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Powdery Scab of Potato

Mitchell J. Bauske
University of Idaho (UI), Parma Research and Extension Center

Christian J. Cumagun
UI Parma Research and Extension Center

Mackade Murdock
UI Parma Research and Extension Center

Jeff Miller
Miller Research, Rupert, ID

Jonathan L. Whitworth
United States Department of Agriculture–Agricultural Research Service, Aberdeen, ID

Kasia M. Duellman
UI Idaho Falls Research and Extension Center

James W. Woodhall
UI Parma Research and Extension Center

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University of Idaho Extension

Introduction

Spongospora subterranea f. sp. *subterranea* (commonly referred to as *S. subterranea*) is a soil- and tuber-borne pathogen that causes powdery scab of potatoes. The fungus-like protozoan pathogen can be found in nearly every major potato production area across the United States and the rest of the world. The disease causes gall formation on roots as well as lesions on potato tubers. Root gall formation may inhibit plant growth and yield, while powdery scab tuber lesions reduce the quality of potato tubers intended for the fresh, processing, and seed markets.

Field-to-field spread of *S. subterranea* occurs through planting infected seed tubers, movement of infested soil and seed tubers, or machinery with adhered infested soil. The pathogen also has been detected in wind-blown soil, suggesting another possible method of moving infested soil to adjacent fields. Once the pathogen has become established within a field, it can remain infectious for over ten years, even in the absence of a potato crop. Due to the formation of resting spores, arranged in aggregates

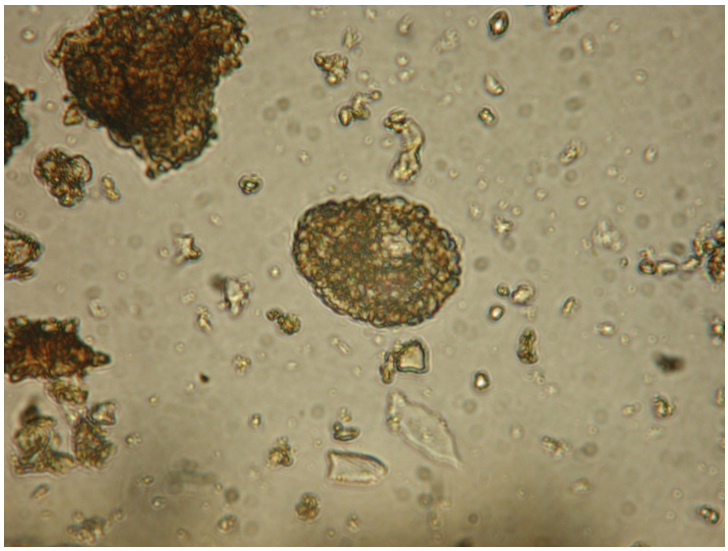

Figure 1. An aggregate of resting spores called a sporeball (cystosorus) of *Spongospora subterranea*. *S. subterranea* is the fungus-like pathogen that causes powdery scab. Photo by Jeff Miller.

referred to as sporeballs or cystosori (Figure 1), the pathogen can withstand a wide range of environmental conditions. Powdery scab flourishes in cool, wet, and heavy soils, but the disease still occurs in production areas with arid climates due to irrigation practices that provide favorable conditions for the pathogen.

Currently, there are very few effective strategies available for powdery scab management. No commonly grown potato cultivars are immune to the disease. The increase in powdery scab outbreaks in recent years has been attributed to the use of popular but susceptible cultivars, increased use of irrigation, and a seed-tuber inspection scheme that does not prioritize detecting and limiting the pathogen. In addition to being the causal agent of powdery scab and root gall formation, *S. subterranea* can carry and infect potatoes with *Potato mop-top virus* (PMTV), an increasingly important, emerging virus. PMTV causes a separate disease of potato that further reduces marketability by causing discolored rings or arcs in the tuber flesh.

Figure 2. Gall formation on the roots of a potato plant caused by *S. subterranea*. Root galls caused by the pathogen are creamy white in color initially but may turn dark brown in color as they mature. Photo by Jeff Miller.

Symptoms

Powdery scab symptoms are confined to belowground plant organs. On root and stolon tissue, *S. subterranea* induces the plant to form more cells (hyperplasia) that are larger than normal (hypertrophy), leading to visible, warty galls containing a mixture of plant tissue and pathogen growth (plasmodia) inside the enlarged plant cells. Root galls caused by *S. subterranea* are creamy white in color initially (Figure 2) and may turn dark brown in color when they mature. Root galls vary in size, 1/16 to 7/16 inch in diameter, and may appear as early as five weeks after planting.

On tubers, powdery scab symptoms appear as small blister-like lesions on the skin (Figure 3). Powdery scab lesions are generally smaller and circular in shape. Initial symptoms on tubers may appear as purplish-brown lesions, which later develop into a blister appearance approximately six weeks after planting. Individual lesions also may grow together, increasing the area of the tuber with blistering symptoms (Figure 4). Lesions often appear as small, dark, and slightly raised on the tuber skin (Figure 5). Under the right conditions, powdery scab lesions will rupture the tuber skin over the infection site, resulting in an open lesion (Figure 6), slightly raised around the edges, brownish in color, and filled with a brown, powdery mass of pathogen sporeballs.

Infected roots and tubers may not always show visual symptoms, but these latent *S. subterranea* infections are capable of transmitting *Potato mop-top virus* if the virus is present. Initial *S. subterranea* inoculum in the soil does not always correlate well to visual symptom development or disease severity, possibly due to the rapid production of secondary zoospores that cause new infections.

Disease Cycle

The pathogen goes through two major phases during its lifecycle: one made up of highly mobile zoospores that can swim in water and another in which resting spores are produced.

The infection process begins as the resting spores germinate in either *S. subterranea*–infested soils or on infected seed pieces. These thick-walled resting spores overwinter in aggregate, or grouped together, and this grouping is referred to as a sporeball or cystosorus. A single sporeball may contain more than 500 resting spores. The germinating resting spores release zoospores, which use two unequal-length whip-like flagella as propulsion to swim. These zoospores can swim in moist soil for about two hours in search of a host, using plant cues such as root exudates to try and find suitable plant tissue.

Figure 3. Dark and raised powdery scab lesions on potato tubers caused by *S. subterranea*. Photo by Jeff Miller.

Once a suitable host is found, these primary zoospores pierce cell walls of stolons, root hairs, or young tubers and form a mass (also known as a plasmodium) within the plant cells. These masses lead to the galls and lesions visible on infected tissue. Once in the host tissue, the pathogen undergoes several inoculum-producing cycles, thereby releasing new generations of mobile zoospores which cause secondary infection of other nearby host tissue. This polycyclic nature, where multiple cycles of infection occur in a growing season, is rare among soil-borne pathogens and results in the rapid increase of inoculum and the spread of infection. Later in the season, the pathogen begins to form resting spores, which group together as sporeballs that allow long-term survival of the pathogen in the soil. The disease cycle begins anew when clean potato seed is planted into *S. subterranea*–infested soil, when infected seed potatoes carrying *S. subterranea* inoculum are planted, or when infested soil is moved from field to field.

Infection of potato tubers is favored by cooler soil temperatures, around 53°F–55°F, while root gall formation is favored by temperatures around 63°F.

Figure 4. Powdery scab symptoms on potato tubers often start as small blisters and may turn into open lesions as they mature. Photo by Mitchell J. Bauske.

Figure 5. Close-up image of powdery scab lesions on a potato tuber. Lesions develop into small blisters occurring around five weeks after planting. Smaller lesions may initially appear purplish brown in color. Photo by Mitchell J. Bauske.

Figure 6. Mature powdery scab lesions on tubers are often round, slightly raised, and shallow. These circular lesions may burst open, rupturing the skin over the infection site. Photo by Christian J. Cumagun.

Since the swimming zoospores of *S. subterranea* require free water, wet soil conditions are conductive for disease development, especially if soil moisture is between 15% water content to soil saturation during tuber initiation.

Management

Most powdery scab management strategies are aimed at minimizing the risk of pathogen dissemination or spread and reducing disease severity within infested fields. Unfortunately, no single management tactic can completely control the powdery scab pathogen in a meaningful time frame or economically feasible manner once it has become established in the field.

Recommended management strategies for powdery scab disease management:

- Plant certified, powdery scab-free seed potatoes.*
- Avoid planting seed potatoes into *S. subterranea*–infested soils.*
- Plant in well-drained soils.
- Do not use noncomposted manure from animals that have fed on powdery scab-infected tubers.
- Avoid excessive nitrogen fertilization since higher nitrogen rates increase powdery scab severity on harvested tubers.
- Sanitize all equipment and implements after use in *S. subterranea*–infested soils.
- Plant potato cultivars that are resistant or less susceptible.

Chemical options. No consistently effective chemical is available for powdery scab management. When *S. subterranea* inoculum is already present in the soil of a field, soil fumigation with metam sodium may reduce the severity of powdery scab symptoms to some degree. In the United States, fluazinam (Omega) is registered for the management of disease in roots and on tubers and may result in 20%–40% disease suppression when applied in-furrow at planting. However, the powdery scab suppression offered by fluazinam has been shown to be inconsistent from year to year. Soil fumigation with chloropicrin has been shown to reduce *S. subterranea* inoculum in the soil but may result in increased root gall formation and powdery scab symptoms on tubers of susceptible cultivars.

Cultivar resistance. Russet-skinned potato cultivars are generally more resistant to powdery scab on tubers compared to red- and white-skinned potato cultivars. However, the susceptibility to root gall formation in certain cultivars may not be related to powdery scab severity on tubers. That is, root galls

* University of Idaho Plant Diagnostic Services can determine the presence of both *S. subterranea* and *Potato mop-top virus* from the same 300 g soil sample, as well as in tubers.

may be present in cultivars that are resistant to powdery scab on tubers. Development of resistant cultivars has been hindered by a lack of potato germplasm that is resistant to both powdery scab on tubers and root gall formation, as well as a limited understanding of the population biology and genetics of the pathogen. The relative susceptibility of several cultivars to powdery scab and root gall formation are detailed below (Table 1).

Table 1. Powdery scab and root gall formation susceptibility rankings of several potato cultivars commonly planted in Idaho.

		Root Gall Formation		
		Resistant	**Intermediate**	**Susceptible**
Powdery Scab on Tubers	Resistant	Alturas		
		Bannock Russet		
		Clearwater Russet	Alpine Russet	
		Dakota Russet	Canela Russet	
		Dakota Trailblazer	Russet Burbank	Snowden
		Dark Red Norland	Umatilla Russet	
		Desiree		
		Ranger Russet		
		Russet Norkotah		
	Intermediate		Purple Majesty	
	Susceptible			Bintje
				Kennebec
			Mountain Rose	Satina
				Shepody
				Superior

References

Bittara, F. G., A. L. Thompson, N. C. Gudmestad, and G. A. Secor. 2016. Field evaluation of potato genotypes for resistance to powdery scab on tubers and root gall formation caused by *Spongospora subterranea*. *American Journal of Potato Research* 93: 497–508.

Bittara, F. G., G. A. Secor, and N. C. Gudmestad. 2017. Chloropicrin soil fumigation reduces *Spongospora subterranea* soil inoculum levels but does not control powdery scab disease on roots and tubers of potato. *American Journal of Potato Research* 94: 129–47.

Houser, A. J., and R. D. Davidson. 2010. Development of a greenhouse assay to evaluate potato germplasm for susceptibility to powdery scab. *American Journal of Potato Research* 87: 285–98.

Merz, U., and R. E. Falloon. 2009. Review: powdery scab of potato—increased knowledge of pathogen biology and disease epidemiology for effective disease management. *Potato Research* 52: 17–37.

van de Graaf, P., A. K. Lees, S. J. Wale, and J. M. Duncan. 2005. Effect of soil inoculum level and environmental factors on potato powdery scab caused by *Spongospora subterranea*. *Plant Pathology* 54: 22–28.

van de Graaf, P., S. J. Wale, and A. K. Lees. 2007. Factors affecting the incidence and severity of *Spongospora subterranea* infection and galling in potato roots. *Plant Pathology* 56: 1005–13.

Zeng, Y., A. C. Fulladolsa, A. M. Cordova, P. O'Neill, S. M. Gray, and A. O. Charkowski. 2020. Evaluation of effects of chemical soil treatments and potato cultivars on *Spongospora subterranea* soil inoculum and incidence of powdery scab and potato mop-top virus in potato. *Plant Disease* 104: 2807–16.

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