



# Disease Management in Home-Grown Tomatoes

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Several disease problems occur on home-grown tomatoes in North Dakota. Reduce disease problems with a combination of practices that include:

1. Purchase vigorous, healthy plants from a reliable supplier.
2. Rotate the planting area within your garden (plant tomatoes in the same place only once in three to four years).
3. Plant disease-resistant tomato varieties, if needed.
4. Remove and destroy all plant refuse in the fall and use deep cultivation to bury any remaining refuse.
5. Avoid overwatering with sprinklers. Use surface watering methods. Do not handle plants when the vines are wet.
6. Control weeds in and around the garden plots. Weeds not only compete with vegetables for soil moisture and nutrients but also serve as hosts for insects and disease organisms.
7. Control insect pests (especially aphids) which may transmit a disease organism from plant to plant.
8. Remove abnormal appearing plants as soon as they are observed. Virus diseases may be involved. To reduce the spread of viruses, wash hands and tools with a detergent after handling diseased or unusual looking plants.
9. Do not use tobacco products while handling tomato plants. These products may carry viruses, especially tobacco mosaic virus.
10. Use plastic or organic mulches to reduce disease and blossom-end rot problems.

11. If possible, choose a sunny location for your tomatoes. You are less likely to have leaf disease problems in a sunny location than in a semi-shady one.
12. Apply a recommended fungicide according to label directions at the first sign of leaf spot diseases.

Such a combination of cultural practices, variety selection and timely use of fungicides is an integrated control program, usually referred to as integrated pest management (IPM).

There are several different types of tomato disease problems in North Dakota. The most common ones are spots or blights of leaves or fruit, rots, wilts, virus diseases and non-parasitic disorders.

## FUNGAL LEAF AND FRUIT SPOTS OR BLIGHTS

Three blights cause serious spotting of tomato leaves in North Dakota. Septoria leaf spot (or blight) is the most common disease and is a serious problem in many years. Early blight is also fairly common. These diseases usually begin after the first fruits have set. The third disease is late blight, which may occur only in unusually cool, wet weather. All are fungal diseases spread by airborne spores which require dew or rain to infect the plants. These diseases build up rapidly in wet weather and cause dark leaf spots followed by yellowing and defoliation (leaf drop). Some of these diseases also produce spots on the fruits.

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1992



**NDSU EXTENSION SERVICE**

North Dakota State University, Fargo, ND 58105

NOVEMBER 1992

## Septoria Leaf Spot (Septoria Blight)

Septoria leaf spot, caused by the fungus *Septoria lycopersici*, usually appears on the lower leaves after the first fruits set. The spots are circular, about 1/8 inch in diameter, with dark margins and gray centers with tiny black dots in them (Figure 1). When spots are numerous, the leaves turn yellow and drop. Fruits are rarely infected, but spots may appear on the vines (Figure 2). Rapid leaf loss reduces fruit yield and quality. Exposed fruits may be more susceptible to sunscald. Rainy weather with temperatures of 68 to 77 degrees Fahrenheit favors disease development and a



Figure 1. Septoria leaf spot on leaflet. Photo by James Berg.



Figure 2. Septoria leaf spot on vine. Photo by Harold Caldwell.

rapid spread of the disease to the upper leaves. The fungus is spread by splashing water and by working among the plants when they are wet. The fungus may infect weeds in the nightshade (potato-tomato) family. It overwinters (survives the winter) on tomato and weed refuse.

## Early Blight

Early blight, caused by the fungus *Alternaria solani*, appears first on the lower leaves, usually after a heavy fruit set. It normally forms a few large (up to 1/2 inch) spots on a leaf. The spots are dark brown to black and roughly circular. Concentric rings develop in the spot forming a "target spot" (Figure 3). The leaf area around each target spot turns yellow, and soon the entire leaf turns yellow and drops. The disease spreads rapidly to the upper leaves in rainy weather at temperatures of 75 to 85 F, causing severe defoliation. The early blight fungus also infects stems and may produce stem cankers. It occasionally attacks the fruit, producing large sunken black target spots on the stem end or shoulder of the fruit. Infected fruits often drop before they mature. This disease is most common late in the growing season. Potato and eggplant are also attacked by the early blight fungus. The fungus overwinters on old tomato vines and on weeds in the nightshade family.

## Late Blight

Late blight, caused by the fungus *Phytophthora infestans*, is a rare problem in North Dakota, occurring only in moist weather with cool nights and moderately warm days. Night temperatures of 50-55 F and heavy dew favor late blight. Daytime temperatures above 86 F are unfavorable to late blight development. Dark green to nearly black spots begin spreading in from the leaf edge. These spots have a greasy or wet appearance with no definite margin. In wet weather the spots may

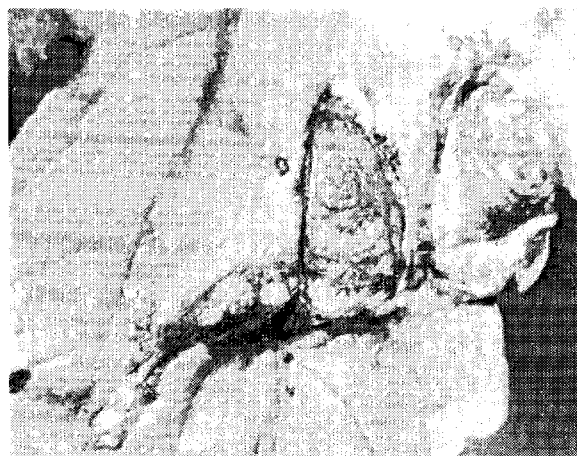


Figure 3. Early blight on leaflet. Note target pattern. Photo, Clemson University.

have a downy white growth on the lower leaf surface near the outer portion of the spot. Spots also develop on the fruits. At first the spots are gray-green and water-soaked, but they soon enlarge to affect half the fruit, then turn dark brown and firm, with a rough surface. When conditions are favorable, the disease may progress very rapidly.

## Management of Leaf Spots

The danger from leaf diseases is reduced by rotating the planting areas in your garden; plant tomatoes in the same place only once in three or four years. Remove and destroy tomato vines in the fall. Use cultivation (plowing or rototilling) to bury the remaining crop refuse. Use healthy transplants. Remove badly diseased lower leaves, as these are a source of leaf spot fungus spores that help spread the disease.

Water at the base of the plants. Use a garden hose to trickle water into a shallow trench or depression in the soil. Avoid watering with overhead sprinklers in late afternoon or evening; if the plants stay wet all night, leaf spot infections are likely to occur.

Use fungicides when needed. These diseases spread rapidly, and are difficult to control once established. Chlorothalonil fungicide (Ortho Multi-Purpose Fungicide) must be applied to the plant before the disease first appears or at the first sign of disease. Since timing is critical, it may be preferable to start a preventive spray program when the first fruits are marble-sized. Usually good control is achieved if you begin spraying about mid-July. Mancozeb and maneb fungicides can be applied to commercial tomatoes but are no longer available for home gardeners. Chlorothalonil can be applied up to the day of harvest. Captan fungicide is available, but should not be used because it does not control Septoria leaf spot. Check the list of ingredients to determine the active ingredients in fungicides or home garden fungicide-insecticide mixtures. Current fungicide recommendations can be found in Circular PP-469 Rev., **Plant Disease Control in the Home Garden**.

Trials at North Dakota State University indicate that varieties differ in their susceptibility to Septoria leaf spot. The most susceptible varieties tested were Bounty, Firesteel, Lark, Sheyenne, Spring Giant, and 044. Other susceptible varieties include Cannonball, Coldset, Mooreton, Patio, Super Fantastic, and Super Sioux. Varieties which were moderately susceptible include Beefmaster, Beefsteak, Betterboy, Bettergirl, Big Early, Fantastic, Floramerica, Goldenboy, Golden Jubilee, Lowe's, Quickpick, Red Pak, Sweet 100, and Terrific. A few varieties which were moderately resistant to Septoria leaf spot include Big Boy, Breggar, He Man, Oxheart, Red Pear, Roma Hybrid, Sunripe, and Tiny Tim.

## BACTERIAL LEAF AND FRUIT SPOTS

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### Bacterial Speck and Bacterial Spot

Bacterial speck, caused by the bacterium *Pseudomonas syringae* pv. *tomato*, produces tiny brown circular specks, less than 1/16 inch across. These specks are slightly raised and may occur on fruit or leaves. Tissues next to the fruit specks are slow to ripen. The bacterium is seed-borne. Infection by the bacterial speck pathogen is favored by temperatures of 65 to 75 F, dew and high humidity; disease development is favored by temperatures of 55 to 77 F.

Bacterial spot, caused by the bacterium *Xanthomonas campestris* pv. *vesicatoria*, produces circular scabby spots on immature fruits and on leaves. The spots are 1/8 inch across (Figure 4). Bell peppers also may be attacked. The bacterium is seed-borne and is often carried on diseased transplants. It can also occur in weeds of the nightshade family and on volunteer tomatoes. It overwinters in soil and on old tomato vines and pepper plants. Bacterial spot is favored by warm temperatures (68-95 F), high humidity, long dew periods, and driving rain. Night temperatures of 75 to 85 F are especially favorable for infection by the bacterial spot pathogen.

Manage bacterial speck and spot by using disease-free tomato transplants from a reliable source or by starting your own plants from disease-free seed. Grow them in sterilized potting medium. Rotate tomato and peppers in the garden; do not plant tomatoes or peppers in the same part of the garden more than once in four years. Dispose of old tomato and pepper plants. Control all weeds, especially those in the nightshade (potato/tomato) family. If either disease appears, copper

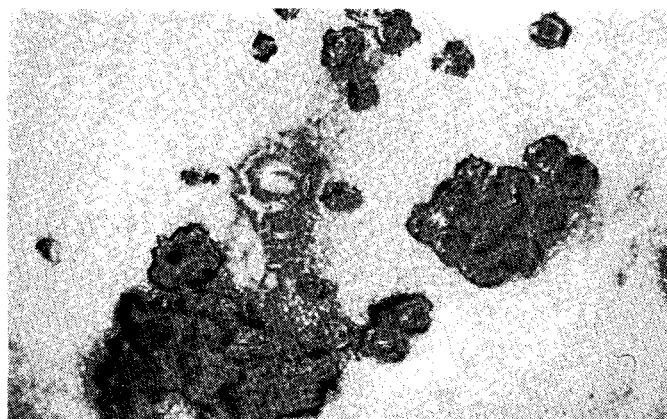


Figure 4. Bacterial spot on fruit. Photo, Clemson University.

fungicides will slow the spread of disease, but they will not give complete control if the disease is well established and wet weather persists.

Additional information on these two diseases is contained in Circular PP-736, **Bacterial Spot and Bacterial Speck of Tomato.**

## Bacterial Canker

Bacterial canker, caused by the bacterium *Corynebacterium michiganense* pv. *michiganense*, is uncommon in North Dakota, but can be destructive when it occurs.

Systemically infected plants often begin to wilt from the lower leaves up. The outer edges of the leaves wilt, then turn brown and die. Sometimes the leaflets on one side of a leaf wilt. The disease progresses up the plant. Spots on fruits begin as white, slightly raised blisters. Later, these spots break open and have a rough yellow to brown surface with a white halo or "bird's eye" (Figure 5). The spots are about 1/8 inch across. The vascular (water-conducting) tissues inside the stem develop light yellow to brown streaks. The center of the stem may have a yellow to red-brown mealy appearance. A yellowish bacterial ooze can be squeezed from infected stems. Above-ground roots may form on the stem.

Diseased seedlings are the primary source of infection. The canker bacteria also survive in the soil, on old tomato stakes, on dead stems, and on members of the nightshade family. They are spread by rain, splashing water, pruning, and by gardeners and their tools. Temperatures of 75 to 90 F and low light intensity favor the disease. The "bird's eye" symptoms on fruit are most common when plants are watered with a sprinkler or when there are frequent rains.

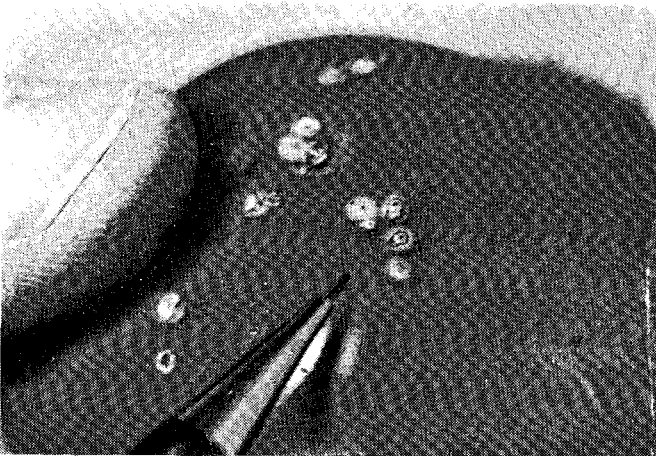


Figure 5. Bacterial canker on fruit. Photo by Cynthia Ash.

Management practices include using disease-free seed, pasteurized potting mix, and sterilized pots or buying disease-free seedlings. Control weeds in the nightshade family. Avoid working among the tomato plants when they are wet. Use new or pasteurized stakes and trellises. Disinfect pruning tools using a mixture of 10% household bleach and 90% water — be sure to wash the tools with water, dry and oil them before putting them away. Wash hands frequently with soap and water when working among diseased plants.

## ROTS

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### Soil Rot

Soil rot, a fruit rot caused by the soil-borne fungus *Rhizoctonia solani*, occurs during rainy periods. A soft brown rot develops, usually on the sides of fruits which are touching the ground, or where soil is splashed up. The spots are sunken, large, and may have a closely-spaced target pattern (Figure 6). Often the surface of the fruit cracks open.

Staking may be used to reduce soil rot by keeping fruit off the ground. In larger plantings, reduce soil rot by using a mulch as described in the section on blossom end rot.

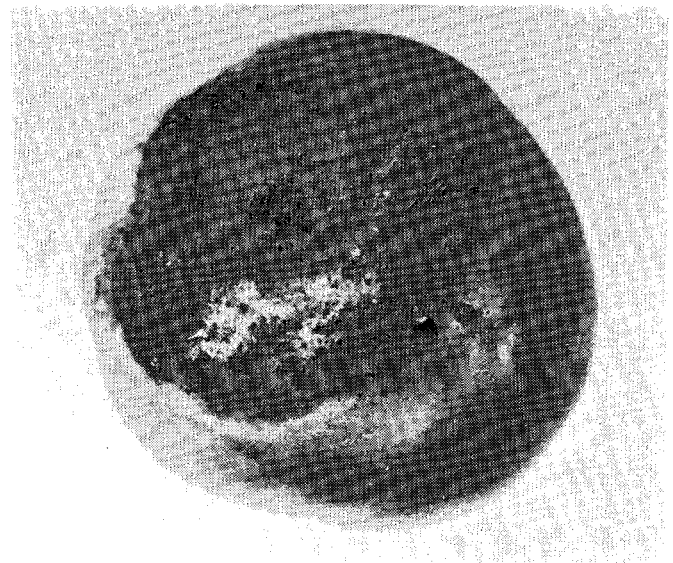


Figure 6. Soil rot of fruit. Photo by Arthur Lamey.

## Timber Rot

Timber rot, caused by the white mold fungus, *Sclerotinia sclerotiorum*, has not been seen on tomatoes in North Dakota (1992). Since white mold has increased dramatically on susceptible crops (sunflower, dry beans, and others) as well as on ornamental flowers, it may occur on tomatoes in years with abundant rainfall.

Infected tomato plants may be infected on the main stem near the soil line or the stem may be infected at a node (the point where a branch is attached to the stem). A mushy brown rot develops and eventually the plant above this area wilts and dies. If the rotted stem is split open, hard, black pebble-like fungus bodies are found imbedded in a cottony mass of fungus growth.

Timber rot is favored by rainy weather which keeps the soil wet for several weeks, as well as by rain, fog or overhead sprinkling. Infection may occur at temperatures of 32 to 82 F, but is favored when temperatures range from 60 to 70 F.

There is no satisfactory management for timber rot. To help reduce damage, do not plant tomatoes in areas where susceptible crops (beans, ornamental flowers, melons, etc.), have been grown and do not provide excessive overhead irrigation.

## WILTS

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There are two wilt diseases that can attack tomatoes in North Dakota. Neither one is common. Both are caused by fungi that infest the soil, remaining there for years.

### Fusarium Wilt

Fusarium wilt is caused by *Fusarium oxysporum* f. sp. *lycopersici*. The first symptoms are a yellowing and drooping of lower leaves on a single stem. Early symptoms may appear on only one side of the plant. A progressive yellowing and wilting of the leaves occurs, and the plants may die. When the stem is cut open, the vascular (water conducting) tissues under the surface are frequently discolored brown. This vascular browning extends from the roots to the upper portions of the plant and into the leaf petioles. This fungus infects only tomato.

Fusarium wilt is rare in North Dakota and is common primarily south of latitude 40°. It is favored by soil temperatures around 80 F, a low soil pH (North Dakota soils have a high pH), and a short day length. The fungus survives many years in the soil and can also be carried on the seed.

### Verticillium Wilt

Verticillium wilt is caused by the fungi *Verticillium albo-atrum* and *V. dahliae*. Since the disease resembles Fusarium wilt, a laboratory diagnosis is usually needed to distinguish between the two. Verticillium occurs more frequently in North Dakota than Fusarium because North Dakota soils and climatic conditions are more favorable for its development.

Verticillium wilt begins with a general or blotchy yellowing of the lower leaves and a wilting of young shoots at midday. Initially, wilted shoots may recover over night. The leaf veins turn brown, followed by shoots browning and lower leaf drop. Leaves higher up on the plant turn dull green in color and the edges curl upwards. Plants are stunted and defoliated with only the growing tips remaining green. The fruits are small and may sunscald. The branches tend to be less erect than those of healthy plants, giving Verticillium-infected plants a prostrate appearance. When the stem is cut open, the vascular tissues may be brown near the soil line, but the discoloration usually occurs only in the lower part of the stem.

The Verticillium fungus survives up to eight years in the soil as tiny black resting structures called microsclerotia. Infection and disease development are favored by soil temperatures of 70 to 77 F. The disease seems to be more severe in neutral to alkaline (high pH) soils. The Verticillium fungus also attacks pepper, eggplant, potato, cucumber and melon, strawberries and many other broad-leaved plants.

### Wilt Control

The first line of defense against wilt is to use disease-free seedlings. This avoids introducing wilt fungi into the garden. Remove and destroy wilted plants and all debris of tomato and other susceptible crops at the end of the growing season. Rotate tomato-growing areas, growing tomatoes in the same part of the garden only once in four years. The benefit of rotation is less with wilts than with other diseases since both wilt fungi survive for years in the soil and the Verticillium fungus attacks many different crops. Fungicides for control of leaf blights have no effect on the wilt diseases, which are internal infections. Once soil is infested and further rotation impossible, the only possible management practice is use of resistant varieties.

North Dakota varieties, although well adapted to North Dakota conditions, have no wilt resistance. Varieties are available which are moderately well adapted to North Dakota conditions and are wilt resistant. Varieties that have resistance to both Verticillium and Fusarium are usually designated VF on the seed package. VF varieties with moderate adaptation for North Dakota include Big Set Hybrid (65 days to maturity), Springset (67 days), Celebrity (70 days), Redpak

(71 days), Jet Star (72 days), Red Glow (72 days), Campbell 1327 VF (73 days), and Floramerica (79 days). Floramerica is also tolerant to the early blight fungus, tobacco mosaic virus, blossom end rot, catface, and concentric cracking. Floramerica and Celebrity are All-America Selection Winners for 1979 and 1984, respectively.

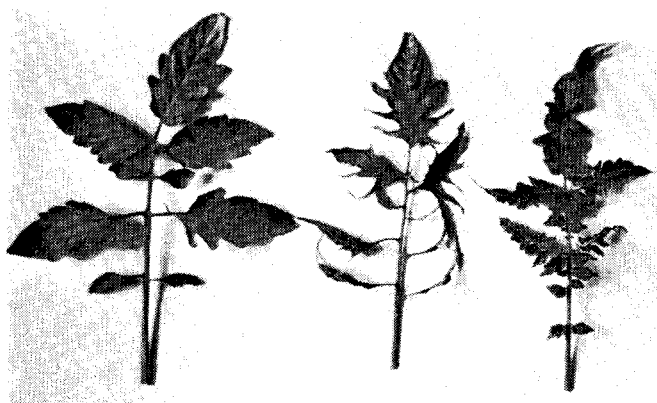
## VIRUS DISEASES

Virus diseases cause a mottling and distortion of foliage (leaves) and sometimes cause a mottling of fruits. Tobacco mosaic, cucumber mosaic and spotted wilt have occurred sporadically in recent years.

### Tobacco Mosaic

Infection by the tobacco mosaic virus causes leaves to be mottled light and dark green. The plants are stunted and the leaves rough, occasionally fern-like, and the edges turned down (Figure 7). The fruits usually do not show symptoms but may be reduced in size and ripen unevenly. Occasionally fruits are mottled light and dark green and may have brown streaks. The interior walls may be gray.

Tobacco mosaic virus may be seed-borne, soil-borne on crop debris and is carried on tobacco products and by certain chewing insects. It is readily transmitted mechanically from plant to plant by gardeners' hands, their clothing, and their tools. Tobacco mosaic virus frequently infects pepper, petunia, snapdragon, delphinium, marigold, and occasionally infects other vegetables, flowers and many weeds. The most common sources of tobacco mosaic virus in North Dakota are tobacco products or nursery and bedding plants.



**Figure 7. Tobacco mosaic symptoms on leaves. The leaf on the left is healthy; the other two illustrate the range of symptoms.** Photo by Arthur Lamey.

### Cucumber Mosaic

Early symptoms of cucumber mosaic are yellow, bushy and stunted plants. Later symptoms are similar to tobacco mosaic except that leaves are frequently elongate, narrow, and distorted to form a "shoestring" effect. These symptoms are distinguished from 2,4-D injury, because the leaf is not thick and leathery. Cucumber mosaic virus also causes a fern-leaf effect on some tomato leaves.

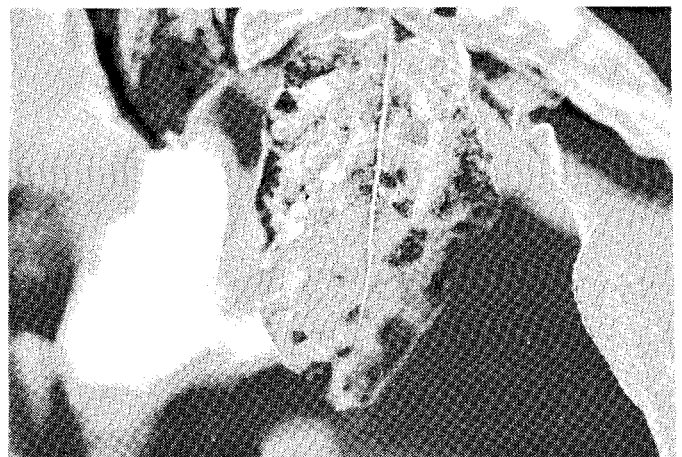
Cucumber mosaic virus is spread primarily by aphids, but can also be spread mechanically. The virus also infects cucumber, melon, pepper, various flowers, and many weeds.

### Mosaic Management

Avoid all tobacco products while working with tomato plants. Use only vigorous, healthy-looking plants. Remove virus-diseased plants as soon as symptoms appear. Wash hands and tools with detergent immediately after contact with virus diseased plants. Detergent is more effective than soap because detergent inactivates the virus. Control all weeds within 150 feet of garden areas. Control insects. Avoid handling other susceptible plants (eg. flowers, peppers, cucumbers and melons) while working with tomatoes. Do not grow tomatoes next to susceptible crops such as potatoes, peppers, cucumbers and melons.

### Spotted Wilt

Symptoms vary widely, but often the first symptoms of spotted wilt are orange flecks or a bronzed appearance of young leaves. On some cultivars, leaf spots may appear target-like as in early blight. Older leaves may turn brown, droop and die. Young shoots may develop dark streaks, progressing to a top dieback and eventually leading to plant death (Figure 8). Raised yellowish spots up to 1/2 inch across develop on green



**Figure 8. Spotted wilt lesion on potato leaf.** Photo by Gary Secor.

fruits. As the fruits ripen, these spots become striking with concentric rings of yellow or brown alternating with green and later pink or red. Early infection may lead to premature death of the plant, while later infections may lead to symptoms on the developing fruits.

The tomato spotted wilt virus is transmitted by the immature or larval forms of thrips. The virus can infect many plants, and the following can all be sources of the virus: potato, pepper, eggplant, pea, many flowers and weeds such as bindweed, nettle, mallow and chickweed.

No satisfactory management plan is available, but control of weed hosts and separation of vegetable hosts from flower beds may reduce, but not eliminate, the problem. When purchasing tomato plants, home gardeners should select vigorous and apparently healthy plants and avoid plants that appear stunted or have an abnormal color. Most introductions of this virus disease will come with infected plants from the greenhouse.

## NON-PARASITIC DISORDERS

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Non-parasitic disorders are caused by various physiological abnormalities. These problems may be more prevalent across North Dakota than biological diseases.

### Blossom End Rot

Blossom end rot first appears as a light tan water-soaked spot on the blossom end of partially grown fruits. The water-soaked area becomes sunken, leathery, and turns brown to black in color (Figure 9).



Figure 9. Blossom end rot on fruit. Photo by Robert Askew.

Blossom end rot is caused by calcium deficiency brought on by fluctuating soil moisture, especially moisture stress. Contributing factors are the use of excessive amounts of nitrogen fertilizer (especially ammonium) and root pruning.

Prevent blossom end rot by protecting the roots from injury; don't cultivate too close to the plants. Use a fertilizer high in phosphorus such as superphosphate and containing a nitrate form of nitrogen. A fertilizer such as 4-12-4 or 5-20-5 is good for tomatoes. Keep plants uniformly supplied with water — avoid wide cycles of wet and dry. Use a plastic or organic mulch, as this helps provide a more uniform moisture supply. A plastic mulch works well. If rows are 5 feet apart, the plastic mulch should be 4 feet wide in clay soils and 3 feet wide in sandy soils. The edges of the plastic should be weighted down with soil to prevent the wind from getting under the plastic. This can be done by digging a shallow trench around the edge of the plastic, placing the edge in the trench, then covering the edge with soil. Small holes should be cut in the middle of the plastic to plant the tomato transplants. It is best to use clear plastic which warms the soil faster in spring, producing a better root system; it may even result in an earlier crop of tomatoes. When transplanting the tomatoes, be careful that the plastic does not touch the plants as this can result in heat injury to the stem. A space of at least 1/2 inch should separate the plastic from the plant stem. In a rainy growing season, the soil under plastic may remain too wet too long, setting the stage for root disease development.

### Sunscald

Sunscald develops on the side of fruits suddenly exposed to the sun, first appearing as a light colored spot on green fruits. This spot develops into a blister, and later becomes sunken and whitish with a paper-like surface.

Sunscald may develop following sudden loss of leaves, such as that caused by leaf spot diseases. Sunscald management requires the prevention and control of leaf diseases and the shading of exposed fruits.

## Physiological Leaf Roll

Leaf roll develops in rainy periods. The lower leaves roll upward until the edges touch and become thick and leathery (Figure 10). Leaf roll is favored by cool wet weather, excessive fertilizer, and pruning. It has no serious effect on plant growth or yield, and usually no management practices are required.

## Growth Cracks

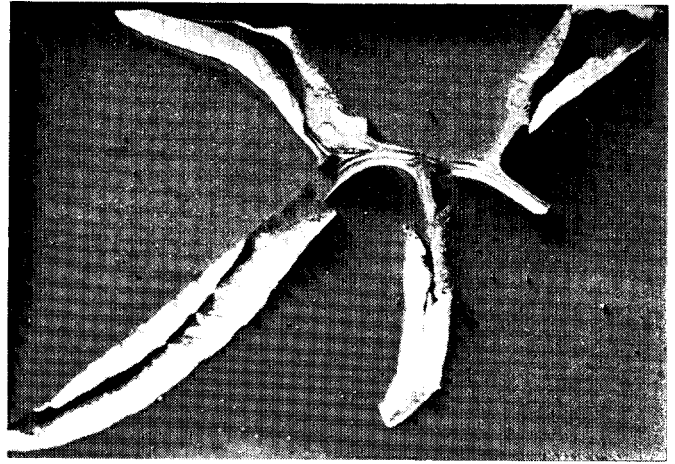
Cracks frequently develop on the stem end of fruits ripened during hot, rainy weather. These conditions promote rapid growth. Cracks may radiate away from the stem end or form in concentric bands around the stem end. Growth cracks are most severe when wet weather follows a dry period. Varieties differ in their susceptibility to growth cracks, and this information is frequently part of the variety description.

## Catface

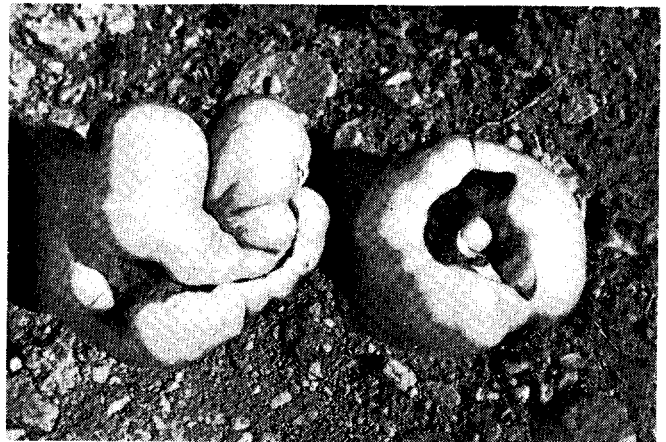
This abnormality generally develops on the blossom end of the fruit, resulting in puckered, swollen protuberances and deep cavities (Figure 11). Cool weather at blossom time may cause this abnormality. Some varieties are more susceptible to catface than others.

## Herbicide Injury

Tomatoes are very sensitive to injury by 2,4-D and related growth regulator herbicides. Leaves may become cupped, or veins may become parallel with leaves thick and leathery. Fruits may be catfaced or may only partially ripen. Growth may be stunted and abnormal or twisted. Symptoms of 2,4-D injury on tomatoes may resemble symptoms of virus diseases, except that 2,4-D usually causes the leaves to be thickened. Herbicides may drift when being applied to lawns; if a volatile ester is used, the fumes may cause injury several days after treatment. Never mulch tomato plants with grass clippings if the lawn was treated with 2,4-D during the previous two or three weeks. Do not use lawn-type weed killers close to the vegetable garden.



**Figure 10. Leaf roll.** Photo from the R. W. Samson Collection of Plant Diseases, Purdue University.



**Figure 11. Catface.** Photo by A. A. MacNab, Pennsylvania State University.

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