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Potato Late Blight

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Quick Facts

- Late blight is a fungal disease of potatoes caused by *Phytophthora infestans*. Infected seed tubers, potato cull piles, and volunteer potatoes are important sources of the fungus.
- Late blight epidemics are initiated by fungal spores produced on living, infected plant tissue. Spores are spread by rain, overhead irrigation, and wind.
- Spores produced on foliage and stems infect tubers in the till and during harvest. Infected tubers are invaded by secondary decay organisms and rapidly decay during storage.
- Eliminating cull piles and volunteer potatoes reduces spore and disease risk. Plant only high-quality certified seed potatoes from fields with no history of late blight.

Introduction

Late blight cause by the fungus *Phytophthora infestans* is an important disease of potatoes. It is the disease that caused the Irish potato famine during the 1840s. Today, late blight is found in nearly all areas of the world where potatoes are a crop. It is most destructive when potatoes are grown under cool, moist conditions. Late blight is also very destructive to tomatoes and several other species in the family *Solanaceae*. Although late blight can cause devastating losses, its impact can be reduced by the use of sound disease management practices.

Symptoms

Foliar lesions first appear as water-soaked spots at the tips or edges of lower leaves where water or dew tends to collect. Under moist, cool conditions, water-soaked spots enlarge rapidly, becoming brown with indefinite borders. A broad yellow halo may surround each lesion. A spore-producing zone of white moldy growth may appear at the lesion's border and is usually more evident on lower leaf surfaces. The appearance of this zone is influenced by the environment. Under continuously wet conditions, the fungus sporulates pro-

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Moldy Stem Lesion

Figure 1. Late blight lesions on leaves and stems often have fungal sporulation evident under cool, wet growing conditions. The growth indicates that spore production is occurring and disease spread is likely. (Source: R. Goth).

Moldy Leaflet Lesions

fusely and disease develops rapidly as the fungus rots both leaves and stems (Figure 1). Dry weather will slow or stop disease development. This effect is enhanced by high temperatures. When disease development stops, lesions turn dark and wither, and the fungus is no longer visible. As conditions become moist, the fungus resumes growth and disease development resumes. Figure 2 shows the growth of other stem fungi that may be confused with signs of late blight.

Tuber lesions first appear as irregular, dark blotches. When tubers are cut, affected tissue appears water-soaked with a reddish-brown discol-

R. solani

Figure 2. Fungal growth on stems that may be confused with late blight are shown. The sexual stage of *Rhizoctonia solani* (top photo) is harmless and will appear near the soil line as a gray, superficial film that is easily removed by scraping. White mold (bottom photo) caused by *Sclerotinia sclerotiorum* is characterized by fluffy, white growth. As white mold progresses, hard, black fungal sclerotia form within stems. (Source: G. Franc [top], Western Regional Research Publication #011 [bottom]).

S. sclerotiorum

oration that extends irregularly into the tuber (Figure 3). Lesions may start as a superficial decay that continues to develop after tubers are placed into storage. Older lesions may become firm and sunken due to water loss, and tubers may appear shriveled. Infected tubers are commonly invaded by secondary decay organisms such as soft-rot bacteria and frequently decay during storage.

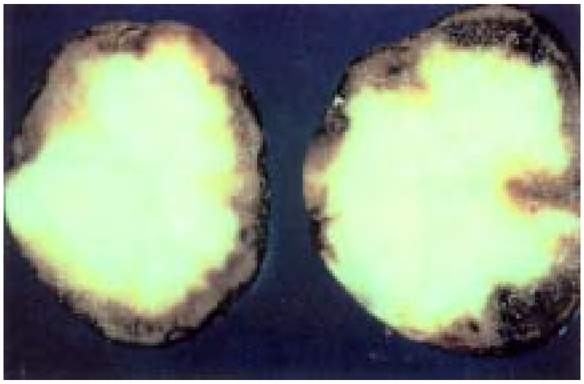

Figure 3. Late blight lesions on tubers consist of reddish-brown, granular, rotted tissue that extends irregularly into each tuber. Tubers can appear healthy at the time of harvest. (Source: Western Regional Research Publication #011).

Disease Cycle

Late blight is caused by the fungus ***Phytophthora infestans*** (Mont.) de Bary. This fungus is classified as a "water mold" and is especially adapted for growth under conditions where free water is present and cool temperatures persist. Temperatures ranging from approximately 50 to 95 degrees Fahrenheit favor disease development. However, the upper temperature limit for disease development is poorly defined, and, in the presence of sufficient moisture, disease development will continue at elevated temperatures.

New late blight epidemics are initiated by fungus spores produced on the surface of living, infected plant tissue. Infected seed tubers, tomato transplants, potato cull piles, and volunteer potatoes are extremely important sources of inoculum. Spores are readily spread by splashing rain, overhead irrigation, and wind. Spore germination only occurs when free water is present on the plant surface. Repeating cycles of spore production and spread give late blight its potential to develop rapidly. Spores washed from foliage and stems can infest tubers in the hill before harvest. Spores present on vines are also generally believed to infect tubers during harvest. Very little is know about the potential for tuber-to-tuber spread in storage and its impact on disease development. A diagram of the late blight disease cycle is shown in Figure 4.

Disease Management

Effective disease management programs integrate different disease-control methods. Disease management programs that rely on a single control method frequently fail.

Asexual forms of the late blight fungus overwinter only within infected, living plant tissue. Thus, the elimination of cull piles and other sources of volunteer potatoes is one of the most important management practices.

Planting certified seed from fields with no late blight is also extremely important for reducing risk from late blight. Most states do not have a zero tolerance for late blight; therefore, seed buyers should review inspection records for each certified seedlot before making purchases. Although seed certification is not a guarantee of freedom from disease, planting non-certified "common" seed is an unacceptable risk. Seed-piece fungicide treatments will not control late blight. Once the crop is planted, tilling to keep daughter tubers well below the soil surface reduces tuber infection if leaf and stem tissue become infected during the growing season.

Potato cultivars traditionally planted in the United States are susceptible to varying degrees with none being totally resistant or immune (Figure 5). The level of disease resistance depends on growing conditions as well as the characteristics of the fungus isolate. In general, planting resistant cultivars may slow disease development sufficiently to reduce the need for fungicide.

Disease prediction models based on weather data are used to schedule foliar fungicide applications. These models are based on the duration of temperature, rainfall, and / or humidity. Although models are very helpful in areas where late blight is an annual threat, their use is not documented in irrigated production areas where the amount of moisture applied to each field is likely to vary and the presence or absence of inoculum is unknown. Ideally, forecasts enable growers to apply fungicide at the optimal time(s) for disease management. Fungicide applications made too early are wasteful, and applications made after disease spread has been initiated are less effective.

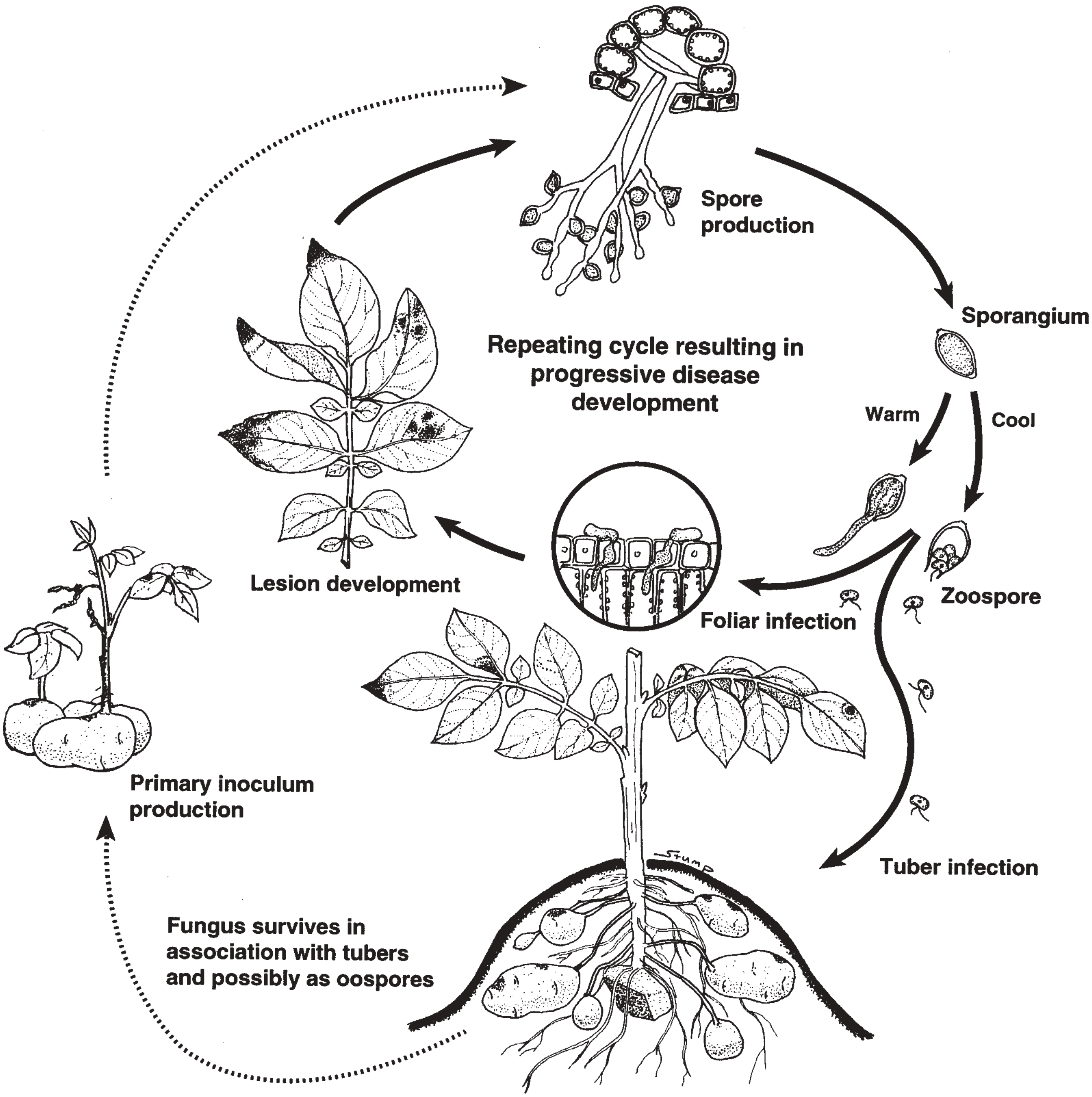

Figure 4. This is the late blight disease cycle. The fungus survives in infected tubers and volunteer plants. Spores are only produced on the surface of living host plant tissue. Disease progression is influenced by many factors including host susceptibility, fungicide use, and environmental conditions. Cool, wet conditions favor disease progression. Simultaneous plant infection by the A1 and A2 mating types may result in sexual spore production and soil survival. (Prepared by G. D. Franc and W. L. Stump).

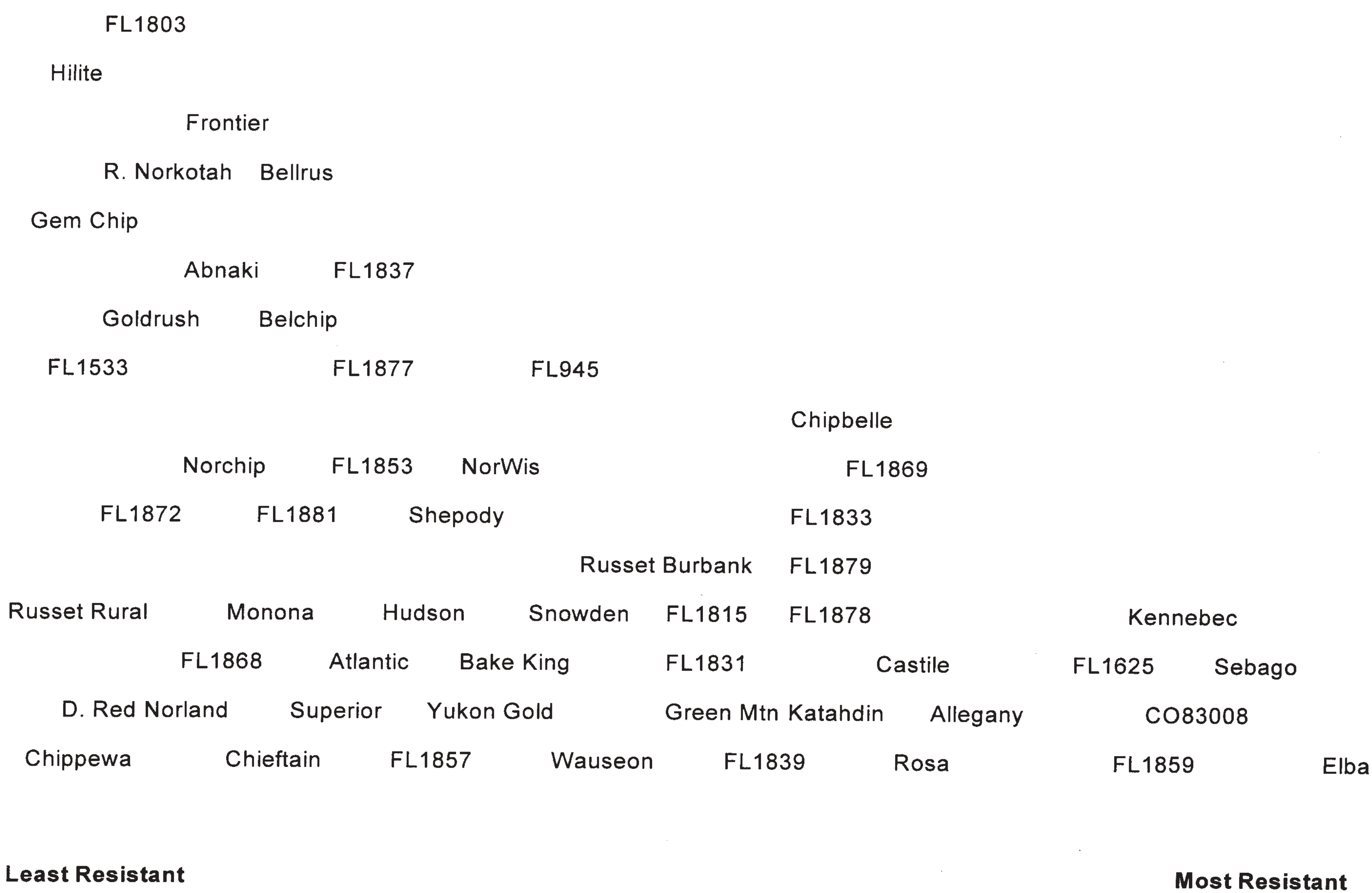

Figure 5. The relative susceptibility of common potato varieties to late blight is shown. The selection of the most resistant varieties may decrease the need for fungicide should late blight develop (prepared by D. A. Inglis et al., 1996 *Plant Disease* 80:575-578 and W. E. Fry, personal communication, prepared by W. E. Fry).

Careful field scouting is needed to detect late blight as early as possible. Skips in fungicide placement and varying environmental conditions both among and within fields can result in "pockets" of disease development. Late blight is most likely to develop in shaded, cool portions of a field where the relative humidity is greatest. Fungicide should be immediately applied to an entire field if late blight is detected. If pockets of disease development are found, spot treatment with herbicide or tillage to quickly kill infected plants can reduce disease spread. Late blight spore production continues as long as any infected plant tissue remains alive.

When used properly, fungicides are highly effective tools for late blight management. Thorough coverage is essential for effective disease management. Fungicide applications made before row closure will result in better coverage and will be more effective than applications made when an extensive canopy is present. Applications made with properly calibrated ground rigs result in better coverage than those made by airplanes. Increasing the carrier volume applied per acre will improve coverage when fungicide is applied by airplane. Chemigation is effective, provided sufficiently small volumes of water are applied as specified on the label.

Fungicides have either systemic or protectant activity. Systemic fungicides are "taken up" by actively growing plants and moved in the plants to a greater or lesser extent depending on the type of fungicide. Therefore, plant parts not directly contacted by systemic fungicide, such as tubers and developing foliage, may become treated. However, because movement is primarily upward in a plant, thorough coverage of foliage is still necessary when applying systemic fungicide. The widespread use of some fungicides in the past has selected insensitive (resistant) fungal isolates. In contrast to system activity, protectant fungicides only coat plant surfaces and reduce new infections by spores. The use of protectant fungicides is less likely to select for insensitive fungal isolates. Label instructions must be carefully followed if fungicide efficacy is to be maintained.

Harvest preparation significantly reduces tuber infection and loss. Complete vine kill prior to harvest is essential since the fungus cannot sporulate on dead tissue. Allow three weeks between the application of vine kill agent and tuber harvest to ensure that vines are dead and good skin set has occurred. When late blight is present, protectant fungicides should be applied to dying vines to minimize spore spread and tuber infection. Preharvest intervals listed on fungicide labels must be followed.

Delay harvest if tuber infection has already occurred. This infection promotes pre-harvest decay. Avoid harvesting infection "hot spots" in a field. If greater than five percent tuber infection exists, it is considered a "do-not-store" guideline. Infected tubers should not be stored, and tubers from infested fields, if storage is necessary, should only be stored for a short time. The application of thiabendazole (TBZ) to tubers for Fusarium control will not control late blight. Because infected tubers have a high decay potential, continuous storage monitoring for hot or wet spots is necessary. High air movement rates to dry tubers will reduce decay. However, the tradeoff between decay loss and the shrinkage that results from increased air movement must be considered. Tuber storage at 38 degrees Fahrenheit will retard decay significantly while storage at 48 degrees Fahrenheit is likely to result in extensive decay.

Recent Developments

Recent developments pertaining to late blight are significantly impacting the North American (United States and Canada) potato industry. Historically, only Mexico had diverse late blight fungal populations consisting of both the A1 and A2 mating types. In contrast to Mexico, North America and Europe had a stable clonal population for many years consisting of only the A1 mating type.

However, populations of the late blight fungus are rapidly changing. After the mid 1980s, both A1 and A2 mating types were found in Europe and, since the early 1990s, were also widely recovered from North American production areas. Both metalaxyl sensitive and insensitive isolates were recovered for both mating types. The new fungal isolates are aggressive pathogens and are quickly displacing the old clonal populations. Rapid spread of the new fungal isolates is occurring throughout North America, primarily due to the movement of infected seed potatoes.

The significance of finding both mating types in North America is not yet known. However, the potential exists for both mating types to simultaneously infect a plant and to produce sexual spores. The population structure of the late blight fungus in British Columbia indicates that sexual reproduction is occurring and will enable greater variability and more rapid adaptation of fungal populations. For example, the fungus could become better adapted to infected varieties grown under local environmental conditions. Also, the production of sexual spores could make it possible for the fungus to overwinter in soil. In the absence of soil-borne inoculum, most overwintering sources of the fungus are currently eliminated by destroying cull piles and volunteer plants and by planting healthy seed. If soil survival via sexual spores occurs, disease management will become more difficult. New strategies and attention must be given to this old disease that once again has become a major threat to the potato industry.

Sources of Information

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