BLACKLEG/RING ROT
A LOOK AT THE CURRENT SITUATION

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These two diseases have many things in common; they are both caused by bacteria, they can be serious and little control exists. Both diseases have also been investigated for many years by many scientists, resulting in a tremendous amount of information about the disease and the organisms that cause the disease.

In the past few years, much new information about these diseases has been realized. The purpose of this presentation is briefly examine some of these new discoveries and research results. The results are from our work in North Dakota and the work of other scientists in the United States, Canada and Europe.

Blackleg. This disease has probably been intimately associated with potatoes forever, but was first described and worked on about 1900. It is caused by Erwinia carotovora, a bacterium with an extremely wide host range. It causes soft rot decay of almost all plant material, especially vegetables. There are two forms of this bacterium infecting potatoes in the U.S.; Erwinia carotovora pathovar atroseptica (Eca) and Erwinia carotovora pathovar Carotovora (Ecc). A third species, Erwinia chrysanthemi infects potatoes in warm climates and Australia. Erwinia causes three diseases - blackleg, stem soft rot and soft rot of tubers. In North Dakota, and other temperate regions where winter occurs, pre- and post-emergence blackleg is caused by Eca and occurs early in the season when temperatures are cool. Stem soft rot is caused by Ecc and occurs in mid-late season when temperatures are warm. Both grow at low temperatures and both cause tuber soft rot in storage.

By following the life cycle of a potato from planting to replanting, there are many areas where research has been conducted on the disease. I will follow this potato-Erwinia cycle to point out new findings which hopefully may lead to what we are after - control.

1. Seed. In ordinary seed, almost every tuber is infested. The Erwinia bacteria reside in lenticels and this can be a source of inoculum. However, disease may not occur; it needs cool, wet weather to cause disease and express it. What if we start with Erwinia free seed? Using meristem/stem cutting we can easily get Erwinia free seed. It will remain clean for 3-4 generations, then will become recontaminated and disease appears. By the time this seed reaches large acreages it is recontaminated. The number of bacteria/lenticel remains the same but the number of infected tubers increases with increasing generation. Initial recontamination is by Ecc, but later switches to Eca. This recontamination pattern is similar in Scotland and other areas of the U.S.

2. Cutting. There has been much talk about using disinfectants during the cutting operation. This is good in theory but impractical for several reasons. The machinery is not designed for this operation. Many disinfectants do not work in heavy organic loads - dirt and potatoes. Water favors and spreads bacteria and makes infestation worse if the disinfectant goes bad.

3. Seed treatment. If you plant cold seed in cold wet ground, you will get blackleg - no seed treatment will prevent this. Many growers use seed treatment of fresh cut seed to

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protect it from decay. These are primarily fungicides, not bactericides, and hence control fungi. We know the presence of other pathogens (Verticillium, Fusarium) results in higher blackleg levels. Therefore, a seed treatment fungicide which reduces these fungi indirectly reduces blackleg. Some seed treatment may be bactericidal - bleach, streptomycin, mercury. When we lost mercury as a seed treatment we lost a good control of Erwinia. Should we work to get this back for basic seed production? We also investigated the influence of wound healing on Erwinia seed decay and the effect of chemical treatment on wound healing. We found the following results. Seed inoculated at cutting and placed in conditions favorable to infection does not heal rapidly enough to prevent infection. Two days of wound healing protect against infection by Erwinia (seven days are needed for Fusarium). Of the seed treatments tested, mancozeb, zineb-streptomycin, zineb-firbark, captan, captan-fir bark and bleach do not interfere with normal wound healing. Mercury, pyrrolidine and streptomycin (100 ppm) do. A standard recommendation is to warm your seed before planting. The reason for this is to lower the reducing sugar (RS) levels. We have found a strong correlation between RS and seed piece decay. The higher the RS the more susceptible to Erwinia infection. When you warm the seed, you use up (lower) the RS and lower seed decay. Beneficial bacteria as seed treatments have been tested. In theory they outcompete and reduce Erwinia populations. They did not work well in early trials but this has potential as a new control.

4. Certification/roguing of blackleg plants. This is done to remove sources of inoculum to prevent further spread of Erwinia. In theory this is good, but in practice does not work because there are too many sources of inoculum (covered later). The presence of a blackleg plant only means that conditions were right for Erwinia to infect and express. Little, if any, correlation exists between percent Erwinia infested seed and amount of blackleg in the field when that seed is planted. Roguing and removal of blackleg infected plants does little to lessen spread. Most states have dropped blackleg from seed certification requirements.

5. Sources of inoculum. I mentioned earlier that stem-cutting and roguing are not effective controls for blackleg because of too many inoculum sources. What are some of these sources?

1) blackleg plants - the bacteria are spread by wind/rain as aerosols, can survive 1-2 days and travel up to 5 miles.
2) soil - bacteria last 1-2 years, longer in debris, survive at 12-24 inch depths.
3) cull piles - Erwinia can be transmitted from these by fruit flies.
4) water - Erwinia easily found in all kinds of water - rivers, lakes, snow, etc.
5) other crops - sunflowers.
6) weeds - very low levels.

Erwinia from these sources either reside on the potato plant without causing disease or cause stem soft rot, especially where injury occurs. Injury can be from hail, broken petiole (walking), center pivots, etc.

6. Bacteria infect new tubers. Bacteria move into the new tubers before harvest. They can already be in the soil from the previous season. They can be washed from blackleg or stem soft rot plants by rain or irrigation water into the soil and swim to new tubers. Erwinia can also move from degenerating seed to the daughter tubers. Erwinia can infest the tubers at harvest as well. Bacterial aerosols are generated when vines are pulverized. The bacteria can enter lenticels or wounds. Two major ports of entry are bruises and frost injury. When tubers go into storage, Erwinia is already in/or the tubers, which completes the cycle.

To summarize:

1) Erwinia can be seedborne.
2) bacteria are transient in the soil.
3) bacteria can be eliminated from seedstocks by stem cutting.

4) bacteria can exist in a latent condition.
5) little correlation exists between amount of Erwinia in seed and amount of blackleg.
6) Erwinia is ubiquitous.
7) no single control measure exists.

Erwinia diseases cannot be controlled by chemicals, cultural practices, resistant varieties or ordinary certification procedures. Control must be by a combination of things - an integrated control. No magic cure exists. There are a number of control measures that will minimize disease losses:

1) avoid wet conditions at planting and storage.
   -Erwinia very susceptible to dry conditions.
   -Erwinia can grow without oxygen.
   - potato tubers lose resistance without oxygen.
   - a film of water blocks oxygen movement.
2) if potatoes are wet in storage, provide vigorous air movement.
3) avoid bruises/entry wounds.
4) allow bruises/wounds to heal in storage.
5) warm seed before planting.
6) soil fumigation.
7) chemicals-using Mertect for dry rot control results in less soft rot as well. Experimental chemicals, such as ClO_2, may have a future.
8) plant in warm soil - 50F.
9) clean seed helps - use faster seed flush programs.
10) crop rotation.

Two more areas of Erwinia research deserve discussion: early dying and compensation. Early dying is a combination of pathogens that cause premature plant death and lower yields - nematodes plus Verticillium, Verticillium plus Erwinia, Erwinia plus Fusarium. This occurs in almost all potato areas and has been the subject of several lawsuits. A cooperative research project investigated the source and identity of the Erwinia causing early dying. Some blackleg was caused by same Erwinia in the seed; other blackleg was caused by Erwinia different than that in the seed.

In fields with blackleg, losses are not as great as it appears because healthy plants can compensate for loss of diseased plants. With blackleg levels of about 5%, yield loss will be about 2.5%. Generally, yield losses are roughly half the percent infected plants.

Bacterial ring rot. The following information summarizes new research findings in the past 3-4 years on this most serious disease. Bacterial ring rot (BRR) is caused by Corynebacterium sepedonicum (CS).

1) BRR bacteria can last as long as two years on burlap, paper, plastic and dried potato stems. They last longest in cool, dry conditions and can survive freezing temperatures.
2) High light levels (long, sunny days) inhibit ring rot symptoms.
3) Small numbers of ring rot bacteria can remain latent (not cause symptoms) for 2-3 generations under certain conditions.
4) A strain of BRR has been found which does not cause foliar or tuber symptoms.
5) New serological tests can be used to diagnose/confirm BRR.
6) Disinfectants must be used properly to work. Of 9 commonly used disinfectants, only one was effective against BRR after 5 min. exposure.
7) Some potato varieties have been shown to be symptomless carrier of BRR. This should be checked in breeding program.