fayetteville, Arkansas.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Director, Cooperative Extension Service, University of Arkansas. The University of Arkansas System Division of Agriculture offers all its Extension and Research programs and services without regard to race, color, sex, gender identity, sexual orientation, national origin, religion, age, disability, marital or veteran status, genetic information, or any other legally protected status, and is an Affirmative Action/Equal Opportunity Employer.