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LATE BLIGHT OF TOMATO AND POTATO IN CONNECTICUT

Late blight is a devastating disease that has historical significance for its association with the Irish potato famine of the 1840's. This disease can affect tomatoes and potatoes in commercial fields, backyard gardens, greenhouses, and high tunnels and can result in substantial losses of tomato and potato crops. Late blight has the ability to rapidly kill plants under favorable environmental conditions, and if left unchecked, it can completely destroy entire crops.

In 2009, an unusually early and widespread outbreak of late blight occurred throughout Connecticut and the Northeast. It was initiated by widespread distribution and sale of infected tomato transplants by "big box" and chain stores in the area. Many growers and homeowners experienced this disease for the first time and were surprised by the devastation and crop losses.

Cloudy, cool, wet weather is favorable for the development and spread of late blight. When the disease is detected in nearby states, it is important for commercial growers and home gardeners to be on the alert for symptoms. Scouting should be done on a regular or daily basis, since even small outbreaks in backyard plantings can significantly impact commercial production.

DISEASE DEVELOPMENT:

Late blight is caused by the oomycete or fungus-like organism *Phytophthora infestans*. This pathogen is appropriately named and is derived from the Greek words "phyto" meaning plant, and "phthora" meaning destroyer, thus "plant destroyer." There are several strains of *P. infestans* in the U.S. (e.g., US-8, US-22, US-23), some of which are specialized on potatoes, some on tomatoes, and some are equally pathogenic on both hosts.

The host range for *P. infestans* includes plants in the Solanaceae family, primarily tomato and potato, although infections of eggplant and pepper have been reported. *P. infestans* has also been found to infect hairy nightshade (*Solanum sarachioides*) and bittersweet *(S. dulcamara)*, as well as ornamental hybrid petunia. Because of the potential for an outbreak of late blight this season, all tomato and potato plants should be considered at risk and inspected on a routine basis.

Disease development is favored by cool, moist weather. Night temperatures in the

50's and day temperatures in the 70's accompanied by rain, fog, or heavy dew are optimum for infection. Under these conditions, symptoms may appear on plant tissues 3-5 days after infection. Once symptoms develop, the pathogen grows and sporulates on the surface of infected tissues. *P. infestans* produces fruiting structures called sporangia, which are visible to the naked eye as white fuzzy growth. Up to 100,000 to 300,000 sporangia per day can be produced in an individual lesion, and each sporangium is then capable of initiating a new infection. Sporangia are easily dislodged and spread by irrigation, rain, wind, human activities, and equipment. They can travel several miles or more. When sporangia land on susceptible tissue, they initiate new infections and another cycle of late blight begins. Because of the high reproductive potential of this pathogen, epidemics can be rapid and devastating.

P. infestans does not survive in the soil or in plant debris. However, it can survive in infected potato tubers located in cull or compost piles. It has also been found to overwinter in infected tubers in storage. *P. infestans* is not seed-borne in tomato.

Sporadic outbreaks occur from year to year in Connecticut. However, they are usually attributed to wind-blown spores of the pathogen that are introduced into the state. Since these introductions occur late in the growing season, losses are usually limited.

SYMPTOMS:

Tomato and Potato Stems and Leaves:

The late blight pathogen can attack all above-ground parts of tomatoes and potatoes, as well as potato tubers. Symptoms on stems and leaves of tomato and potato are very similar (Figure 1).

They are readily visible to the naked eye and appear as water-soaked, olive-brown to black blotches or lesions on leaves and stems. Stem lesions are dark brown, dry, and superficial. They can appear as small spots or can be several inches long (Figure 2).

Figure 1. General symptoms of collapse on tomato associated with late blight.

Figure 2. Dry, brown lesions on stems (arrows).

On leaflets and leaves, late blight lesions vary in size from ½ to ¾ inch or larger. Lesions are water-soaked, olive brown, and

sometimes have yellow margins (Figures 3 and 4).

Figure 3. Early symptoms of late blight appear as brown, water-soaked lesions with yellow margins.

Figure 4**.** Typical olive-brown late blight lesions on tomato leaflet.

When many lesions develop, they coalesce into large, brown areas. These infected tissues dry out and shrivel.

Symptoms commonly develop on leaves, but can occur on petioles, stems, and calyx tissues (Figure 5). After rainfall or heavy dew, white growth of the pathogen is visible on infected stem tissues or on the top or bottom leaf surfaces (Figure 6). When these lesions dry out, the white growth disappears and lesions may appear lime-green or ash-gray in color. Symptoms rapidly develop on leaflets, leaves, and stems when weather is favorable for infection and spread, so plants can be killed in several days.

Figure 5. Late blight lesions on fruit calyx and stem tissues.

Figure 6. White sporulation of the pathogen on the undersurface of infected leaflets.

Tomato Fruit:
Late blight infections on tomato fruit can

develop on the stem end or on any part of the fruit. They appear as dark brown, sunken lesions (Figure 7). The lesions rapidly expand, and eventually surround the entire tomato fruit (Figure 8). This is often followed by secondary soft rot and rapid disintegration of the fruit.

Figure 7. Green tomato fruit with symptoms of late blight.

Figure 8. Dark brown, sunken late blight lesions on green fruit.

White, fluffy growth of the pathogen develops on infected fruit during periods of high humidity or moisture (Figure 9). This growth comprises thousands of sporangia of *P. infestans* (Figure 10).

Potato Tubers:

Potato tubers are infected in the field when sporangia are washed from the foliage down into the soil. Infections generally begin in cracks, eyes, or lenticels of the tubers.

Figure 9. White sporulation of the pathogen on the surface of an infected fruit.

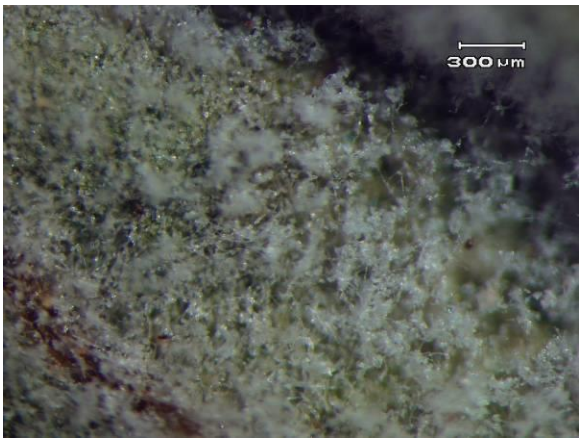

Figure 10. Close-up of sporangia of *P. infestans* from Figure 9.

Sporulation or fruiting structures of the pathogen may occur on surfaces of infected tubers in storage or in cull piles. Infected tubers are usually invaded by soft rot bacteria, which rapidly convert adjoining healthy potatoes into odoriferous, rotten masses that must be discarded.

Look-Alike Symptoms:
Symptoms of late blight are sometimes confused with **Septoria leaf spot of tomato** caused by *Septoria lycopersici*, and **early blight of tomato**, caused by *Alternaria solani*. Both of these fungal diseases are more common in Connecticut than late blight and can be differentiated by microscopic identification and by macroscopic features. Early blight symptoms can develop on any aboveground plant tissues. Initial symptoms are dark brown to black, dead spots that range from a pinpoint to ½" in diameter. As the spots enlarge, diagnostic concentric rings may form as a result of irregular growth patterns by the organism in the leaf tissue. This gives the lesion a characteristic "target-spot" or "bull's eye" appearance (Figure 11).

Figure 11. Symptoms of early blight caused by *Alternaria solani*.

Symptoms of Septoria leaf spot usually develop on lower leaves first and appear as small, water-soaked, circular spots 1/16 to 1/8" in diameter that gradually turn gray to tan and have dark brown margins (Figure 12). Infected leaves often turn yellow. In addition, dark brown, pimple-like fruiting bodies of the fungus are readily visible in the tan centers of the spots. Once there are many lesions on the leaflets, the lesions coalesce and form large brown blotches that can be identified as late blight or early blight (Figure 13).

Figure 12. Symptoms of Septoria leaf spot of tomato.

Figure 13. As the spots age, they sometimes enlarge and often coalesce to form brown blotches on the leaflets.

MANAGEMENT:
Management of late blight requires aggressive measures that include combined use of culture, scouting, sanitation, and when necessary, fungicide sprays.

1. It is very important to start each season pathogen-free by purchasing healthy, locally produced tomato transplants or certified potato tubers. It is important to avoid using potatoes saved from last year's garden or from the grocery store, since they can sometimes harbor undetected infections by the late blight pathogen. Purchasing certified seed potatoes effectively reduces, but does

not completely eliminate potential sources of inoculum.

2. Choose fields with good air movement and well drained soils. Rotating tomatoes into new areas of the garden every year is a good idea. Although the late blight pathogen does not persist in the soil, other plant pathogens such as those associated with early blight and Septoria leaf spot, can overwinter in plant debris in the soil so rotation can be very helpful.
3. Pull all volunteer tomato or potato plants, as well as any Solanaceous weeds that grow in and around the garden.
4. Scout and inspect all tomato or potato plants daily or weekly. **As soon as late blight symptoms are detected, immediately pull and remove whole plants and place them in a plastic bag to avoid carrying the infected material through the garden. Infected plant material should NOT be composted.**
5. If you observe suspicious symptoms on tomatoes or potatoes, it is important to have the disease accurately identified by a specialist. An image gallery of late blight can be found at: http://www.ct.gov/caes/lib/caes/documents/publications/fact_sheets/plant_pathology_and_ecology/late_blight_image_gallery_2009.pdf .
6. Once late blight is confirmed, it is helpful to inform your neighbors, since the pathogen can easily spread to nearby properties. Communication is an important component for effectively managing this disease.
7. Since water is important to the spread and development of late blight, avoid overhead watering. It also helps to avoid working with plants (e.g., staking, suckering, harvesting) when they are wet, since this pathogen can be spread during these types of activities.
8. Staking and mulching can also help reduce infections. Staking increases air circulation and helps to dry the leaves—this reduces favorable conditions for infection. Although the late blight pathogen cannot survive on stakes, they should be disinfected between crops to minimize the spread of other diseases, especially bacterial diseases.
9. Research is ongoing to develop cultivars of potato with effective genetic resistance to *P. infestans*. Some potato cultivars available in the U.S. that have moderate to strong foliar (and tuber) resistance are 'Defender' (russet, brown skin and white flesh), 'Jacqueline Lee' (round, yellow skin and flesh), and 'Ozette' (fingerling, white skin and flesh). Research is also underway to develop tomatoes with resistance or tolerance to late blight. The tomato cultivars Defiant, Mountain Magic (large cherry), and Plum Regal (plum) show resistance to the strain of late blight most prevalent in the region.
10. The final strategy for minimizing late blight involves selection, timing, and application of fungicide sprays. Fungicides can be effective and are often necessary to supplement other management strategies previously outlined, especially when weather is favorable for disease. When there is a risk of late blight occurring, fungicide applications need to be used on a regular preventive schedule. Thorough coverage of all parts of the plant is necessary and the sprays should be applied until run-off. The fungicide label will contain information on dosage rates, pre-harvest interval (PHI), and safety precautions.
    a. For Connecticut homeowners, chlorothalonil is registered and effective for use. For those who prefer an organic option, copper

is registered for use. In addition, several biological controls (biopesticides) acceptable for organic use are available (with trade names such as Sonata, Serenade, and Regalia). Since most fungicides are protectant materials, they should be applied before symptoms are observed and repeated as necessary when conditions are favorable for disease development and spread.

b. Commercial growers should follow a fungicide program that includes both protectants and systemics. Systemics, which have translaminar or curative properties, are most effective when mixed with protectants such as chlorothalonil or mancozeb. Since *P. infestans* can develop resistance to systemic fungicides, mixing systemic with contact fungicides is often necessary. Organic options for commercial growers include copper products, hydrogen peroxide (Oxidate), and several biological controls (with trade names such as Sonata, Serenade, and Regalia). Growers can contact the Experiment Station for a complete list of registered fungicides.

USAblight is a national website that serves as an information portal for all types of information on late blight. New outbreaks throughout the US are regularly posted. The address for this website is http://www.usablight.org/.

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