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Figure 1.—Silver scurf infection originating from the field.

Figure 2.—Silver scurf on Ida potatoes.

Figure 3.—Silver scurf on Russet Burbank following secondary spread in storage.

Silver Scurf Management in Potatoes

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Silver scurf is caused by a fungus, *Helminthosporium solani*, a relatively new problem related to potato production in North America. It wasn't until the early 1990s that this fungus was identified as being a serious problem in the Pacific Northwest.

This fungus produces a surface blemish on tubers, causing them to look dirty. Although some tubers initially become infected in the field, the greatest damage occurs in storage, particularly with increasing time in storage. Economic losses also occur due to increased requirements for inspection and sorting in lots with damage.

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The fungus likely attacks all potato cultivars, but it causes the most economic damage on those that are fresh marketed. Smooth-skin types are more susceptible than russet types, and the scurf is especially visible on their tubers.

Symptoms and damage

Damage often does not appear until tubers have been stored for a month or more. Symptoms consist of tan to silvery gray, circular or irregular lesions on the tuber periderm. Lesions generally have a definite margin and vary from pinhead in size to patches that cover most of the tuber. As the disease progresses, individual lesions coalesce. The silvery appearance of older lesions is most evident when the tuber is wet.

Lesions caused by infection in the field generally are irregular in shape and associated with the stolon end (Figure 1). Lesion appearance is somewhat different on smooth-skin cultivars compared to russet types (Figure 2). Lesions caused by infection in storage are circular and produce a "measles" appearance over the surface of the potato (Figure 3).

Similar surface blemishes are produced by *Colletotrichum coccodes*, the cause of black dot. However, black dot lesions frequently are darker than those of silver scurf. Unlike silver scurf lesions, black dot lesions generally have a poorly defined margin. They also contain microsclerotia—small, round, black structures embedded in the tuber surface (Figure 4). The silver scurf pathogen does not produce microsclerotia.

Identification of these two diseases requires examination with a hand lens or microscope to distinguish between the characteristic black sclerotia of black dot and the conidia and conidiophores of silver scurf. Both fungi can infect the same tuber (Figure 5).

Figure 4.—Closeup view of black dot on tuber. There are no conidiophores (contrast with Figure 6).

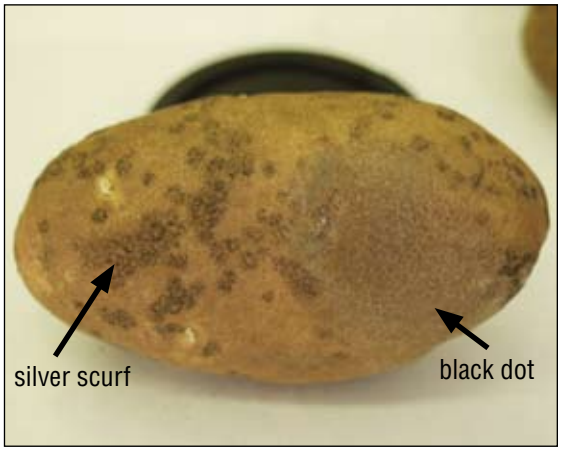

Figure 5.—Silver scurf and black dot infection on the same tuber.

Silver scurf lesions usually remain superficial, causing no damage to underlying tissues, but in some cases tissue immediately beneath the lesion becomes slightly discolored. After some time in storage, the infected epidermis cracks, and tubers may become shriveled and wrinkled due to excessive moisture loss from the infected areas. Moisture loss can be substantial during long-term storage.

After tubers have been stored at high humidity, margins of young lesions may have a sooty appearance due to the presence of fungal spores. Close evaluation with a hand lens or microscope may reveal structures with a Christmas tree shape, which are spore-producing conidiophores (Figure 6). The "branches" are spores. If the spores have dislodged, the conidiophores look like short, black strings.

Figure 6.—Closeup view of silver scurf on tuber. Note the production of conidiophores with conidia (spores).

Source of inoculum and disease cycle

Seed lots can be highly infected, and the older the seed generation, the higher the incidence of silver scurf. In addition, recent studies have shown that infected seed tubers are the main source of inoculum, particularly in fields where the rotation practice consists of 3 or 4 years between potato crops. Planting highly infected seed pieces can result in high infection rates of daughter tubers. Figure 7 shows the life cycle of this pathogen.

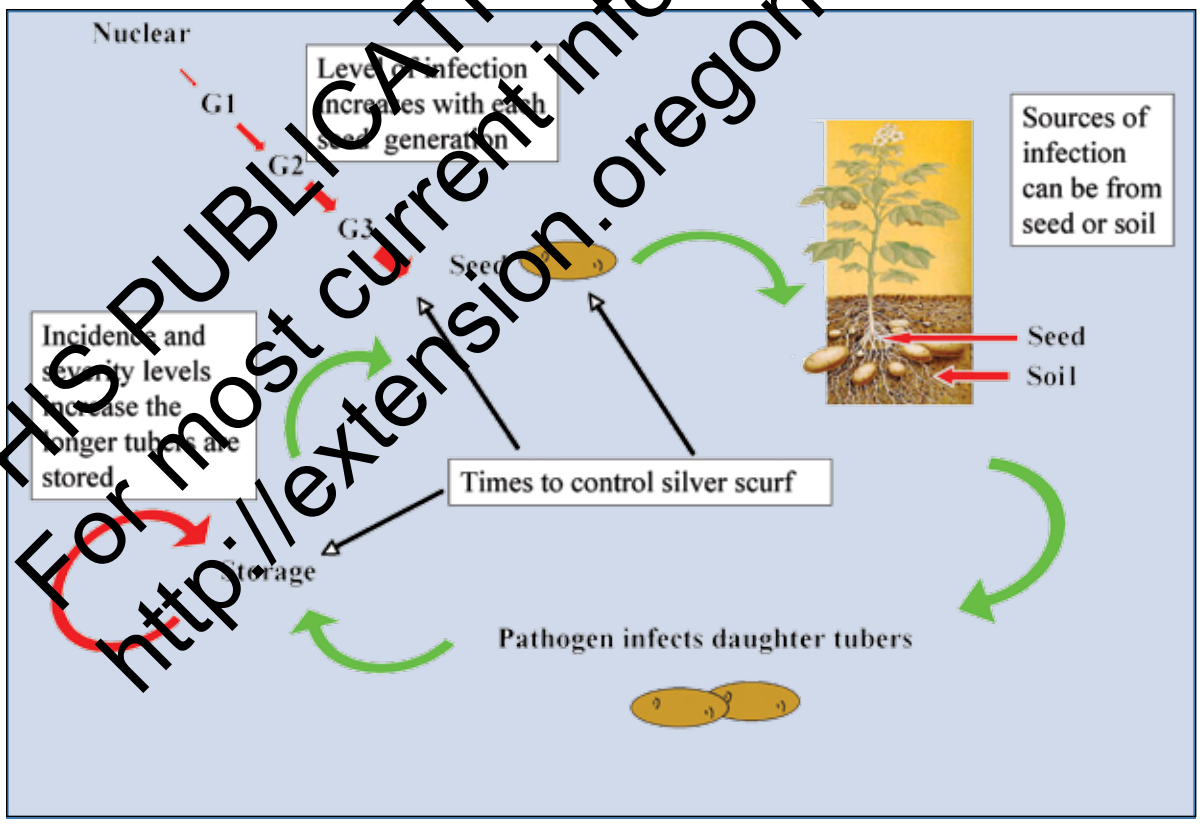

Figure 7.—Silver scurf disease cycle (modified from Brad Geary, Brigham Young University).

The fungus forms spores on the surface of diseased seed pieces in the soil. If these spores are not washed off by rain or irrigation, they can grow down the roots or stolons and infect developing tubers. The pathogen gains entry into developing tubers through lenticels or directly through the periderm.

Soil is occasionally, but not often, a source of daughter tuber infection. Spores of the silver scurf fungus typically do not survive in the soil more than 2 years. Therefore, if 3 or more years separate potato crops, it is unlikely that soil-borne spores will infect daughter tubers.

Disease severity and damage increase the longer tubers are left in the ground after vine death and skin set. Tubers are most susceptible after the periderm has begun to mature. Although the greatest problems occur in storage, a significant amount of infection and damage can already be present on smooth-skin cultivars at harvest. Time in the field after skin set and time in storage are cumulative for disease development.

In storage, spores arise primarily from infected tubers but also can originate from contaminated soil brought into storage. Contaminated wood, concrete, and organic materials can also be a source of spores.

Spores of *H. solani* form on the surface of diseased tubers at relative humidity above 90 percent (especially above 95 percent) and temperatures above 38°F. Spores are easily dislodged from the conidiophore and they move through the storage unit's air system to infect additional tubers.

When free moisture is present on tuber surfaces, a result of fluctuating temperatures and high relative humidity in storage, the spores germinate and tuber infection occurs. Given adequate humidity and time, a large proportion of tubers in storage can become infected. Generally, secondary lesions (infections occurring in storage) first become apparent in russet cultivars after 3 to 4 months of storage.

Management

Management of silver scurf requires an integrated approach from each generation of seed-tuber production through production and storage of fresh-market or processing potatoes. All of the following management tactics must be used to provide the best control of silver scurf.

Seed

Silver scurf problems start with infected seed. Use seed that is free or relatively free of silver scurf.

There seems to be no relationship between infected seed and regional origin of the seed. All seed-producing states and Canadian provinces may produce some seed lots with silver scurf infection. A recent study showed that, in some seed lots, all of the seed tubers were infected over most or all of the surface area; other lots were free or nearly free of infection. Perhaps the most important consideration in silver scurf management is how effectively the seed grower managed the disease.

Before purchasing seed to be grown for the fresh market, test for silver scurf infection. Place a representative sample of washed tubers (25 to 50 tubers/sample) in a plastic bag containing moist paper towels. Seal the bag, punch a few holes (about 1/16 inch in diameter) in the bag, and store the bag in the dark at 60 to 75°F for 2 to 3 weeks. Do not allow the tubers to dry out. The pathogen can be detected with a hand lens. The fruiting structures and spores are dark brown to black and look like tiny Christmas trees (Figure 6, page 3). Some laboratories do this test for a nominal fee.

Seed growers can manage silver scurf. Research has shown that silver scurf may increase with each seed generation. The fungus can infect tubers of an early generation seed lot when the early generation seed is stored in the same facility as an infected lot. In other words, placing a generation 2 seed lot containing even a low incidence of silver scurf in the same storage as a clean nuclear lot allows spores to move from the infected lot to the clean lot. Equipment and storages contaminated with *H. solani* spores from a previously infected crop may also contribute to infection of an early seed generation.

In addition to separating seed generations, seed growers should keep seed lots separate in storage because different lots may have different levels of silver scurf infection. This practice requires smaller, more specialized, and compartmented storage space, but isolating clean lots is the only way to ensure that an infected lot does not contaminate a clean lot.

Crop rotation

Research has shown that *H. solani* does not survive long periods of time in soil. Practicing crop rotation—with at least 2 years between potato crops—greatly reduces the chance of infection from fungal spores surviving in the soil.

Seed treatments

Seed treatments can reduce silver scurf infections in most cases. The following products have provided good control:

- Thiophanate-methyl plus mancozeb (Tops MZ)—8 oz/cwt
- Fludioxonil (Maxim)—8 oz/cwt or 0.04 fl oz/cwt
- Fludioxonil plus mancozeb (Maxim MZ)—8 oz/cwt

The combinations of mancozeb with fludioxonil (Maxim MZ) and thiophanate-methyl (Tops MZ) are recommended as a way to control spread of late blight on seed tubers/pieces and to reduce the likelihood of the development of fungicide resistance in silver scurf. Research continues on other seed treatments that may provide better control. Contact your local Extension potato specialist for updated information.

The use of seed treatments does not permit growers to plant highly infected seed. While these seed treatments are effective at reducing silver scurf, they will not prevent all infection of daughter tubers, particularly if the seed is highly infected.

Manage early dying

Tubers under vines that die early are more likely to become infected than tubers under green plants; as the periderm matures after vine death, tubers become more susceptible to infection. Use cultural and chemical practices to keep vines healthy until frost or vine kill.

Sanitation

When increasing seed tuber generations, clean and disinfect seed cutting and handling equipment between lots. Clean storage facilities well before storing the crop. Remove plant material, debris, straw (a favorite substrate for the silver scurf fungus), and soil. Thoroughly clean the entire facility with a detergent and steam wash in order to disinfect all surfaces. After the storage facility is cleaned, avoid bringing in field soil on equipment.

Harvest

Harvest potatoes as soon as skins are adequately set. Leaving fields unharvested beyond skin set will encourage higher levels of infection. Reduce the amount of soil going into storage with tubers. Soil can be a source of inoculum, and can also restrict air movement around tubers, possibly increasing humidity at the tuber surface.

Storage

Considerable silver scurf infection can occur in storage, sometimes infecting all tubers in a storage unit. How much disease develops depends on the amount of infection on tubers when placed into storage, environmental conditions in storage, and how long tubers are stored.

The three basic tools of storage management are temperature, relative humidity, and air flow. As a general rule, cooler temperatures, lower humidity, and adequate ventilation help reduce development of silver scurf in storage.

The wound healing or curing period is important for rapid suberization (the production of suberin to seal the wound and reduce water loss) after tubers are placed into storage. To ensure optimal healing, maintain high humidity (95 percent), optimum temperature (50 to 55°F), and good ventilation (up to 25 cfm per ton of potatoes) to avoid condensation. Temperature and humidity should be reduced immediately once adequate healing has occurred.

During storage, keep temperatures at the lower range of the optimum conditions for the type of potato being stored (about 38°F for seed, 42°F for table stock, 45°F for french fry processing, and 50°F for potato chip processing).

Modifying the storage environment does not eliminate silver scurf development, so the principal management tactic is to know how much infection is in the potato crop and to adapt storage placement and length of storage accordingly.

Test representative tubers going into storage, particularly those likely to be stored for 4 or more months. This procedure is best performed by digging some

tubers from each lot of potatoes just before vine kill and assaying for silver scurf. It is important to take a representative sample from each lot because levels of infection may vary among lots.

When placing potatoes in storage, separate lots with high levels of infection from those with little or no infection. (Lots can be assayed following harvest, but then it is too late to make decisions about storage placement.)

Knowing the amount of infection of all lots also can help you decide how long tubers might be storable without large-scale secondary infection. Research has shown that secondary infection does not appear on Russet Norkotah tubers until the end of January, given a normal storage environment. It apparently takes this long for infected areas on tubers infected in the field to produce spores in storage and for these spores to move via the air system and infect new potatoes. Therefore, even heavily infected Russet Norkotah lots likely can be stored until late January. Low-risk lots (those with little or no infection at the beginning of the storage season) can likely be stored until May or later, given a proper storage environment, but periodic assaying for silver scurf is important. Smooth-skin cultivars seem to be more susceptible, so they may not be successfully stored for the same duration.

If long-term storage is planned, do not open the storage facility to pack and ship some tubers and then reclose the facility. Major losses have occurred in these situations, apparently due to the dislodging of spores by vibrations that occur from equipment; the air system then serves to spread the pathogen throughout the pile.

Thiabendazole (Mertect 340-F) can be used for silver scurf suppression in storage. Due to disease resistance, however, the postharvest application is no longer recommended. Research has shown limited or no efficacy for the following labeled products:

- General biocides such as ozone, hydrogen peroxide/peroxyacetic acid mixtures, and chlorine dioxide
- Biological products such as *Bacillus subtilis* and *Pseudomonas syringae*
- Clove oil

Use pesticides safely!

- Wear protective clothing and safety devices as recommended on the label. Bathe or shower after each use.
- Read the pesticide label—even if you've used the pesticide before. Follow closely the instructions on the label (and any other directions you have).
- Be cautious when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

Management practices

- Practice crop rotation with at least 2 years between potato crops.
- Use seed that is free or relatively free of silver scurf. Before purchasing seed, test for silver scurf.
- Seed growers should prevent the mixing of air between different seed lots and should not store different generations in the same facility.
- Use registered products to treat seed tubers.
- Keep vines healthy until frost or vine kill.
- Harvest potatoes as soon as skins are adequately set.
- Thoroughly clean and disinfect storage facilities before storing tubers. Remove plant material, debris, and straw.
- Cure tubers under conditions of high humidity (95 percent), optimum temperature (50 to 59F), and good ventilation (up to 25 cfm per ton of potatoes) and then reduce temperature immediately to the normal storage temperature.
- During storage, keep temperatures at the lower range of optimum for the type of potato.
- Test tubers for silver scurf infection before storage and adjust storage times accordingly.
- Separate lots with high levels of infection from those with little or no infection.
- If long-term storage is planned, do not open the storage facility to pack and ship some tubers and then reclose the facility.

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