An introduction to an important potato disease

Powdery Scab

By Nadav Nitzan, Dennis Johnson, Dallas Batchelor and Chuck Brown

Introduction

Powdery scab of potato is caused by *Spongospora subterranea.* Potato cultivars that are susceptible to the disease present sponge-like galls on the roots and stolons (Fig.1), and scabby lesions on the tubers (Fig.2). Potato plants that are infected with the pathogen develop necrotic and deformed roots, which may affect plant vigor. The reduction of plant vigor can potentially influence the development of large tubers (10 oz. and above) that are needed for processing. The development of scab on the tubers reduces the quality of tubers for both the fresh and the processing markets. As a result, the disease may reduce the useable potato yield.

Pathogen characteristics

The powdery scab pathogen is biologically classified as a *Plasmodiophorid* and is also known as an intracellular parasitic slime mold. Its characteristics include:

- obligate parasitism, which means that it can develop only on a living tissue – i.e., a functioning potato root, or developing tuber;
- the formation of intracellular plasmodium inside the roots and the tubers – a sack-like structure with multiple nuclei (Fig.3);
- zoospores (flagellated spores) that can swim in water, indicating the need for free water and high soil moisture for infection of the host (Fig.4);
- cool temperature ranging from 50 - 68°F for infection and development; and e) the formation of resting spores, commonly referred to as "sporeballs" and also known as cystosori or sporosori (Fig.5). The aggregating sporeballs can be found in the root galls, and the tuber lesions as a powder (Fig.6), hence the disease name "powdery scab". The sporeballs are quite durable and may survive in the field for many years.

Life cycle

The life cycle of *S. subterranea* initiates with the sporeballs that may be tuber or soil-borne and are the primary source of inoculum in the field. In the presence of a potato plant, and favorable conditions, primary zoospores (Fig.4) are produced in the sporeballs. They are then released from the sporeballs and infect the roots and developing tubers. Following infection, a plasmodium develops within the root or the tubers (Fig.3). The plasmodium may either cleave into multiple zoosporangia (Fig.7) that release secondary zoospores that would continue to infect roots, or become a root gall or tuber lesion in which new sporeballs develop. Both options occur at the same time during the life cycle of the pathogen. As powdery scab is a polycyclic disease with multiple infection cycles per season, zoospores would go on infecting roots, and new sporeballs would develop on roots and tubers until the environmental conditions are no longer favorable for the development of the pathogen, or the potato completes its life cycle.

Figure 1. Powdery scab galls on potato roots.

Figure 2. Powdery scab lesions on tuber (ctv. Ivory Crisp).

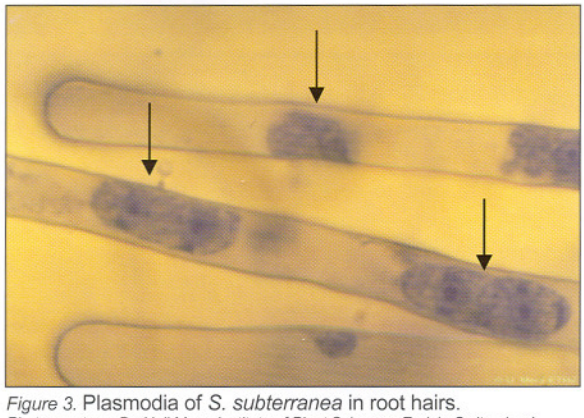

Figure 3. Plasmodia of *S. subterranea* in root hairs.
Photo courtesy: Dr. Ueli Merz, Institute of Plant Sciences, Zurich, Switzarlend.

One may divide the life cycle of *S. subterranea* into a complete life cycle and a partial life cycle. In the complete life cycle primary zoospores emerge from the sporeballs, intracellular structures are formed, secondary zoospores are formed and infect the roots, while at the same time new sporeballs develop. The partial life cycle is the same as the complete one in all but one aspect, new sporeballs are not formed. The complete life cycle is almost uniquely restricted to potatoes, but may occur in yellow mustard, oat, and tomato. The partial life cycle may occur on buckwheat, rye and rapeseed, and in eastern black nightshades, jimsonweed and pigweed.

Disease management

The lack of an effective chemical control for powdery scab poses a challenge in managing this disease, suggesting limited remaining options — crop rotations and resistant potato cultivars. In the case of crop rotations, three to four years is not sufficient to reduce the soil-borne inoculum as the sporeballs may survive for many years in the field and stay viable. In this case the integration of plant species that support the partial life cycle of the pathogen may promote germination of zoospores from sporeballs without the formation of new sporeballs.

Consequently, the amount of sporeballs in the soil may be reduced. This approach was adopted for *Plasmodiophora brassica*, the causal agent of club root of crucifers, and reduced the soil-borne inoculum by 71 percent.

The second management approach is the use of resistant and tolerant potato cultivars, which may be the most reliable and sustainable approach. Potato plants vary in susceptibility to powdery scab, and may react differently on roots and tubers. On the roots, most if not all industrial cultivars demonstrate root galling of different levels. On tubers however, russet skin cultivars usually do not develop noticeable tuber lesions while white and red skin potatoes do. This variation presents a potential for a resistance breeding program, as powdery scab affects both root development and tuber quality. In our next installment we will discuss what is known about resistance.

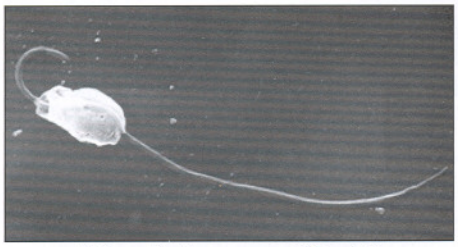

Figure 4. Biflagelated zoospore of *S. subterranea*. Photo courtesy: Dr. Ueli Merz, Institute of Plant Sciences, Zurich, Switzerland.

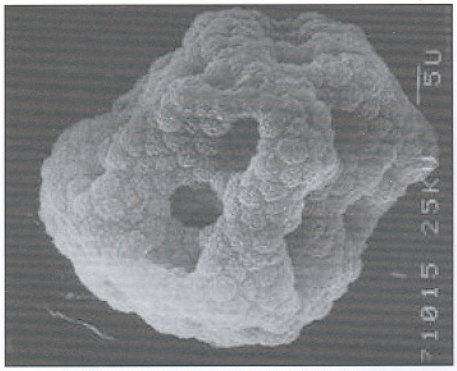

Figure 5. Sporeball of *S. subterranea*. Photo courtesy: Dr. Ueli Merz, Institute of Plant Sciences, Zurich, Switzerland.

Figure 6. A root gall with a mass of sporeballs. *Photo courtesy: Dr. Ueli Merz, Institute of Plant Sciences, Zurich, Switzerland.*

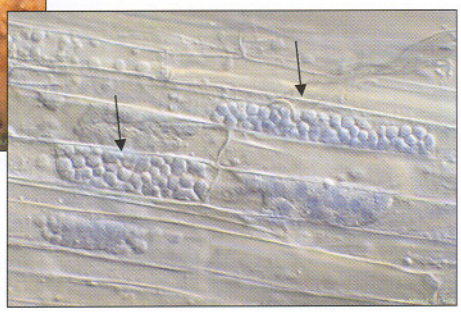

Figure 7. Zoosporangia of *S. subterranea* in roots. *Photo courtesy: Dr. Ueli Merz, Institute of Plant Sciences, Zurich, Switzerland.*

Literature cited

1. Harrison, J.G., Searle, R.J., and Williams, N.A. 1997. Powdery scab of potato – a review. Plant Pathology 46:1-25.
2. Murakami, H., Tsushima, S., Akimoto, T., Murakami, K., Goto, I., and Shishido, Y. 2000. Effects of growing leafy daikon (Raphanus sativus) on populations of *Plasmodiophora brassica* (club root). Plant Pathology 49:584-589
3. Qu, X., and Christ, B.J. 2006. The host range of *Spongospora subterranea f.sp. subterranea* in the United States. American Journal of Potato Research 83:343-347.

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