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LATE BLIGHT OF TOMATO AND POTATO IN CONNECTICUT--2010

Late blight was confirmed on tomatoes in Connecticut in June 2010. This follows the unusually early and widespread outbreak of late blight that occurred throughout Connecticut and the Northeast in 2009. Last year's outbreak affected tomatoes and potatoes in commercial fields, backyard gardens, greenhouses, and high tunnels. This devastating disease has historical significance for its association with the Irish potato famine of the 1840's, and it rapidly kills plants under favorable environmental conditions such as cool, cloudy, windy, wet weather—conditions that characterized May, June, and July 2009. Strain US-22 of the late blight pathogen, *Phytophthora infestans*, was responsible for most of the losses in the Northeast last year.

This year, the season started with the potential for a high level of overwintering inoculum. This was primarily from volunteer plants from potato tubers from infected plants from 2009 that were saved, survived compost piles, or overwintered directly in the garden. By contrast, in 2009 the potential for overwintering inoculum was minimal. However, the 2009 outbreak was initiated by widespread distribution and sale of infected tomato transplants by "big box" and chain stores throughout Connecticut and the Northeast. In addition, once the infected transplants were set in the ground, they were exposed to favorable weather for disease development and spread. These conditions resulted in the unprecedented and unusually outbreak.

DISEASE DEVELOPMENT:

Late blight is caused by the oomycete or fungus-like organism *Phytophthora infestans*. This pathogen is appropriately named and is derived from Greek words "phyto" meaning plant, and "phthora" meaning destroyer, thus "plant destroyer." There are several strains of *P. infestans* in the U.S., 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 widespread outbreak of late blight this season, all tomato and potato plants should be considered at risk.

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

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.

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 the soil.

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

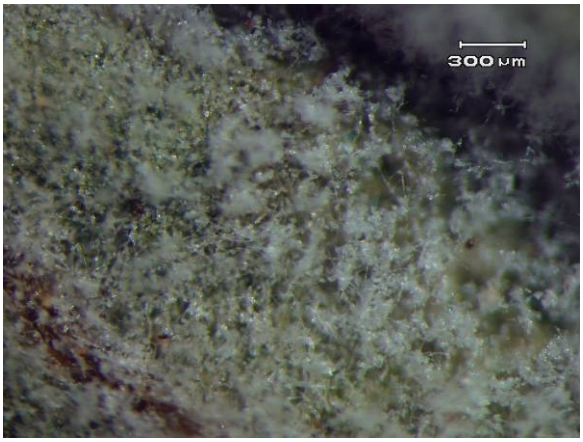

Figure 10. Close-up of sporangia of *P. infestans* from Figure 9.

Infections generally begin in cracks, eyes, or lenticels of the tubers. 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: Septoria leaf spot symptoms usually develop on lower leaves 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 11). 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.

Figure 11. Symptoms of Septoria leaf spot of tomato.

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 12).

Figure 12. Symptoms of early blight caused by *Alternara solani*.

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, tomato transplants or certified potato tubers. This effectively eliminates initial 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 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. 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.
7. Staking and mulching can also help reduce infections. Staking increases air circulation and helps to dry the leaves—this reduces favorable conditions for infection.
8. 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. However, last year, the tomato cultivars Mountain Magic F1 (large cherry), and Plum Regal F1 (plum) showed excellent resistance to the strain of late blight most prevalent in the region.
9. 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, the fungicides chlorothalonil and copper (organic option) are registered for use. In addition, several biological controls (biopesticides) acceptable for organic use are available (with trade names such as Sonata, Serenade, Regalia, and Oxidate). 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 and several biological controls (with trade names such as Sonata, Serenade, Regalia, and Oxidate).

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