Controlling Bacterial Soft Rot and Blackleg of Potatoes

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Two varieties of the same bacterium have the ability to cause soft rot in potatoes: *Erwinia carotovora* var. *carotovora* and *E. carotovora* var. *atroseptica.* The reason for distinguishing between the two varieties and studying them separately was that the *atroseptica* variety was believed to cause blackleg in potatoes, while the other variety did not. Blackleg in potatoes is a dark, black rotting of the lower stem. Recent work has shown that both varieties of the bacterium can cause blackleg symptoms, and since the two are spread in the same way they are discussed together in this circular.

One of the more important features of potato *Erwinia* bacteria is the ability to function normally with or without the presence of oxygen. When oxygen is present their metabolism utilizes oxygen in the same manner as potatoes or animals. When oxygen is absent, or is in short supply, they use alternate metabolic pathways to supply the energy needed for growth and reproduction. The potato *Erwinia* bacteria can cause severe losses in potatoes when oxygen is present, but in the absence of oxygen the diseases are even more severe. The ability to function without oxygen gives the bacteria an advantage when attacking potatoes under low oxygen levels. Many of the most effective control measures for these diseases are aimed at giving the potatoes adequate oxygen so their natural defenses will keep the bacteria under control.

Source of the bacteria

Research in Europe, the United States, and Canada has shown that these bacteria can be introduced into a crop of potatoes by the seed tubers or from the soil.

Seed transmission of the bacteria is one reason for sudden increases in the potato blackleg symptom. The bacteria can be found in lenticels, eyes, and on the skin of the tubers without causing any disease development if conditions remain favorable for the potatoes. When infected tubers are placed in favorable conditions for the bacteria, disease development occurs rapidly. The movement of infected seed from a cool area of seed production to a warm commercial growing area is a common way to induce such outbreaks of the diseases. Other factors that are known to favor the diseases are mechanical damage to the plants, over irrigation, planting in extremely dry or wet soils, insect injury, and infection of seed pieces by fungi.

The effects of soilborne soft rotting *Erwinias* are not clear. When potatoes follow potatoes or another crop that is susceptible to soft rot, the soft rot bacteria can be found in soil samples as long as refuse from the susceptible crop persists. Soft rotting *Erwinias* were thought to die out when this residue disappeared. However. the use of new techniques has demonstrated that *Erwinia* bacteria can persist in the soil after the disappearance of residue. The role of these soil bacterial populations is unknown. Since some potato lines have been maintained apparently free of blackleg the reinfection rate must be low in some soils. Rapid reinfestations of seed lots free of *Erwinias* have been reported, but the source of this recontamination is unknown.

Symptoms

Two separate sets of disease symptoms exist. The blackleg disease is usually associated with *E. carotovora* var. *atroseptica,* but can be caused by *E. carotovora* var. *carotovora.* The first aboveground symptom of this disease is the yellowing and longitudinal rolling of the leaves. The leaves are wilted during warm portions of the day, and as the disease progresses the wilting becomes permanent. Aerial tubers are frequently formed on infected plants. In the early stages only the seed piece and belowground portion of the plant is rotted. The infected area develops a black lesion that gives the disease its name. As the disease progresses the lesion extends as much as 2 feet above ground. The center of the stem is at first soft and then drys up completely, leaving only the outer tissues of the stem intact. Any part of the stem above or below ground, may develop the black lesions when injured mechanically. The blackleg bacteria causes soft rotting of the tubers after working its way along the stolons. There are varietal differences in susceptibility to this

Control of soft-rotting *Erwinias* in a potato "seed" production

What to do	Why do it?
Purchase seed from a certification scheme that checks for Erwinia. Schemes which have a step involving stem cuttings are a good second choice.	Eliminates or reduces seed borne soft rotting bacteria. Stem cutting usually cleans up stock even without testing.
Use new bags.	Keeps bacteria on last years bags from spreading into new seed.
Plant single drop seed.	Bacteria spread rapidly on cut surfaces.
Wash and disinfect handling equipment.	Prevents bacteria from spreading.
Cutting and planting equipment should be resterilized between seed lots and once or twice a day even when using the same lot.	Prevents spread of the bacteria between seed lots and limits spread within the seed lots.
Avoid the use of a picker planter.	The picks spread the bacteria.
Use fungicides to treat seed pieces.	Fungicides do not kill the bacteria but promote healing which helps prevent infection.
If seed is to be stored prior to planting store at 50-55° F and at high humidity to promote suberization.	Rapid healing helps prevent infection.
Do not plant in cold, wet soil.	Bacteria are favored by lack of oxygen and slow potato growth.
Do not plant in dry soil.	Seed pieces cannot heal, allowing entry of bacteria.
Minimize mechanical damage to plants by using little or no mechanical weed control and solid set irrigation.	Wounds provide entry for the bacteria. Cultivation equipment spreads the bacteria.
If you cultivate, do it when vines are dry.	Wetness is necessary to spread the bacteria.
When rouging, use a sack or other container to remove vines and tubers from the field.	Bacteria are spread when infected vines are dragged through the field touching healthy plants.
Allow sufficient time between vine death and harvest to allow skins to "set."	Thin skinned tubers are easily damaged and bacteria enters through wounds.
Avoid mechanical damage to tubers when harvesting.	Wounds provide entry points for the bacteria.
Control insects, particularly Colorado potato beetle, flea beetle, and wireworms.	Wounds provide entry points for the bacteria.
Control volunteers.	Bacteria live over from year to year in volunteers. Volunteer tubers become mixed with bacteria free seed at harvest and reinfests bacteria free seed stocks.
Rotate for at least 4 years between potato crops.	Eliminates volunteers and allows potato refuse to rot. This reduces the soilborne Erwinias to low levels.
Follow all directions in storage section.	Seed potatoes, like commercial potatoes, must survive storage.

Control of blackleg and soft rot in commercial potatoes

What to do	Why do it?
Buy seed that has been inspected for blackleg—if it has not, buy your seed elsewhere.	Reduce seed borne bacterial infection.
Disinfect cutting, planting, and handling equipment between seed lots and once a day when within a seed lot.	Limits spread of bacteria by equipment.
If you use a commercial cutter—insist he follow disinfection procedures.	The most common way of spreading bacteria in potatoes is with the cutting equipment.
Treat cut seed pieces with a fungicide.	Fungicides do not effect the bacteria directly, but promotes suberization which heals wounds.
Avoid planting in cold, wet soil.	Low oxygen supply and slow plant growth favor the bacteria.
Do not plant in dry soil.	Seed pieces cannot heal, so bacteria attack rapidly.
Cultivate as little as possible.	Cultivation wounds plants and spreads the bacteria.
Make sure vines are dry when you cultivate.	Water is necessary to spread the bacteria.
Control insects, particularly flea beetle, wireworms, and Colorado potato beetle.	Wounds made by insects act as entry points for bacteria.
Rotate between potato crops.	Reduces volunteers and allows refuse to rot—reducing bacterial population in the soil.

Control of bacterial soft rots in potatoes for storage

What to do	Why do it?
Cut down on irrigation during final weeks of plant growth.	Helps "set" skins and reduces water rot. Water rot breaks down in storage and promotes bacterial soft rot.
Allow 2 weeks between death of vines and harvest.	"Sets" skins which prevents bacterial entry through wounds.
Prevent mechanical damage to tubers during harvest.	Wounds provide an entry for bacteria.
Have potatoes as dry as possible when entering storage.	A film of water on the potato causes a lack of oxygen within the tuber favoring the bacteria.
Sort out all potatoes with leak, soft rot or water rot.	These breakdown in storage and cause wet spots where bacterial soft rot can start due to lack of oxygen.
Pick out all rocks, dirt or grass.	These materials prevent air flow causing local oxygen shortages favorable to the bacteria.
Run air without the humidifier until all the potatoes are dry on surface, even those in the center of the pile.	Films of moisture on tubers prevent oxygen from entering. Low oxygen conditions favor the bacteria.
Lower temperature as rapidly as possible. Sufficient time at higher temperatures must be allowed for wound healing.	Oxygen requirements of the tubers are reduced. Bacterial growth is inhibited by the low temperature.
Fans should circulate air within the pile, even when air cannot be brought in from outside due to high air temperature. This is very important when tubers are warm.	Provides an even flow of oxygen to all parts of the pile. Prevents local temperature rise within the pile.
If large wet spots occur in the pile, fans should be run without humidifier to dry up tuber surfaces.	Wet tubers do not get adequate oxygen which favors the bacteria.

Prevention of bacterial soft rot in packing operations

What to do	Why do it?
Allow two weeks between vine death and harvest to "set" skins.	Thin skins are easily broken allowing the bacteria to enter.
Avoid mechanical damage to tubers in harvest operation.	Wounds act as entry points for bacteria.
Remove any rotten tubers before placing tubers in a water bath.	Water will spread the bacteria from rotted tubers to healthy ones.
If possible, do not recirculate water.	Water will spread bacteria.
Last washing treatment should be a *spray* containing 75 ppm available chlorine. Dip treatments are not effective. Tuber must be completely covered by spray.	Spray kills bacteria on tubers.
Tubers must be dried before packing. (See Methods of Drying)	A film of water keeps oxygen out of the tuber favoring the bacteria.
The type of container effects soft rot development in the pack. a. Plastic bags—most soft rot. b. Carton—less soft rot. c. Burlap—least soft rot.	Different trypes of containers vary in the amount of oxygen that can enter.
When baling plastic bags, use netting rather than plastic film.	Plastic film excludes oxygen.
Cool the packaged potatoes as rapidly as possible.	Tubers require less oxygen at lower temperatures. Bacteria are slowed by low temperature.

Methods of drying

Drying method	Why do it?
Sponge rollers.	Wipes off excess water after last spray.
Lengthen belt on line.	Allows more drying time before packing.
Add fans or heaters and fans over belts.	Accelerates drying.

disease. The variety Norgold Russet is highly susceptible while Russet Burbank is fairly resistant. No known potato variety is immune.

The tuber soft rot induced by these *Erwinias* is normally associated with *E. carotovora* var. *carotovora,* but can be caused by *E. carotovora* var. *atroseptica.* The first symptom is the development of a water-soaked area on the tuber around a lenticel or the eye. If you cut through one of these lesions you'll find the tissue is extremely soft. The lesions rapidly expand and grow together and the tuber is destroyed. Frequently, all that remains of diseased tubers is the skin. These symptoms are found most frequently in packaged potatoes or in storage, but soft rot can occur in the field before harvest.

Decontamination of equipment

Decontaminate all equipment that comes in contact with the tubers or vines each year. Decontaminate planting and cutting equipment daily and between seed lots.

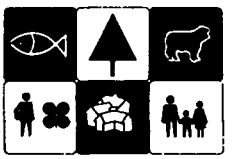
The best procedure is to wash the equipment with soap and water or a steam cleaner. Then spray with a decontamination solution containing hypochlorite (common household bleach), formaldhyde, Lysol, or a quaternary ammonia compound at the rates found on the label for bacterial disinfection. Allow the solution to stand on the equipment for at least 15 minutes and then wash off with water. Decontaminating solutions usually are corrosive to metal, so rinse equipment thoroughly. Completely saturate any sponge rollers or seed cutters with the solution, or remove and soak in the decontaminating solution. If possible, replace sponge rollers with nonabsorbent rollers.

Control

Specific steps to control *Erwinia*-caused diseases in different types of potato operations follow. At first glance these may seem complex, but really represent four control measures.

1. Keep potatoes, bacteria free.
2. Limit the spread of bacteria that are present.
3. Control conditions so the potatoes are favored over the bacteria.
4. Kill the bacteria by chemical means.

No single control will solve the problem but management as suggested here will sharply limit loss from these diseases.



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