Blackleg and Soft Rot of Potatoes
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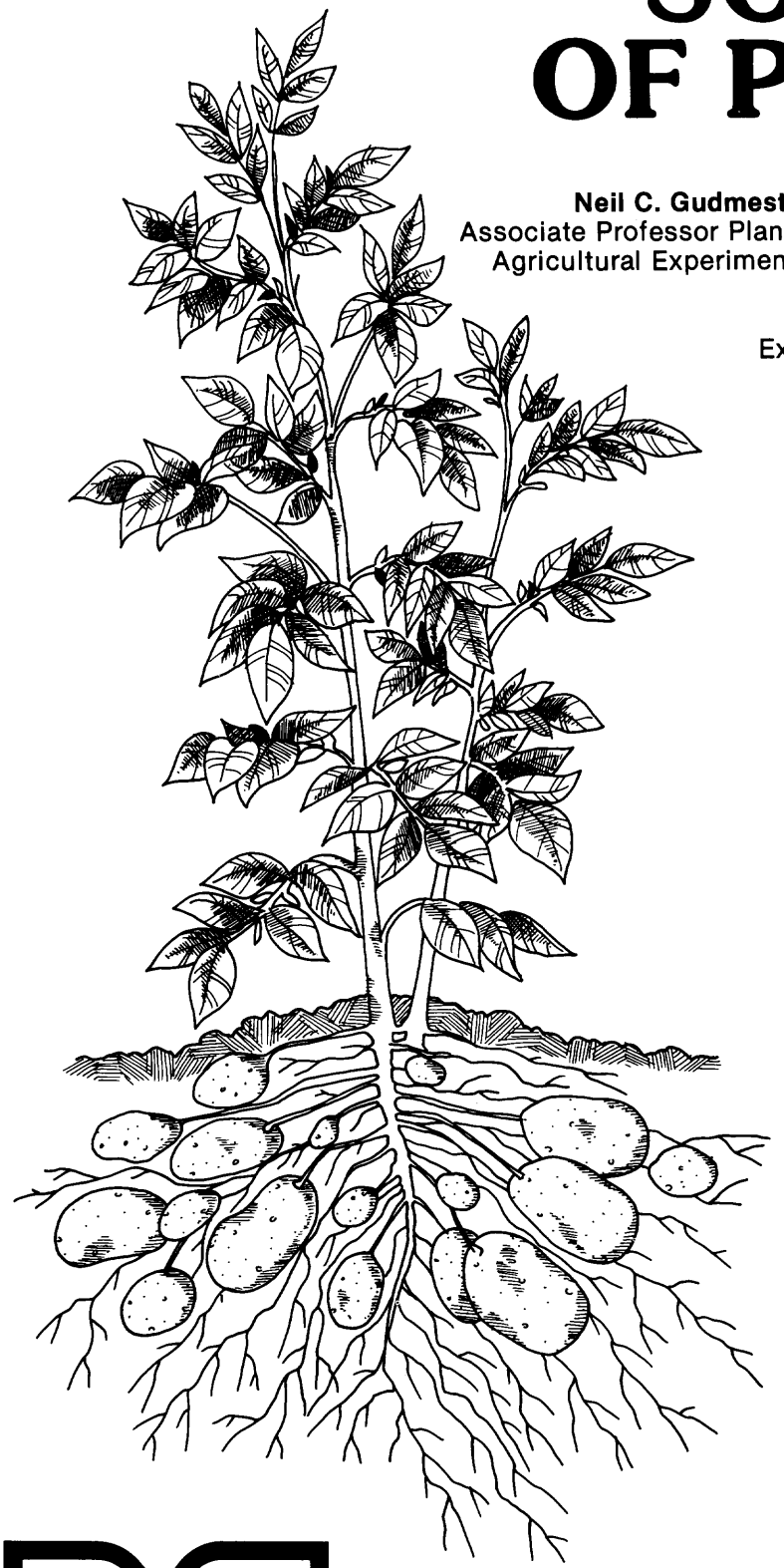
BLACKLEG AND SOFT ROT OF POTATOES



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Blackleg and soft rot are caused by related subspecies of the bacterium *Erwinia carotovora.* These two diseases are found wherever potatoes are grown. The subspecies of *Erwinia carotovora* causing blackleg generally affects only potato but has been reported on sunflower in North Dakota and Mexico. The bacterium that causes soft rot has a much wider host range and will cause the disease on all fleshy vegetables.

Blackleg is generally regarded as a field disease causing decay of potato stems either before or anytime after emergence from the soil. Soft rot affects tubers while in storage or in the soil prior to harvest. In addition, seed tubers or seed pieces may decay after planting due to soft rot.

Each subspecies of *Erwinia carotovora* is capable of causing both diseases and heavy economic losses under the proper environmental conditions. For these reasons, blackleg and soft rot are generally discussed together.

Symptoms

Blackleg. Stems of infected potato plants typically exhibit an

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inky-black decay which begins with a decaying seed piece (Figure 1). The decay may extend for less than one inch or the entire length of the stem. Blackleg symptoms may develop during any stage of plant development. The leaves of infected plants tend to roll upward at the margins and become yellow. Growth of the entire plant becomes stunted. Eventually the plant will wilt and die as the stem becomes girdled. Blackleg may also affect seed piece sprouts and kill them before they emerge. This latter phase of the disease is often termed pre-emergence blackleg or blanking.

Any above-ground portion of a potato plant may become infected through wounds caused by hail, wind or cultivation damage. Infections in this manner may progress rapidly in wet weather, moving both up and down stems or petioles (Figure 2). This type of blackleg is frequently referred to as "aerial" and does not originate from infected seed pieces. The sources of these infections are other blackleg plants in the field or nearby cull piles from which insects may transmit the bacteria at low levels.

Tubers produced from blackleg-infected plants may display symptoms in the stolon or stem end. These symptoms may range from vascular discoloration to a soft rot of the central portions of a potato tuber. In some cases the entire tuber may decay due to soft rot/ blackleg.

Figure 1

Figure 2

Soft rot. Infections of soft rot in storage generally occur through the lenticels (breathing pores) of the tuber. Infections may also occur in wounds and through the stem end of the tuber via an infected mother plant (blackleg). Infections associated with the lenticels appear as tan to dark brown, circular water-soaked spots on the tuber surface. Under moist conditions these spots will rapidly enlarge and the tissue beneath will decompose (Figure 3). Under dry conditions, these lesions may become sunken, dry and hard (Figure 4).

Internal soft rotted tissues are wet and mushy, cream to tan-colored with a black border between the diseased and healthy tissues (Figure 3 and 5). The decayed tissue is very soft with a slightly granular consistency. As the disease progresses, the decay may consume most of the tuber and the skin above the decayed area collapses.

In the early stages of soft rot, the decay is generally odorless. A foul odor and a ropy or tacky consistency will develop as secondary decay organisms invade the infected tissue. Under drying conditions, the mushy, decayed tissue will dry to a chalky-white mass.

Soft rot infection of seed pieces generally progresses as described above. However, infections may develop from either the lenticels or from the cut edge of a tuber seed piece (Figure 5).

Cause

The bacteria that cause blackleg and soft rot are seed-borne primarily in the lenticels of infected potato tubers. These bacteria may also be spread during seed cutting

and planting operations. They do not persist in the soil for long periods of time in the absence of potato debris. However, the bacteria occur widely in surface water in the United States and Europe. They may be present in a latent or symptomless state doing no harm to the tuber until environmental conditions favorable for disease development exist.

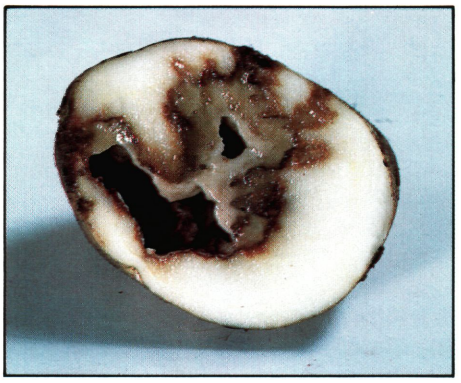

Figure 3

The presence of moisture is the most critical factor in the initiation of blackleg and soft rot. When potato tubers in storage or seed pieces in the soil become covered with a film of water, oxygen depletion occurs in the affected tissues. The lack of oxygen in potato tuber tissues inhibits the natural defense mechanisms while the soft rot and blackleg bacteria are relatively unaffected. Soft rot does not spread from tuber to tuber in storage if they have been well healed after harvest. However, the wet, mushy decay of soft rotted tubers can initiate soft rot in surrounding tubers by inducing conditions of oxygen depletion in those tubers. In the presence of moisture, soft rot and blackleg can develop under a wide range of temperatures.

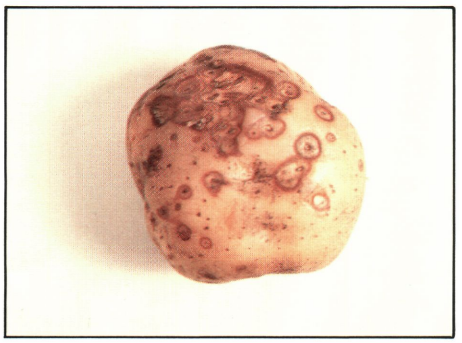

Figure 4

When seed pieces decay in the field due to soft rot or when blackleg develops in a stem, large numbers of these bacteria are liberated into the soil. These bacteria perpetuate themselves by moving short distances in the soil water to contaminate the lenticels of developing tubers of adjacent plants. The contamination of developing tubers varies greatly from season to season depending upon environmental conditions.

Figure 5

The bacteria that cause soft rot seed-piece decay can be spread during the cutting operaton and during planting if picker-type planters are used and in the field by some insects such as corn borer larvae. They can also spread rapidly in the field by rain splash or overhead irrigation.

Disease Management

Blackleg. Because of its seedborne nature, management or control of this disease should be directed toward the use of disease-free, "clean" seed. However, under irrigation, mid to late-season infection may come from other sources of bacteria for which little control exists. Most states with seed potato certification systems have clean seed stock programs and limited generation systems. In these schemes, seed lots of potato varieties are rendered disease-free by either a stem-cutting or meristem tissue culture system. These procedures effectively break the infected seed piece/mother plant connection and thereby produce plantlets that are free of bacteria and other pathogens. Extensive laboratory testing of these seedstocks is performed to ensure freedom from seed-borne disease organisms such as blackleg bacteria. These seedstocks then are grown under a limited generation system that permits seedstocks to be grown and increased as certified seed for only a few years or generations (generally seven to nine). Low generation numbers do not guarantee that the seed lot will have low contamination levels of soft rot/blackleg bacteria. However, seed lots with a low generation number should be utilized by potato growers since exposure to soft rot/blackleg bacteria has been minimized.

Recent research in North Dakota has demonstrated that seed lots of tubers with less than 50 percent of the tubers infected with blackleg bacteria can be grown without appreciable economic losses due to blackleg and related diseases. Seed lots with more than 50 percent of the tubers infected should

be avoided if possible because of the potential for high disease development. However, no guarantee can be given for the amount of blackleg or soft rot that will be expressed based on the degree of infection in the seed lot, because handling practices and environment play a critical role in disease development. Many private agricultural consulting companies offer services to determine the extent of tuber infection by blackleg and soft rot bacteria. This service is also offered by the Plant Health Testing Laboratory at North Dakota State University.

In addition to the use of relatively disease-free seed, there are cultural practices that may be employed by the grower to minimize the development of blackleg in infected seed. Seed tubers should be planted in well-drained soil. Where irrigation is available, excessive irrigation after planting should be avoided to prevent anaerobic conditions in the soil (oxygen depletion).

Soil temperature at the planting depth is also important in minimizing losses caused by soft rot seed-piece decay and early season blackleg. Recent research in North Dakota has demonstrated that soil temperatures at planting of 50 to 56 degrees Fahrenheit are ideal for sprout development and emergence. Temperatures below or above this range tend to favor the bacterium rather than the potato plant, causing a higher potential for disease development.

Research at NDSU has shown that seed pieces should be treated with a recommended fungicide before planting to reduce infection by Fusarium spp. seed-piece decay (dry rot). This disease predisposes the developing potato plant to invasion by the blackleg bacterium, often resulting in increased soft rot seed-piece decay and early season blackleg.

Seed cutting, handling and planting equipment should be thoroughly cleaned between each seed lot to reduce contamination. The removal of infected cull piles and the removal of infected plants from the field will also minimize spread and reduce the development of aerial blackleg. Recommended rates of nitrogen should also be used in fields to be planted to potato since weak plants are more susceptible to blackleg development.

Soft rot. The management of soft rot is similar to that of blackleg. If seed tubers with relatively low infections are planted and grown, the resulting crop will have a lower potential for soft rot in both field and storage.

Potato tubers should be harvested only when they are mature, the skin is properly developed and soil temperatures are lower than 68 degrees. Bruising and other mechanical damage should be minimized during harvesting and handling procedures. These wounds provide infection sites for soft rot bacteria.

Potato tubers placed in storage should be given a minimum of three to five days under optimum conditions of high humidity, high oxygen levels and 55 to 60 degree temperatures to promote the healing and suberization of tuber tissue. Under less than optimum conditions, 14 days should be allowed for the healing process. Tubers should then be cooled to 50 degrees or cooler, depending on the intended use of the potato crop, to reduce and slow soft rot development. It is extremely important during the entire storage period to provide good ventilation. Ventilation will aid uniform cooling of a storage pile, prevent accumulation of carbon dioxide and prevent moisture films from accumulating on the tuber surfaces.

It is important to remember that soft rot develops in potato tubers most frequently under conditions of oxygen depletion in the tuber tissue. These anaerobic conditions are generally induced by carbon dioxide accumulation or by moisture films. Soft rot bacteria that are liberated by a decaying potato tuber have no means with which to enter a nearby tuber in the storage pile except via a wound. Therefore, the wound healing period is very important after harvest. In addition, there is little information that supports the use of commercial bactericides or disinfectants through humidification and ventilation systems to reduce, slow or halt soft rot development. It is the moisture from a decaying potato tuber that induces anaerobic conditions in nearby tubers and initiates soft rot, not the soft rot bacteria in that moisture. Therefore, ventilation is more useful in drying that moisture than is a chemical introduced into the system for the killing of soft rot bacteria.

In table stock operations or wash plants, tubers should be dried as rapidly as possible, and they should be packaged in well-aerated containers. Wounds made by the handling of tubers during the washing procedure are ideal infection sites. Therefore, only clean water should be used to wash potato tubers and wash water can be treated with chlorine to reduce the amount of soft rot bacteria.

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