UNIVERSITY OF ILLINOIS EXTENSION
College of Agricultural, Consumer and Environmental Sciences

report on
PLANT
DISEASE

RPD No. 937
June 1990

DEPARTMENT OF CROP SCIENCES
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

BACTERIAL RING ROT OF POTATO

Ring rot, caused by the bacterium *Clavibacter (Corynebacterium) michiganense* pv. *sepedonicum*, is a continuing threat to the potato industry. This highly infectious disease spread rapidly in the United States and Canada during the 1930's through widespread dissemination of infected seed tubers. Losses were heavy, approaching 100 percent in many fields and storages. Rigid enforcement of potato certification standards, as well as the widespread adoption of stringent sanitary precautions, has reduced losses to a low level in recent years. In seed-producing states, a **single** infected plant or tuber in a field disqualifies the entire field from certification. The disease develops rapidly during hot dry weather and more slowly under continuously cool conditions.

Figure 1. Leaf symptoms that normally appear only in dry, hot weather.

SYMPTOMS

Vines. Ring rot does not usually appear on plants until after midseason. Infected plants may not show symptoms. Development of ring rot is most rapid at temperatures of 64° to 72°F (18° to 22°C). During years with cool springs and warm summers, interveinal areas in the lower leaves of infected stems usually turn pale yellow, then pale green, become mottled and yellow with the leaf margins rolling slightly upward and becoming scorched (Figure 1). Frequently only one or two stems in a hill may appear stunted and wilt during the day and recover at night.

Eventually infected plants may turn yellow and die. Wilting and yellowing of the vines usually progresses upward from the lower leaves. When an infected stem of a plant showing advanced stages of the disease is cut across at the base, the vascular tissue appears brown. A milky white to creamy bacterial exudate can be squeezed from the vascular area.

Ring rot is extremely difficult to diagnose in the field or storage when other disorders such as early blight (see Report on Plant Diseases No. 935), late blight (Report on Plant Diseases No. 936), blackleg, brown rot, freezing injury, and water damage are present.

Tubers. At harvest or early in the storage period, infected tubers may break down rapidly with a slimy, foul-smelling, bacterial soft rot, making it difficult to find typical ring-rot-infected tubers.

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The causal organism may remain for two or three months in stored tubers without producing internal or external symptoms. An infected tuber may even carry the ring rot organism internally and produce symptomless plants and tubers, although both plants and tubers are infected.

Figure 2. Typical bacterial ring rot after a period in storage (courtesy Dr. A.O. Paulus).

Diseased tubers may have reddish areas near the eyes or the skin may be cracked and swollen. When an infected tuber is cut across at the stem end, a creamy yellow to light brown rot is evident in the vascular ring, the area about one-fourth inch below the skin. This area has a crumbly to "cheesy" consistency and a straw to yellowish cream color that turns light brown to reddish brown with age (Figure 2). When the tuber is squeezed, a creamy bacterial exudate oozes from the vascular area. Later, the tissue in the vascular ring disintegrates and an enlarging brown cavity forms. The affected areas may then become crumbly and powdery or, if invaded by soft-rot bacteria, mushy and foul-smelling (Figure 3). In advanced stages the rot involves much of the pith or center of the potato, leaving a hollow but rather firm shell of tissue (Figure 4). When tubers are severely infected, the skin may crack anywhere, often in the region of the eyes. Secondary, soft-rotting bacteria become established in these wounds.

Figure 3. Advanced stage of ring rot showing mushy, foul-smelling rot and enlarged cavities.

The characteristic morphology of the Clavibacter cells, a Gram-positive reaction (bacterial cells stained blue), taken together with the host and the symptoms described above, are the primary diagnostic tests for this disease. Further laboratory and greenhouse confirmatory tests may involve serology and inoculation of tomato and eggplant followed by isolation. Under experimental conditions, the bacterium can infect 29 plants in the potato-tomato family (Solanaceae).

DISEASE CYCLE

In nature the ring rot organism infects only the potato and lives from season to season in potato vines and tubers. Volunteer plants, growing from infected tubers left from the previous crop, reestablishes the disease in a new potato crop. The organism survives 10 to 24 months in dried bacterial slime from infected tubers and stems on sacks, crates, baskets, storage bins, and warehouses as well as on the surface of harvesting, grading, planting, and cultivating equipment. Cool dry conditions are most favorable for survival.

The bacterium is spread primarily while cutting seed potatoes, planting with a picker-type planter, and during digging and harvesting. It spreads from plant to plant in the field by cultivation and other operations in which machinery injures plants and provides entry sites. Dirty trucks can be a major source of contamination. When infected tubers are planted, ring rot bacteria move slowly through the vascular tissue, reaching all lower portions of the growing plant. Late in the season, bacteria migrate from the stem through the stolons, infecting the new tubers, which can be a source of inoculum the following year.

CONTROL

Figure 4. Final effect of ring rot and soft rot. Only the tuber shell remains.

1. Carefully remove all infected potato stocks from the farm and storage areas.

2. Maintaining strict sanitation in storage areas and with all potato digging, grading, planting, and cultivating equipment is extremely important. This two-step process requires thorough cleaning followed by thorough disinfecting. Remove all dirt, trash, debris, and potato refuse from warehouse floors, bin walls, pallet boxes, truck boxes, conveyers, and other potato equipment and machinery that contacts potato tubers and vines. Discard and burn all dirty bags or those suspected of having contained ring-rot-infected tubers. Thoroughly disinfect equipment and storage areas before disease-free seed is delivered. Remove caked mud and debris with steam or soap and water before applying a disinfectant chemical because most disinfectants are inactivated by soil and organic matter. The disinfectant (Table 1) must contact the bacterium to be effective. The longer a disinfectant is in contact with a surface the more effective it will be in killing bacteria on that surface. For most disinfectants, a minimum treatment exposure period of 10 minutes is suggested. After treatment with a disinfectant, storage areas and equipment must be rinsed with tap or other drinkable water before coming in contact with potatoes intended for human consumption; check the label on the disinfectant container for details.

3. Plant **only** certified, blue tag, healthy seed tubers. Certified seed has a zero tolerance for ring rot. New seed potato stocks should never be placed in storage until all cleanup and disinfection procedures outlined above have been completed! Store seed tubers in new bags or cleaned and disinfected containers.

   Clean and disinfect truck boxes before loading seed stocks for transport. In Europe, small uncut tubers, free of cuts and bruises, are used as seed. This is the most feasible way for home gardeners to control ring rot.

4. Use assist- or cup-feed planters rather than picker-type planters.

5. Control insects, especially Colorado potato beetles, plant bugs, aphids, and leafhoppers, that may transmit the bacteria. Follow current recommendations of Illinois Extension Entomologists and your nearest Extension adviser as given in Illinois Agricultural Pest Management Handbook, available at an Extension office or University of Illinois, ITCS P345, 1917 S. Wright St., Champaign, IL 61820.

Table 1. Chemicals that can be used to disinfect potato equipment and storage areas.

Chemical	Concentration	Comments
Quaternary ammonium compounds (e.g., Hyamine 2389, Roccal)	Follow container directions	Odorless and non-corrosive after diluted for use. Mop or spray. Do not rinse. Do not use on bags.
Chlorine-calcium or sodium hypochlorite (e.g., Hilex, Clorox, Purex)	Prepare 1,000-2,000 ppm chlorine solution (e.g., 1 gallon of 5.25% calcium or sodium hypochlorite in 10 gallons of water)	Treat equipment or storage areas. Chemical inactivated rapidly in the presence of foreign matter.
Lysol, 50% solution	1 gallon of solution in 10 gallons of water	
Formaldehyde, 37 to 40% solution	4 cups in 10 gallons of water	Has fumigation action; tightly seal heated storages. Spray and then cover treated equipment with plastic or canvas for 24 hours, then open and air until odor is gone. Caution: corrosive and caustic.
Copper sulfate-soluble	Dissolve 2 pounds in 10 gallons of water	Efficacy is low. Do **not** use on metal because it is corrosive.
Phonol compounds (available under several names)	Dilute to 1 to 3% solution or as directed on the container label	Slight odor, but a very effective disinfectant.
Iodine (available under several names)	Follow container directions	Use only iodine solutions formulated for use as disinfectants.