

Tomato

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Lycopersicon esculentum

Late Blight (fungus – *Phytophthora infestans*): Lesions produced on the leaves are at first irregular, rather large, greenish-black and water-soaked. These areas enlarge rapidly, becoming brown, and under humid conditions, develop a white moldy growth near the margins of the diseased area on the lower surface of the leaves or on stems. The disease spreads rapidly under humid conditions, destroying quickly large areas of tissue. Fruit lesions occur as large, green to dark brown lesions, mostly on the upper half of the fruit, but they may also occur on other parts. White moldy growth may also appear on fruits under humid conditions. The fungus produces abundant numbers of spores which may be splashed by rains or be airborne. These spores infect healthy leaves, stems and fruit readily if climatic conditions are optimum. Ideal conditions for late blight development are cool nights and moderately warm days with abundant moisture. Hot and dry weather reduces disease development. Infection on tomatoes may occur from nearby potato fields or from airborne spores. Control practices include rotating fields so as not to follow potato or tomato; avoiding planting tomatoes near potatoes; using disease-free seed and transplants. Crops should be sprayed regularly with a fungicide. Spraying should begin whenever weather conditions are favorable for disease development. Applications should continue on a 7 to 10 day schedule until harvest.

Early Blight (fungus – *Alternaria solani*): Early blight is first observed on the plants as small, black lesions mostly on the older foliage. Spots enlarge, and by the time they are one-fourth inch in diameter or larger, concentric rings in a bull's eye pattern can be seen in the center of the diseased area. Tissue surrounding the spots may turn yellow. If high temperature and humidity occur at this time, much of the foliage is killed. Lesions on the stems are similar to those on leaves, sometimes girdling the plant if they occur near the soil line. Transplants showing infection by the late blight fungus often die when set in the field. The fungus also infects the fruit, generally through the calyx or stem attachment. Lesions attain considerable size, usually involving nearly the entire fruit; concentric rings are also present on the fruit. The fungus is cosmopolitan, affecting a wide range of plants and is present in and on the seed and on crop refuse. Infection of young seedlings usually results from fungi and soil; it occurs principally during periods of high humidity and warm temperature. Control practices include the use of disease-free transplants and regular preventative fungicide applications during the growing season.

Gray Leaf Spot (fungus – *Stemphylium solani*): First infection appears as minute, brownish-black specks on the lower leaves that extend through to the undersurface of the leaf. These spots usually remain small, but may enlarge until they are about one-eighth inch in

diameter. They become glazed and at times the centers crack and tear across. Infected leaves usually die and drop. Spots also form on the stems. The fungus overwinters primarily on diseased refuse; spread is by airborne spores from diseased to healthy plants. Control measures include crop rotation, seedbed sanitation and preventative fungicide applications as for the control of late and early blight. Resistant varieties should be used when possible.

Leaf-Mold (fungus – *Fulvia (Cladosporium) fulvum*): Leaf mold is usually first observed on older leaves near the soil where air movement is poor and humidity is high. At first, diffuse whitish spots appear on the upper surfaces of older leaves; these rapidly enlarge and become yellow. Under humid conditions, the lower surface of these spots become covered with a gray, velvety growth of the spores produced by the fungus. When conditions are proper for fungal development, large areas of the field are infected, plants are weakened and the crop is greatly reduced. The fungus produces abundant spores during periods of high temperature and very high relative humidity. Infection occurs readily, and the disease becomes established in the fields quickly. The best control of this disease is by using a preventative fungicide program at 7 to 10 day intervals, the same as used for late and early blight control.

Buckeye Rot (fungus – *Phytophthora parasitica*): This disease occurs on tomato mainly on the fruit, particularly where it touches the soil. The fungus is different from the one causing late blight, which affects both leaves and fruit. Buckeye rot is first noticed as a light green water-soaked area on the fruit. Later, dark zonate bands can be seen on the surface of affected areas. The surface of the lesion is usually smooth and firm. With time, the entire fruit will rot. The fungus lives in the soil and it can also affect pepper. The disease is more troublesome in heavy, poorly drained soils during prolonged warm wet weather.

Bacterial Spot (bacterium – *Xanthomonas campestris* pv. *vesicatoria*): Infected leaves show small, brown, watersoaked, circular spots about one-eighth inch in diameter. The spots may have a yellow halo; the centers dry out and frequently tear. On older plants the leaflet infection is mostly on older leaves and may cause serious defoliation. The most striking symptoms are on the green fruit. Small, water-soaked spots first appear which later become raised and enlarge until they are one-eighth to one-fourth inch in diameter. Centers of these lesions become irregular, light brown and slightly sunken with a rough, scabby surface. Ripe fruits are not susceptible to the disease. Surface of the seed becomes contaminated with the bacteria, remaining on the seed surface for some time. The organism may also overwinter in alternate hosts, on volunteer tomato plants and on infected plant debris. Moist weather and splattering rains are conducive to disease development. Most outbreaks of the disease can be traced back to heavy rainstorms that occur in the area. Infection of leaves occurs through natural openings; infection of other fruits must occur through insect punctures, sandblasting and other mechanical injury means. Bacterial spot is difficult to control once it appears in the field. Disease-free seed and seedlings should always be used;

rotate crops so as to avoid last year's crop residue; use a combination of copper and organic fungicides in a regular preventative spray program at 5 to 10 day intervals. Dry, hot weather usually checks the disease.

Bacterial Canker (bacterium *Corynebacterium michiganense*): Wilting of leaflets is the first symptom; on older plants the margins of the lower leaflets wilt first, the margins dry and the leaflets curl upward. Light colored streaks appear on stems. These streaks later break open at intervals to form cankers in which bacteria ooze may appear. Fruits are infected on the surface, spots appearing first as very small and snowy-white; the margins remain white and flat, but the centers become raised, tan colored and roughened. A white halo develops around the spots, which serves to differentiate the disease from other bacterial spots. The canker organism is seedborne and can remain in the soil and diseased plants for some time. Primary infection, however, is mostly from infected seed. Control can be obtained by using disease-free treated seed and clean transplants.

Nailhead Spot (fungus – *Alternaria tomato*): Leaf symptoms are the same as those caused by early blight on fruits; however, spots are smaller, with slightly sunken centers and dark margins. As the spots become older, the edges become roughened. On ripe fruit, the tissue immediately around the spots often remains green. Control is the same as for early blight.

Anthracnose (fungi – *Colletotrichum* sp.): At first, infected fruit show small, slightly sunken, watersoaked spots. These spots enlarge, become darker in color, depressed and have concentric rings. Masses of the pink fruiting fungus can be seen on the surface of the lesions in moist weather. Under warm and humid conditions, the fungus penetrates the fruit, completely destroying it. The fungus persists on infected plant refuse in the soil. Fruit may be infected when green and small, but do not show any marked lesions until they begin to ripen. Fruit becomes more susceptible as they approach maturity. Control of this disease involves the use of well-drained soil, crop rotation and a preventative fungicide program as recommended for other diseases.

Fusarium Wilt (fungus – *Fusarium oxysporum* f. sp. *lycopersici*): The first indication of disease in small plants is a drooping and wilting of lower leaves with a loss of green color followed by wilting and death of the plant. Often leaves on only one side of the stem turn yellow at first; yellowed leaves gradually wilt and die. The stem of wilted plants shows no soft decay, but when cut lengthwise, the woody part next to the green outer cortex shows a dark brown discoloration of the water conducting vessels. The fungus is soilborne, passes upward into the xylem of the stem. Blocking of the water-conducting vessels is the main reason for wilting. The fungus is most active at temperatures between 80 and 90 degrees F., seldom being a serious problem where soil and air temperatures remain low during most of the growing season. Control can be obtained by growing plants in disease-free soil, using disease-free transplants, and growing only resistant varieties.

Verticillium Wilt (fungus – *Verticillium albo-atrum*): The first symptom is yellowing of the older leaves, followed by a slight wilting of the tips of the shoots during the day. Older yellowed leaves gradually wither and drop, and eventually the plant is defoliated. Verticillium wilt does not show the one-sided effect as does Fusarium wilt. Leaves from Verticillium infected plants sometimes show brown dead spots that may be confused with those caused by other fungi. However, they are lighter in color and do not show concentric zones as in early blight. In late stages of the disease, only the leaves near the tips of the branch remain alive. When the stem is cut lengthwise, the base shows a discoloration of the woody tissue similar to Fusarium, but is usually darker, and generally it occurs only in the lower part of the stem. The fungus enters the plant through the feeder roots and grows into the stem in the woody conducting vessels just under the cortex. The fungus lives in the soil for a long time and it is exclusively the source of infection. Progress of the disease is favored by cooler temperatures and is retarded by the high temperatures that are favorable to *Fusarium* wilt. Locating seedbeds and fields in *Verticillium*-free soil, and using resistant varieties are the most effective means of controlling the disease.

Gray Mold (fungus – *Botrytis cinerea*): Plants become more susceptible to this disease as they become older. It is mostly a problem in greenhouses, but it can also affect tomatoes in the field. The fungus first becomes established on dead leaves at the base of the plants. A heavy, gray growth of the fungus covers these, and numerous spores are soon found, giving the affected area a cottony appearance. Affected leaves collapse and shrink. The fungus progresses into the stem, producing cankers. Affected fruits first show a watersoaked, soft area in the points of infection. The dark gray growth of the fungus soon is seen on these spots. Regular fungicide applications should help in controlling this disease.

Botryosporium Mold (fungus – *Botryosporium* sp.): This fungus can often be found on greenhouse tomatoes. It superficially resembles gray mold. Septoria Leaf Spot (fungus – *Septoria lycopersici*): Infection usually occurs on the lower leaves near the ground, after plants begin to set fruit. At first, small watersoaked spots are observed, which under ideal conditions will become numerous. Large areas of the leaves may be affected but the individual spots can be recognized. The watersoaked spots become roughly circular, with dark margins surrounding a light gray center. With time, black specks which are spore producing bodies can be seen in the center of the spots. If the spots are numerous, the lower leaves will turn yellow, die and progressively drop from the plant until only a few leaves remain on the top of the plant. The fungus is most active when temperatures range from 60oF to 80oF, and humidity conditions are high. The disease is usually not serious during periods of hot, dry weather. The fungus can overwinter on crop residue from previous crops, decaying vegetation and some tomato-related wild hosts. Crop rotation, plowing under crop residues, and clean cultivation will reduce the amount of inoculum in tomato fields. Repeated fungicide applications will keep the disease in check.

Southern Blight (fungus – *Sclerotium rolfsii*): The first symptom is dropping of leaves suggestive of other wilts. Wilting progresses and plants die quickly. Stems show decay of outer tissues at the ground line. Frequently, they are covered by a white fungal mat in which are embedded numerous small, light-brown bodies about the size of cabbage seed. The fungus can also attack fruits where they touch the soil. The fungus does not grow at temperatures below 68oF; it requires abundant moisture for growth. Infection takes place below the soil line or close to ground level. Control is obtained by sanitation, crop rotation, and by treating infected soil with a soil fungicide prior to planting.

Blossom End Rot (nonparasitic): Blossom end rot is a physiological disorder of tomato that can appear on fruits at any time in their development, but most commonly appears when fruits are one-third to one-half grown. The initial symptoms are water-soaked spots on the blossom end of the fruit. These spots later enlarge and become black. Secondary infection by other decay causing organisms usually follows. The cause of this disorder is considered to be calcium deficiency in the developing fruit. Extreme fluctuations in moisture, root pruning and excessive nitrogen fertilization can also result in blossom end rot. Best means of control is to maintain a uniform supply of moisture through irrigation and soil mulches. Calcium chloride can be used as a spray for control under some conditions.

Growth Cracks (nonparasitic): Growth cracks result from extremely rapid fruit growth brought on by periods of abundant rain and high temperatures, especially when these conditions take place following periods of stress. Cracks of varying depth radiate from the stem end of the fruit, blemishing the fruit and providing an entrance for decay-causing organisms. No control practices are known.

Tobacco Mosaic (virus): Symptoms are light and dark green mottling of the tomato foliage, and curling and slight malformation of the leaflets. Plants may be somewhat stunted if infected when small, but the plants and fruit are not much reduced in size if plants are not infected until they reach the fruiting stage. Several strains of the virus are known that can cause different symptoms. The virus is highly infectious and readily transmitted by any means that introduces even a minute amount of sap from infected to healthy plants. The most common means of transmission is by handling contaminated plants. The virus may also be present in certain types of tobacco; therefore, smokers may transmit the disease. Control measures are: avoiding handling plants more than necessary, washing hands before handling plants, and protecting healthy plants from infection.

Double Streak Virus (virus): Caused by a combination of viruses. Leaves show a light-green mottling, accompanied by the development of numerous small, grayish-brown, dead spots which have a thick, paper appearance. Numerous narrow, dark brown streaks develop on the stem and leaf petiole. Fruits are often rough and misshapen and on the surface they

have small, irregular, greasy, brown patches which render them unfit to market. The virus is transmitted by workers handling the crop. Avoid infection by tobacco mosaic virus, wash hands before starting to work and remove infected plants.

Spotted Wilt (virus): This disease is similar to streak in that it causes streaking of the leaves, stems and fruits. Numerous small, dark, circular spots appear on younger leaves. Leaves may have a bronzed appearance and later turn dark brown and wither. Fruits show numerous spots about one-half inch in diameter with concentric, circular markings. On ripe fruit these markings are alternate bands of red and yellow. The virus also affects other vegetables and many wild hosts and ornamental plants. Thrips can transmit the disease from the wild hosts. For control, eliminate weeds around field edges and turnrows; remove infected plants when small, and control insects in the field.

Curly Top (virus): Pronounced upward rolling and twisting of the leaflets that expose their undersurfaces, stiff and leathery foliage, and a peculiar dull yellowing of the entire plant are typical symptoms of the disease. There is also some purpling of the veins and the plant is usually very stunted. Very few fruits are produced after infection. The virus is not transmitted through the seed or soil, nor is it spread by mechanical means. The main vector is the beet leafhopper that becomes infected by feeding on wild or cultivated plants having the disease. The disease is difficult to control. Keep field surroundings free of weeds. Controlling insects may effect some control.

Root Knot Nematodes (*Meloidogyne* spp.): Root knot nematodes represent one of the major limiting factors to tomato production. Preventing their entry into growing areas is an important mean of control. Susceptible varieties growing in infested soil will have knots or galls on the root system. Once present it becomes necessary to use a resistant variety or to apply nematicide. Refer to the section on nematodes for more information. Use of resistant varieties is the most effective method of reducing nematode losses.

Greenhouse diseases – All of the diseases affecting tomatoes in the field can damage tomatoes in the greenhouse. If proper precautions are not taken, severe losses can occur to tomatoes grown under greenhouse conditions. Among the most common diseases of tomatoes under greenhouse conditions are:

Soil diseases: Nematodes, Fusarium wilt.

Stem diseases: Bacterial cankers, Botrytis stem canker, early blight canker.

Foliage diseases: Leaf mold, gray mold, late blight, early blight, mosaic.

It is important that special control practices are practiced under greenhouse conditions. Maintaining the proper relative humidity is essential for the control of foliage diseases. Relative humidity should be 85 percent or less, which at times proves to be very difficult. Proper air circulation, ventilation, and temperature control are essential under greenhouse

conditions. Sanitation is extremely important in controlling greenhouse diseases. All debris should be collected and destroyed soon after harvest. Tools and equipment should be properly cleaned at periodic intervals. Hands should be washed with soap and water before entering the house, and smoking should never be allowed. The soil should be fumigated before planting to control nematodes and other soilborne organisms. Whether using gas or liquid fumigants, proper rates and methods of applications should be made periodically to control foliage diseases. Some fungicides can be sublimated by fire under airtight conditions. If properly used, they will effectively control these diseases.

Seedling Diseases (fungi – *Rhizoctonia* sp., *Pythium* sp.): Seedlings fail to emerge or small seedlings wilt and die soon after emergence. Surviving plants may have infected root systems and watersoaked areas on the stem close to the soil line. As the plants mature, they become more resistant to damping-off. Avoid excessive moisture in the seedbed, plant seed treated with fungicides and use sterilized media for growing transplants.