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report on
PLANT
DISEASE

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COMMON SCAB OF POTATO

Common scab of potatoes is caused by *Streptomyces scabies*, a very prevalent, soil-inhabiting bacterium. This serious disease can be found in all potato-growing areas throughout the world. The scab organism sometimes occurs in soils where potatoes have **never** been grown. In most potato soils, however, scab was probably introduced with infected seed tubers.

The major loss from common scab is lower market quality because tubers are unsightly or disfigured and have poor customer appeal. Where scab is severe, yields also may be reduced. The disease causes an annual loss of several million dollars in the United States.

Figure 1. Sunken scab lesions (courtesy R. Loria)

SYMPTOMS

The first symptom of common scab is the appearance of small, brownish specks or spots (lesions) on the young tubers. These spots (usually circular) soon enlarge, darken, and become corky. Certain lesions may merge to form large, irregular scabby areas. Some may be raised slightly above the surface of the tuber; others may be somewhat sunken. The lesions may be so numerous as to give a russeted appearance to the entire tuber. Under certain conditions the scab lesions become quite deep, pitted, and dark brown to almost black (Figure 1). Deep cracking and pitting of the potato surface is often aggravated by attacks of millipedes or the larvae of the potato flea beetle and garden symphylans, which apparently break down the cork (periderm) layers. This allows the pathogen to invade the tuber to a depth of about 1/4 inch. The causal bacterium also produces rather inconspicuous, tan to brown lesions on potato roots, underground stems, and stolons. If scabbed potatoes are stored, they tend to shrink and are often invaded by secondary, soft-rotting organisms.

DISEASE CYCLE

The scab bacterium is disseminated in infected tubers and fleshy roots or in soil. The bacterium overwinters on living roots of weeds and crop residue left in the field or garden. Wind, splashing rain, surface-drainage water, farm machinery, and tools all move soil from one location to another and thus spread the pathogen. The bacterium even survives passage through the digestive tract of animals and is distributed with manure. Once the soil becomes infested, it generally remains so indefinitely.

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Scab is most damaging in slightly acid to alkaline soils of pH 5.5 to 7.5. Comparatively little damage occurs in more acid soils (pH of 4.8 to 5.2) or in alkaline soils with a pH above 8.0.

Scab can attack potato tubers grown in soil within a wide temperature range of about 50° to 88°F (10° to 31°C) with an optimum of 68° to 72° (20° to 22°C). The organism can grow, however, at temperatures as low as 41°F (5°C) and as high as 106°F (40.5°C) with an optimum of 77° to 87°F (25° to 30°C). Generally scab is more severe in dry soils, especially those deficient in organic matter, and becomes less severe in moist soils, although researchers have pointed out some exceptions. The fact that the *Streptomyces* bacterium is extremely variable may partly account for the difference in effectiveness of control measures at various locations and in different soil types.

Figure 2. Scab on radish roots.

Certain strains or races of the bacterium cause scab on fleshy roots or tubers and damping-off or seedling blight of many kinds of plants. The list includes beets (garden and sugar), carrot, dahlia, eggplant, mangel, onion, parsnip, radish (Figure 2), rape, rutabaga, salsify, spinach, Swiss chard, turnip, and several species of weeds. A closely related species of *Streptomyces* causes soil rot or pox of sweet potato.

The *Streptomyces* bacterium is a saprophyte that can survive indefinitely either in its vegetative myceloid form or as minute spores (Figure 3, above) in most soils, except very acidic ones. The vegetative form consists of slender, branched mycelium with few or no cross walls. The spores are cylindrical or ellipsoid and are produced on specialized spiral hyphae that develop cross walls from the tip toward their base. As the cross walls constrict, spores are pinched off at the tip and eventually break away from the hypha. The spores germinate by means of one or two germ tubes, which develop into the vegetative myceloid form.

Young, rapidly growing potato tubers are most susceptible. The pathogen can penetrate through natural openings (lenticels, stomata), mechanical or insect wounds, or usually occur under conditions when tubers are enlarging most rapidly. Following penetration the pathogen grows between or through a few layers of cells. The cells then die and the bacterium feeds on them as a saprophyte. The organism also secretes a substance that stimulates the living cells surrounding the lesion to divide rapidly and to produce several layers of cork cells (periderm) that isolate the bacterium and surrounding tuber cells (Figure 3, below). As the tuber cells–which are cut off by the cork layer–die, the pathogen subsists on them. The cork cell layers are pushed outward and sloughed off and the pathogen grows and multiplies in the additional dead cells which results in the development of large scab lesions.

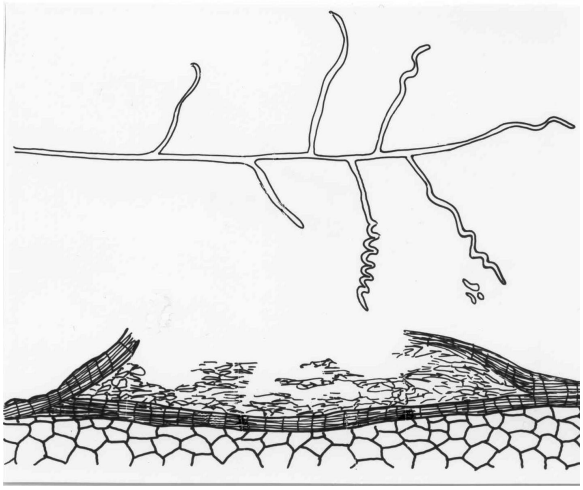

Figure 3. Streptomyces scabies, the common scab of potato bacterium, as it would be seen under a laboratory microscope. (Above) Slender, branching myceloid form and three minute spores; (Below) section of an old scab lesion showing a layer of periderm (cork) cells (drawing by L. Gray).

Resistance is apparently associated with the effectiveness of the periderm, which underlies the scab lesions and walls them off from the tuber. In susceptible potato cultivars with deep scab lesions, successive layers of periderm form as penetration progresses. In resistant cultivars the lesions are shallow and a single periderm layer seems to prevent further infection. Different types of lesions may develop on the same tuber, which may reflect differences in pathogenicity between strains of the organism or in the maturity of the tuber surface at the time of infection.

CONTROL

All of the following measures have been effective in some cases. Usually a combination of control methods should be adapted to the cultural practices used in your area.

1. The best control is to plant certified, disease-free seed potatoes of scab-tolerant varieties. Inspect seed tubers carefully before cutting and planting. Discard all plant materials showing symptoms of scab. Russet types are generally much less susceptible than are smooth-skinned varieties. Tolerant varieties may develop significant amounts of scab when grown in slightly acid to alkaline soils with a history of common scab. Therefore, the importance of soil pH and past cropping history to scab development cannot be overemphasized.

2. Do not apply barnyard manure, wood ashes, other organic matter, lime, coarsely ground limestone, nitrate of soda, or other alkaline materials to fields or gardens just before potatoes are planted. Where you need to lime potato land for growing legumes or other crops, apply the lime after harvesting the potato crop.

3. Adding sulfur (300 to 3,000 pounds per acre) or an acid-forming nitrogen fertilizer, such as ammonium sulfate or diammonium phosphate, to bring the soil down to a pH of 4.8 to 5.2 will generally not be commercially worthwhile unless acid-tolerant crops can be grown in rotation with potatoes. Even then, control is often not satisfactory. The pH level at which potatoes grow satisfactorily, and at which scab can be reduced appreciably, depends to the great extent on the soil type and the strains(s) of the scab bacterium that are present. It is better to reduce soil alkalinity gradually than to try to make the entire change in one year. Annual soil tests should be made to prevent the soil from becoming too acid.

4. Rotation with small grains, grasses, corn, sorghum, soybeans, or alfalfa may be helpful if a period of 4 or 5 years or more is allowed between crops of potatoes. Avoid susceptible crops listed previously in the rotation.

5. Turning under a green manure crop just before planting potatoes has proved beneficial, especially when coupled with liberal amounts of a high-analysis fertilizer applied at a rate based on a soil test.

6. Eradicate weeds, especially fleshy-rooted types, such as pigweed.

7. Where possible, irrigate heavily when the tubers are forming (small swellings on the ends of the stolons). The soil must be kept moist for 4 to 6 weeks. This may involve irrigating every 4 or 5 days in hot, dry weather. Avoid over-watering since it may cause rotting of the tubers and poor vine growth.

8. Good control of scab in **mineral** soils has been obtained by thoroughly incorporating pentachloronitrobenzene (Terraclor, PCNB) into the top 4 to 6 inches of soil at or just before planting. Apply the chemical as a band in the furrow and then disk in. Since PCNB is available in a number of formulations (dusts, granules, wettable powders, emulsions), follow the manufacturer's directions carefully as printed on the container label. PCNB does not control scab in peat (muck) soils. Besides controlling scab, PCNB also reduces infections by *Rhizoctonia*.