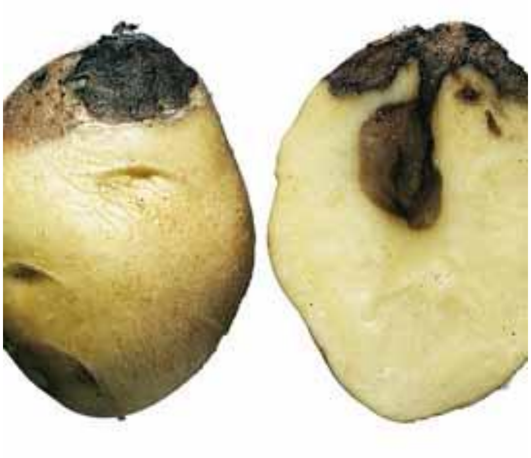
Pectobacterium atrosepticum (potato blackleg disease)

1. Identity:

Preferred Scientific Name:

- *Pectobacterium atrosepticum*.



Preferred Common Name:

- Potato Blackleg Disease

Synonyms:

- *Erwinia carotovora* subsp. *atroseptica*

Taxonomic Position: Class: Gamma proteobacteria **Order:** Enterobacteriales **Family:** Enterobacteriaceae

2. Hosts/species affected

Allium cepa (onion), *Asparagus officinalis* (asparagus), *Brassica oleracea var. botrytis* (cauliflower), *Brassica oleracea var. capitata* (cabbage), *Brassica oleracea var. gemmifera* (Brussels sprouts), *Brassica oleracea var. viridis* (collards), *Brassica rapa subsp. chinensis* (Chinese cabbage),*Brassica rapa subsp. rapa* (turnip), *Brassicaceae* (cruciferous crops), *Carica papaya* (pawpaw), *Coffea* (coffee), *Consolida ambigua* (rocket larkspur), *Cucumis sativus* (cucumber), *Cyphomandra betacea* (tree tomato), *Datura stramonium* (jimsonweed), *Daucus carota* (carrot), *Euphorbia pulcherrima* (poinsettia), *Glycine max* (soyabean),*Helianthus annuus* (sunflower), *Helianthus tuberosus* (Jerusalem artichoke), *Iris* (irises), *Lupinus* (lupins), *Musa* (banana), *Nicandra physalodes* (apple of Peru), *Nicotiana*, *Nicotiana glauca (tree tobacco)*,*Nicotiana rustica* (wild tobacco), *Nicotiana tabacum* (tobacco), *Phaseolus vulgaris* (common bean), *Saccharum officinarum* (sugarcane), *Saintpaulia* (african violet), *Solanaceae, Solanum lycopersicum* (tomato), *Solanum tuberosum* (potato), *Symphytum officinale* (blackwort), *Vicia faba* (faba bean), *Zea mays (*maize) (Plantwise, 2016)

3. Growth stages affected

The disease occurs during the vegetative growing stage and Post-Harvest stage.

4. Biology and Ecology

The causal agent of blackleg is *Pectobacterium atrosepticum (syn.* ***.*** *Erwinia carotovora subsp. Atroseptica*), a gram-negative, rod-shaped bacterium closely related to enteric bacteria of importance as human and animal pathogens. They characteristically produce a variety of cell-wall-degrading enzymes that allow infiltration and maceration of plant tissues on which they feed (Barras *et al.*, 1994). Bacteria in the genus *Erwinia*, however, are not known to be harmful to humans or animals. The pectolytic enzymes are, in fact, an important component of the pathogenicity factors of this and related bacteria. In recognition of the unique pectolytic activity of these bacteria it has been proposed to place them in a separate genus, *Pectobacterium*. Furthermore, it has recently been suggested that on the basis of its genetic composition, the blackleg bacterium be considered a unique species, *Pectobacterium atrosepticum*. A new strain of *E. carotovora* has been described recently which causes a blackleg-like disease of potato in Brazil. Preliminary results suggest that the *atroseptica* subspecies does not occur on potato where the newly-described subspecies, tentatively named *brasiliensis*, occurs.

Figure1: Symptoms of blackleg in a potato plant (Courtesy of Payton Strawser).

Figure 2: Symptoms of blackleg in a potato stem in which a bacteria-laden toothpick was inserted to test for pathogenicity. (Courtesy S.H. De Boer)

Disease Cycle and Epidemiology

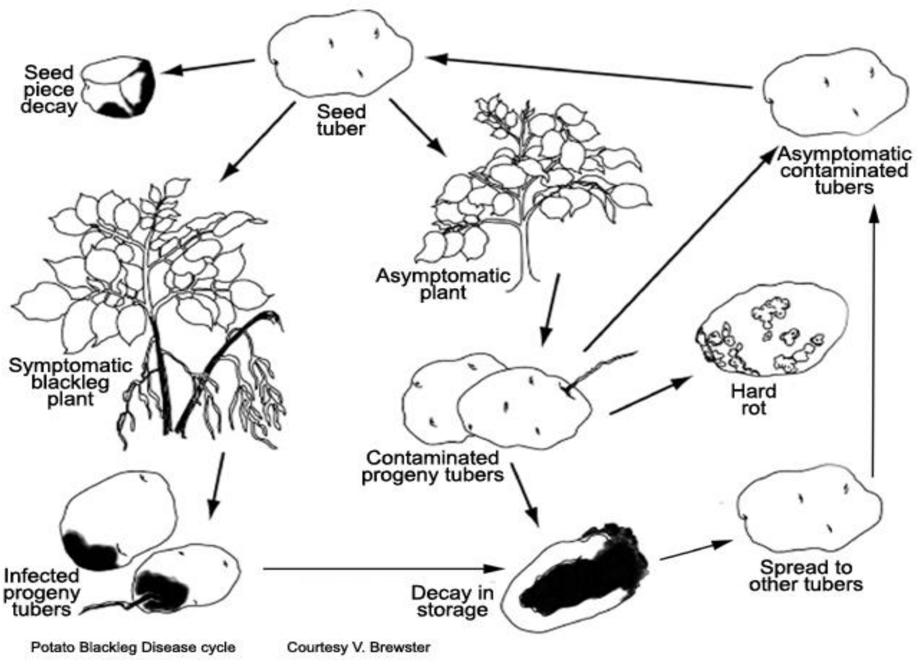


Figure 3. Photo by V.Brewster: Potato Blackleg Disease Cycle

5. Symptoms

Surfaces of the progeny tubers become contaminated with the bacteria surviving particularly well in lenticels. In storage, the contaminated tubers may decay, develop hard rot symptoms, or remain symptomless. When symptomless, but contaminated, tubers are used for planting, which they often are, the cycle is repeated. There are two ways by which the blackleg bacterium may reach the progeny tubers produced on the potato plant. One important route of tuber infection is via the stolon by which the tuber is attached to the plant. Tubers with blackleg disease generally first become decayed at the stolon attachment site where the tuber tissue becomes blackened and soft (Figure 6). As the disease progresses, the entire tuber may decay or the rot may remain partially restricted to the inner perimedullary (or parenchymal) tissue, that is, the tissue inside the vascular ring (Figure 7).

Figure 6: Decay lesions in a potato tuber (Courtesy K. Benlioglu)

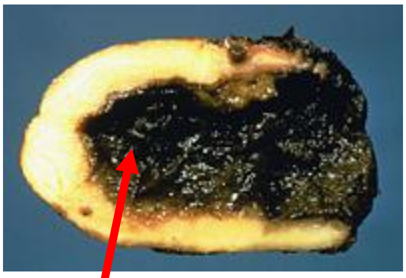


Figure 7: Decay lesions in a potato tuber (Courtesy S. H. De Boer)

In a poorly managed potato storage environment, blackleg bacteria present on the surface of tubers can cause extensive decay (Figure 8). Sometimes when storage conditions are improved, decay lesions around tuber lenticels or mechanically damaged areas become arrested, resulting in a condition known as "hard rot." Hard rot is typified by slightly sunken, brownish-black, dry, necrotic lesions surrounding individual lenticels or damaged areas.

Once decay of potato tubers is incited by the blackleg bacterium, growth of secondary bacteria often contributes to the decay process and certainly modifies symptomatology of the disease. Hence a general bacterial soft rot develops from the initial blackleg infection in tubers. Bacterial soft rot is characterized by total maceration of tuber tissue and seepage of a putrid, dark-colored liquid.

Figure 8. Soft rot lesions in a potato tuber initiated at sites of lenticel infection. (Courtesy S.H. De Boer)

6. Means of movement and dispersal

As the blackleg disease causes the below ground stem and seed tuber to decay, the causal bacterium spreads from infected tissue into soil water and becomes distributed throughout the root zone in which the progeny tubers are growing. Bacterial cells enter lenticels of the progeny tubers and either becomes inactive, or when conditions are favorable, initiate decay.

7. Impact

The economic importance of losses caused by soft rot Erwinias can be great, depending on the value of the crop and severity of the attack. The extent of losses varies among countries and is influenced by climate and conditions of growth and storage. Tuber soft rot also limits potato storage, especially in tropical environments. Under bad handling and storage conditions, and during ocean shipment of ware and seed potatoes, postharvest losses may reach 100% (Plantwise, 2016). The blackleg disease can cause severe economic losses to the potato crop. However, the occurrence of blackleg depends very much on the growing conditions, particularly temperature and rainfall after planting. The different manifestations of potato blackleg as a disease of potato plants, seed piece decay, and storage rot all contribute to economic losses. Although the disease is now considered to be of minor importance in some potato growing regions, it continues to be a major production factor in others. The mean incidence of soft rot ranged from 10 to 100% in 34 potato varieties and selections evaluated for resistance to *E. carotovora* subsp *atropseptica*. The mean reduction of tuber weight ranged from 0.13 to 16.43% and a significant correlation coefficient of soft rot incidence and reduction of tuber weight (%) was obtained (Reeves et al., 1999). Wierzejska-Bujakowska (1994) also recorded yield losses in infected potato cultivars. Averaged over cultivars and years, cutting reduced tuber yield from 35.1 to 33.2 t/ha. The yield decrease caused by cutting was greatest in cultivars susceptible to *E. carotovora* subsp. atroseptica and *Fusarium solani* f.sp. coeruleum. In a field study of 12 cultivars inoculated with E. *carotovora* subsp. atroseptica, a high incidence of blackleg symptoms coincided with extreme yield reductions (72%) in some cultivars (Gans et al., 1984. The effect on yield and development of blackleg symptoms of 15 potato cultivars with *E. carotovora* subsp. atroseptica was investigated by Wastie et al. (1994). *E. carotovora* subsp. atroseptica reduced the mean yield per plant by 8% for whole tubers and by 12% for cut tubers. Yield loss was positively related to the incidence of blackleg late in the season, whereas the relationship between yield loss and the incidence of non-emergence was poor. The threshold number of bacteria necessary for the development of blackleg declined during the season and also varied between cultivars (Plantwise, 2016).

8. Movement in trade

Movement in international trade is mainly on infected potato tubers and infected stems (CABI, 2016).

9. Phytosanitary significance

The pest is a quarantine pest in Kenya.In seed potato production, this disease is next in economic importance to bacterial wilt caused by *Ralstonia solanacearum*, ahead of ring rot and common scab caused by *Clavibacter michiganensis* subsp. *sepedonicus* and *Streptomyces scabies*, respectively (van der Wolf & De Boer, 2007).

10. Management

Several approaches have been studied to control blackleg and tuber soft rot, but the degree of success has been variable. Methods based on avoiding contamination and reliance on seed certification schemes is widely used and have been partially successful. Improved store management can reduce bacterial load on tubers and tuber rotting. Both physical (especially hot water treatment) and chemical methods have been explored, but with limited success. There are currently no chemicals registered for the control of *Pectobacterium atrosepticum* in Kenya. The use of biological control has been and is still being attempted, but it is too soon to say how successful it will be. Finally, breeding for resistance has so far failed, but the use of genetic modification is promising, if politically feasible. Control of the disease relies wholly on crop management practices as there are no chemical control measures (De Boer, S. H. (2004). Control of soft rot and blackleg is difficult because the pathogens are often protected within suberized lenticels and therefore not affected by liquid disinfectant, and the Erwinias are widely spread in the environment.

Pre-planting

- Use of healthy tissue culture plantlets to initiate seed potato stocks has broken the cycle of carrying tuber contamination forward from year to year.

- Limiting the number of field generations to 5 to 7 years for production of individual seed lots after tissue culture, the buildup of tuber contamination is curtailed. (De Boer, S. H. (2004).

At planting

- Planting limited generation seed in well-drained soil after soil temperature has increased above 10°C/50° F is recommended for avoiding the development of blackleg (De Boer, S. H. (2004).

- Use good quality, certified seed tubers. If using your own seed, do not save seed tubers from a disease-affected crop
- Do not plant any seed tubers that are unduly soft or have obvious patches of decay.
- Use of certified seed.

During the growing season

- Roguing out blackleg-diseased plants including belowground portions to reduce the inoculum level in the soil but is only a useful practice if precautionary measures are taken to prevent contact of diseased tissue with other plants in the field (De Boer, S. H. (2004).

At harvest and during storage

- Avoiding injury to potato tubers during harvest is important to minimize decay in storage.
- Removal of decayed potatoes before they spread their contents over grading lines and bin pilers avoids spreading the bacterium to other tubers.
- Wound healing is important in the early phase of potato storage to prevent development and spread of rots.
- During storage, however, the potatoes should be kept at a low temperature with adequate aeration to provide a dry environment and to prevent condensation of moisture on tuber surfaces (De Boer, S. H. (2004).

12. References

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