Bacterial Diseases of Potato.

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Introduction

The soft rot pathogens of potato (*Pectobacterium* spp. and *Dickeya* spp.) are generally thought to be disseminated on seed but may also be soil, mechanically disseminated, and or water borne. *Pectobacterium* spp. (formerly known as *Erwinia* spp.) are important bacterial potato pathogens in Idaho and can be aggressive on tubers and stems causing wilting (blackleg and aerial stem rot) and eventual plant death (Fig. 1). *Dickeya* species (formerly *Pectobacterium chrysanthemi*) have emerged as a new threat to potato production in Europe. *Dickeya* spp. (aka *P. chrysanthemi*) were first reported on potato in the Netherlands in the 1970s. However, since 2004 a new pathogen with the proposed name *Dickeya solani*, has been spreading across Europe on seed tubers. Toth *et al.* (2011) described the symptoms as "indistinguishable from those of the more established blackleg pathogen *Pectobacterium* spp.". However, *Dickeya* spp. are different from *Pectobacterium* spp. epidemiologically in that they can start disease in potatoes from lower inoculum levels, spread more readily through the plant's vascular tissue, are more aggressive, and have higher optimal temperatures for disease development. *Dickeya* spp. also appear to be less able to survive than *Pectobacterium* spp. in soil and other environments. Until recently, reports of *Dickeya* spp. causing disease on potato in the US have been rare. It has previously been reported in Washington state in 2008, but never in Idaho. In 2015 there have been reports of an outbreak of *Dickeya dianthicola* across the country from Maine to Michigan that has been spread via seed potatoes. The pathogen was found in potato fields with poor emergence and a high incidence of blackleg and rotten daughter tubers. In Europe, *D. dianthicola* strains are more variable than the more recently reported *D. solani*. The origin of the US *Dickeya* outbreak and variability among strains is unknown.

The pathogens that cause soft rots of tubers (Fig. 2), wilting, and stem and foliar necrosis may be introduced as secondary infecting pathogens after the plant has been compromised. For example, bacterial soft rots of tubers can be introduced after fungal infection, or through wounds caused by mechanical damage (Fig. 2).

There are two forms of foliar and stem disease caused by the bacterial soft rot pathogens (*Pectobacterium* and *Dickeya*). Blackleg (Fig. 3) is a rot of the lower stem region. Blackleg develops when large numbers of bacteria invade the stem after multiplication in the rotting mother tuber (Fig. 3). The disease doesn't develop in plants grown without a mother tuber, or in plants grown from Pectobacterium-free seed, even in heavily contaminated soil. Factors favoring rotting of mother tubers, such as waterlogged soil will also favor blackleg development. Aerial stem rot (Fig. 4) develops from small bacterial inoculum loads after the potato canopy has developed. It occurs due to wounding to the stem from mechanical damage by insects or other means such as that caused by hail. The bacterial inoculum may be air- or water-borne or bacteria may be latent in stem infections (Fig. 1). Aerial stem rot tends to occur only under wet conditions (frequent irrigation or prolonged rainfall) and or when senescence has set in. As mentioned above it often occurs after violent thunderstorms which produce hail damage to the potato canopy.

Management of bacterial diseases

The management options for control of these two species (*Pectobacterium* and *Dickeya*) are limited, but are the same regardless of the species. Early season management relies on good seed health practices such as planting certified seed and using a good seed treatment to prevent seed piece decay. Research at the UI has shown that copper sprays applied weekly starting at row closure can provide some protection against aerial stem rot in very susceptible potato varieties. Late in the season, practices that reduce exposure to damage during harvest, storage and post-storage are important in the

control of soft rots. These were reviewed by Knowles and Plissey (2007) and included a checklist of pre-harvest factors such as washing digging equipment, timing of crop desiccation (dependent on canopy and tuber maturity), storage preparation including inspection, repair and cleaning of insulation, ducts, fans and humidifiers, doors, sensors and control panels. Modifications to harvest equipment are important factors in managing soft rot bacteria and other pathogens that enter through damaged tuber periderm, such as late blight, pink rot and Pythium. Knowles and Plissey (2007) identified the harvester as being the major source of mechanical damage to tubers and made recommendations that could reduce damage. These included adjustments to the digging blade, reducing drop heights, and use of padding on hard surfaces to decrease bruising. The potential for damage continues from harvest to loading of tubers onto bulk trucks and to the storage-bin piler, and similar recommendations based on the use of improved padding and flow speeds were made. Preferably, crops should be harvested when tuber pulp temperature is in the range 45 - 65°F, to eliminate temperature gradients which can promote the development of condensation that in turn enhance the conditions that are conducive for the development of soft rot. Some other important factors that reduce the risk of soft rot developing during the early storage period include:

- Limiting the pile size to a height of 16 – 18 ft
- Quickly cooling the tubers to the final storage temperature (37, 41, 45 and 50°F for seed, table-stock, French fry and chip processing, respectively
- Fans run to dry the tubers as much as possible
- Do not harvest low spots or other areas that have elevated levels of tuber decay
- Sort out rot during storage filling, aiming to keep infection levels below 3%.
- Pile high risk lots in areas of the storage that can be removed quickly if rot begins to develop
- Daily monitoring for high-risk areas with elevated temperature and/or moisture

Diagnostic testing

Until relatively recently, detection and identification of the soft rot bacteria *Pectobacterium* and *Dickeya* species depended solely on the isolation of viable bacterial cells on semi-selective media followed by serological and biochemical analyses, bioassays and microscopic observations. However, in the past couple of years there has been a big push to develop molecular methods for the detection and discrimination between the different species of *Pectobacterium* and *Dickeya*. There are now multiple PCR-based tests available for the detection and identification of soft rot bacteria down to the species level, but few have been extensively tested and validated in the US. At the University of Idaho we are testing the latest real-time PCR primers to detect and distinguish between *Pectobacterium* and *Dickeya* species and also species specific primers to differentiate between *D. dianthicola* and *D. solani*. As these primers for *Dickeya* were developed in Europe they still need to be validated for use against any *Dickeya* isolates found in Idaho. If you are having a problem with soft rot please send samples to UI Aberdeen, or your nearest UI research center for diagnosis.

Figure 1. The disease cycle of soft rot bacteria.

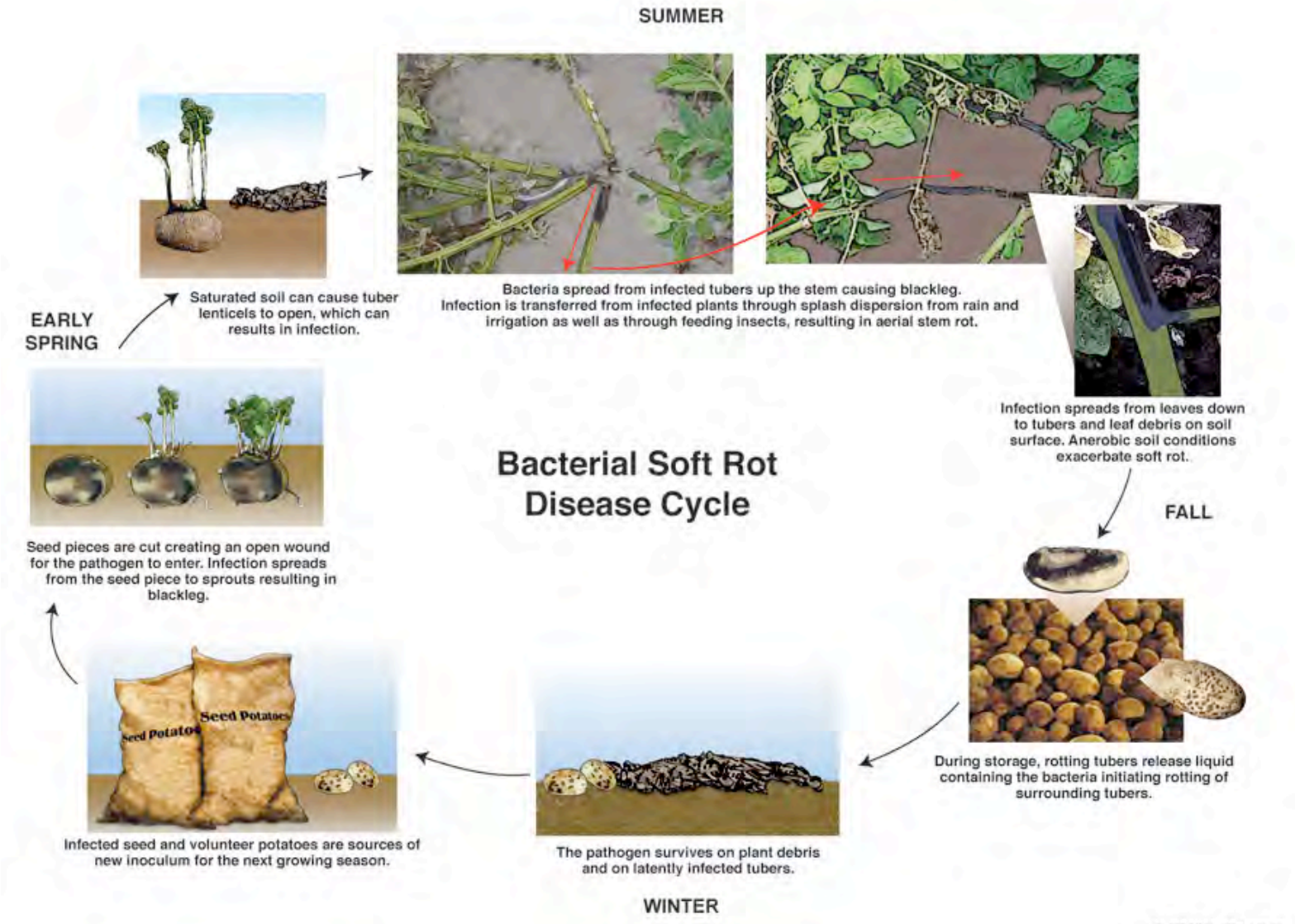

Figure 2. Tuber symptoms caused by bacteria soft rots.

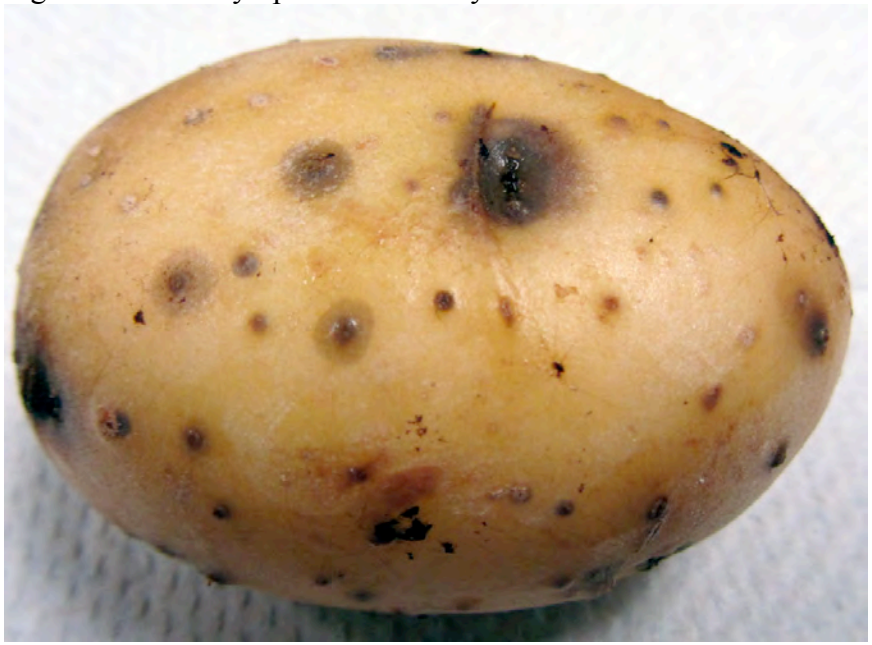

Fig 2a. Pit or lenticel rot caused by *Pectobacterium* spp. usually caused when washed tubers are stored under wet conditions.

Fig 2b. Pure soft rot infection of a tuber.

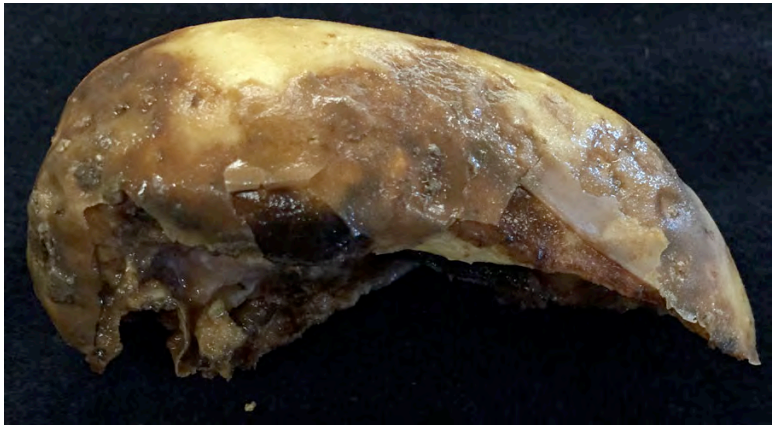

Fig 2c. Soft rot often follows other pathogens such as *Phytophthora infestans* (late blight).

Fig 2d. Soft rot following infection by *Phytophthora erythroseptica* (pink rot).

Figure 3. Blackleg disease symptoms caused by bacterial diseases.

Blackleg symptoms showing wilted foliage and blackened stems. Stems become blackened from the ground up. It is virtually impossible to distinguish blackleg symptoms caused by *Pectobacterium* species and *Dickeya* species. The main differences are that *Dickeya* species are more likely to cause blackleg late in the season while *Pectobacterium* causes blackleg early in the season.

Figure 4. Aerial stem rot symptoms caused by *Pectobacterium* species.

Aerial stem rot symptoms on potato stems. Symptoms can be distinguished from blackleg as infections develop on stems and then spread outwards up and down the stem.

Lesions may be confined to just one side of the stem as opposed to blackleg where the whole stem is killed.