



Managing the risk of powdery scab





Powdery scab affects both seed and ware crops in Great Britain and has been present in British potatoes since records began. In wet years estimated annual losses in Great Britain can be £7-9 million.

The disease is caused by *Spongospora subterranea* which is also the main vector of Potato mop top virus (PMTV), one of the causes of spraing.

Powdery scab is both seed and soil borne and can have an impact in all sectors. Incidence and severity of powdery scab symptoms can vary widely depending on a range of factors, including inoculum level and climatic conditions. Sporadic occurrences can have a big effect on crop value. It can result in total rejection of fresh crop if severe for example, and can have big consequences for peeling before processing.

The current rise in significance of powdery scab can be traced back to the rise in popularity of Pentland Crown in the 1970s. This variety rose in popularity due to high yield and uniform tubers. However, it was highly susceptible to powdery scab. A series of seasons conducive to powdery scab resulted in infected seed being distributed widely to potato growing regions and soils were contaminated. Pentland Crown declined in significance rapidly, partly due to its susceptibility. However, succeeding varieties were also susceptible. Today, three quarters of varieties listed in the British variety database are susceptible or moderately susceptible.

This guide is based on current available knowledge and highlights the key factors that affect the risk of powdery scab.

Follow the guide to help minimise risk factors.

Diagnostic testing

Soil testing

Knowing which fields are contaminated with powdery scab could assist in making decisions on site selection, use of fungicide soil treatment or which cultivar to grow in a particular field. New tests, based on DNA technology, have been developed for powdery scab, black dot and *Rhizoctonia solani* as part of a BPC funded project on disease diagnostics. SAC, SCRI, CSL, supported by Higgins Agriculture, Greenvale AP and MBMG have been using these techniques to see if they can predict which fields are at risk from developing these diseases. The link between amount of inoculum (test result) and risk of powdery scab developing on daughter tubers has yet to be verified.

Powdery scab testing of soil is commercially available but is offered on the basis that research has not yet established a strong relationship between test results and the risk of disease developing. Soil sampling is another area which is important. The optimum sampling regime has not been determined for this pathogen, therefore test results can only give an indication of whether *Spongospora subterranea* is present in the tested sample.

Seed testing

Seed growers should identify if powdery scab exists on their seed stocks by examining a washed sample of tubers. Sometimes symptoms of common scab are similar in appearance to powdery scab and in this instance a sample should be sent to an independent laboratory for testing.

Chemical control

Fluazinam

Recent experiments in the UK (funded by a range of organisations including the British Potato Council) and abroad have indicated that fluazinam is active against powdery scab. The results have been sufficiently encouraging to warrant the SAC to apply for a Specific Off Label Approval (SOLA). The SOLA permits fluazinam to be used as a soil treatment to reduce the severity of soil borne powdery scab. Only seed crops may be treated. There is no approval for the treatment of ware crops.

For more information about fluazinam use on seed crops to reduce powdery scab see: www.pesticides.gov.uk
SOLA approval number 0893/2006

Zinc

Numerous experiments have linked high soil zinc status with powdery scab reduction. However results are highly variable. Furthermore, zinc salts are available as fertilisers rather than crop protection products. Establishing soil zinc status as part of routine soil testing may be advisable.

USE PESTICIDES SAFELY, ALWAYS READ THE LABEL. Always consult your buyer protocols before using any pesticide.

Powdery scab life cycle

The causal organism, *Spongospora subterranea* is a highly adapted organism. It produces multi-celled resting spores called sporeballs.

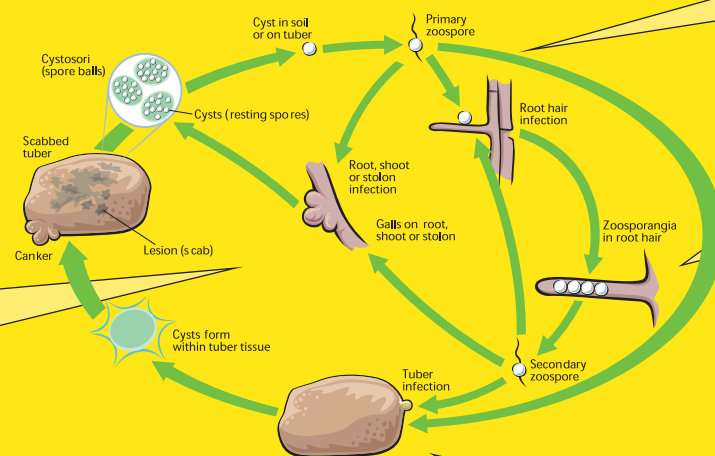
- Sporeballs comprise of 100 or more spores and measure much less than the size of a pinhead.
- Sporeballs can be soil or seed borne.
- Soil contamination can also occur through manure or slurry, from stock fed on infected potatoes.
- They can survive for long periods in the soil (>13 years).
- Sporeballs can fall into the soil from root or stolon galls and infected tubers at planting or harvest or be retained on the tuber.

When stimulated, sporeballs release swimming spores (zoospores). Zoospores swim short distances and infect root hairs, stolons and tubers.

Infection of the root or stolon can sometimes lead to the development of a gall.

- Sporeballs are formed inside the gall.
- When mature, galls release sporeballs into the soil.
- Root galling is greater at higher soil temperatures (17°C).
- Varieties with resistance to tuber infection can be susceptible to stolon or root galls. This can allow the build up of sporeballs in the soil.

Zoospores can multiply in numbers in root hairs, releasing more zoospores. These secondary zoospores can infect further root hairs, stolons and tubers.



Tuber infection occurs through unsubserved tissue. This is mainly through lenticels but sometimes eyes. Infection through lenticels leads to the scab symptom. Infection through eyes can lead to canker symptoms. Research has shown that the optimum temperature for tuber infection is around 12°C. The most susceptible period for infection is at tuber initiation. However, infection can also occur when the rose end of the tuber swells. This later infection often leads to a ring of scab lesions. Depending on temperature, tuber symptoms take 4 – 8 weeks to develop. This can result in the appearance of 'symptomless' crops at test digging.

Latent infection

BPC/SEERAD research has shown, through DNA testing, that tubers can carry symptomless infection. This is called latent infection. These infections have been found to be common. They were first noted in 1991 and appear to be associated with low temperatures and low inoculum levels. It is not known whether these latent infections cause powdery scab infection or even produce sporeballs.

Managing the risk of powdery scab

HIGH RISK	FACTOR	ACTION
Markets with zero tolerance for powdery scab. e.g. certain seed export markets.	Market Check your customer / intended markets' tolerance to powdery scab levels (they may be tighter than standard or certified levels). Use virgin or low risk land for markets with tighter tolerances.	Whilst powdery scab tolerances are quite tight for all seed and ware markets, some markets dictate zero tolerance for any sign of the disease. Powdery scab is thought to be an impediment to opening up new overseas markets or expanding existing ones. Many buyers now wash seed samples and inspect to tighter tolerances than classification standards. Ware tolerances for powdery scab vary depending on market and customer. It is important that you consult with your customers as to their tolerances.
Highly susceptible varieties. e.g. Estima and Maris Piper.	Variety Check varietal resistance to powdery scab at www.potato.org.uk/varieties , in the NIAB pocket guide, or contact your seed supplier.	 Although three quarters of varieties listed on the British potato variety database and in the NIAB pocket guide are either susceptible or moderately susceptible, knowing your varieties' resistance ratings for powdery scab along with your intended market tolerance can help with field selection and agronomy. Variety resistance can be used to reduce both incidence and severity of powdery scab. However in seasons conducive to disease development, variety resistance will have a lower impact. Susceptible varieties include Estima, Maris Piper and Cara. More resistant varieties include Saxon, Hermes and Sante.
Infected seed particularly when planted in uncontaminated land.	Seed Health Use certified seed, especially for more susceptible varieties. Use disease free seed when planting in to uncontaminated land.	Several BPC/SEERAD experiments have been carried out in GB and abroad, examining the relationship between inoculum on seed and disease on progeny crops. All have indicated that powdery scab is more prevalent in cooler and wetter areas, but that there is little evidence of a consistent relationship between seed tuber inoculum and progeny crop disease. However, powdery scab infected seed risks contaminating disease-free soil and should be avoided.
Grading uninfected seed stocks without cleaning and disinfection, after infected ware or seed stocks.	Grading Wash and evaluate samples of all stocks intended for grading. Grade seed stocks before ware stocks. Give priority to higher seed grades. Wash / disinfect grading lines at appropriate times during grading. Fully wash down and disinfect your grading line at the end of each season.	Spore balls can be carried on grading lines and be transmitted on to subsequent healthy seed stocks which could infect the daughter crop. Knowing which stocks carry powdery scab and planning to grade higher grade seed stocks first and cleaning accordingly will help prevent spread. Possible grading strategies to help reduce the spread of seed-borne powdery scab are : 1. Ranking all your stocks. Work with the healthiest first. Take opportunities to clean the grader. 2. After grading an infected stock, clean the grader before returning to healthy stocks. Consult BPC Store Hygiene CD.
Previous field history of powdery scab. Volunteers. Solanaeous weeds. Poor drainage.	Site selection Consider field disease history when developing a cropping plan. Avoid tight rotations and control groundkeepers to minimise disease build up.	Field history is a good indicator to the likely risk of daughter crop infection from the soil. Consider planting high risk crops (varieties or market) on uncontaminated land with uninfected seed. To minimise the build up of soil inoculum ensure good groundkeeper control, maintain longer rotations and use uninfected seed. Soil testing for powdery scab can help assist decision making, however results are still to be validated. See section on soil testing.
Cold wet soils (particularly at tuber initiation). Compaction evident. Poor soil management e.g. excessive cultivation.	Soil conditions Ensure good soil structure to maintain free draining soils, through cultivation to reduce compaction. Ensure good seed bed to promote rapid even emergence. Avoid excessive bed tilling.	Powdery scab is prevalent in cool wet conditions particularly at tuber initiation. Soil conditions that increase retention of water in the soil profile will increase the risk of powdery scab infection. In general, powdery scab incidence and severity is worse in cooler and wetter areas. Depending on temperature, progeny tuber infections may take 6 to 8 weeks to develop and thus may not be evident in the growing crop. More information on good soil management can be found at www.potato.org.uk/soils
Protracted tuber initiation period in cold soils with either seed or soil inoculum. Over irrigation during tuber initiation.	Growth Avoid water stress, especially during tuber initiation. Avoid over irrigation, especially of susceptible varieties.	Good seed and soil management may help reduce crop stress (see other factors). Schedule your irrigation to minimise risk of water logging*. Beware that the risk of powdery scab infections will increase after excessive rainfall. See: * Buckley <i>et al.</i> , 2005 * Stalham <i>et al.</i> , 1999
Dusty stores. Poorly managed forklift traffic.	Store Hygiene Ensure store hygiene policy is in place.	Consult BPC Store Hygiene CD. Dust in potato stores can be contaminated with powdery scab spore balls, which can be transmitted on to clean tubers in poorly cleaned stores (e.g. by forklift traffic). 

TECHNICAL

Basic seed potato & minimum export (outside EU) tolerance

Seed Potato Class	Individual Tolerance (% by weight of tubers)	Allowable % surface area
UK Basic seed (SE, E) ¹	3%	12.5%
UK Certified seed (A) ²	3%	12.5%
Minimum Export tolerance (outside EU) ³	1.5%	12.5%

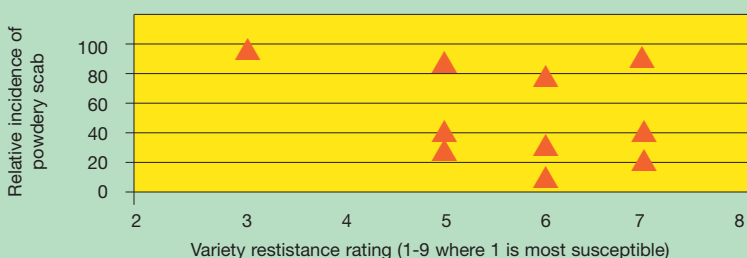
Source: SASA

¹ & ² Seed companies may have tighter individual tolerances than the standard classification scheme.

³ Certain export countries may have tighter individual tolerances than the export minimum.

Varietal resistance can help reduce powdery scab incidence

Relative reduction in incidence of powdery scab by growing a more resistant variety. (resistance rating 3 = 100%). Disease levels for other varieties were ranked proportionately. Varieties assessed were Estima, Maris Piper, Wilja, Record, Saxon, Nadine and Pentland Dell.



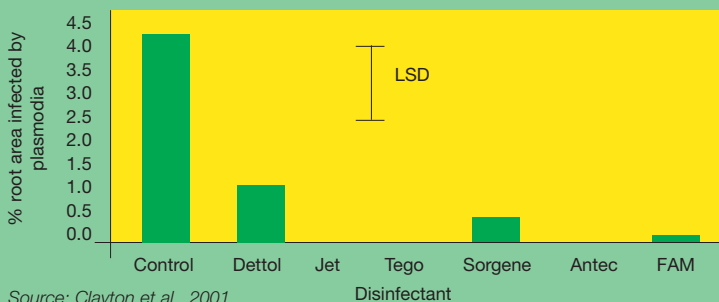
Triangles represent mean powdery scab incidence drawn from three projects conducted during an eleven year period.

In some years variety resistance reduced powdery scab, but in certain years variety resistance had little effect on reducing powdery scab incidence.

Source: *Wale et al., 2005*

Disinfection of machinery

Effects of differing disinfectants on control of powdery scab sporeballs. Area of tomato root showing plasmodia of powdery scab resulting from infection from sporeballs following disinfectant treatment at 0.2% for one hour.



Source: *Clayton et al., 2001*

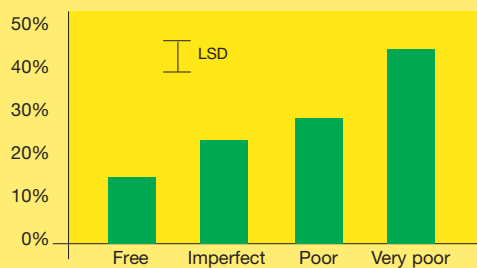
In the absence of disinfectant, tomato roots were infected by the test pathogen. The amount of infection was typical of that found with soil samples regarded as high risk. All disinfectants reduced the level of infection significantly. Disinfectant concentration was low although the exposure time may be greater than that expected with commercial use. The test can be regarded as sufficiently contaminated with soil and debris to reflect commercial use.

Rotation

The role of rotation in powdery scab control is complex and difficult to investigate on a field scale. Nolan *et al* (2001) studied disease expression in maincrops and reported lower powdery scab levels in rotations >6 years. Others have reported survival of sporeballs >13 years. The complexity exists because even low levels of soil or seed contamination can result in severe disease if conditions are conducive (see other risk factors). Furthermore, a previous potato crop which was harvested as visually disease free may have multiplied inoculum in the soil on root and stolon galls (see life cycle).

Drainage can have an effect on powdery scab incidence

Percentage incidence of powdery scab in Maris Piper across four different drainage classes.



Source: *Parker et al., 1984*

Factors influencing powdery scab

Temperature	BPC/SEERAD studies have demonstrated that infection can occur as low as 9°C. Range 9°C – 17°C. Optimum is around 12°C.
Moisture	Free moisture is required for infection and enables zoospores to swim to the host. Previous studies have suggested that alternating saturated and unsaturated soil conditions are most conducive to infection but BPC/SEERAD research showed that continuous saturated conditions are also highly conducive.
Soil pH	There is only a very small effect of soil pH on disease. Disease is slightly greater in alkaline soils than acid soils.
Soil type	Powdery scab has been recorded in all soil types. However, there is insufficient evidence from research to make a judgment on the effect of soil type on disease, but heavier soils might encourage more diseased plants. Importantly, soil moisture was the main influencing factor on disease development.
Soil drainage	The risk of powdery scab is greater in poorly drained soils where water is retained in the soil profile. Soil pans or compaction also increase powdery scab risk. Excessive use of a bed tiller to create an over fine tilth that compacts and retains water can also increase powdery scab.

Source: *Wale et al., 2005*

Powdery scab tuber identification



Scabs on tubers usually erupt to liberate a fine powder of spores leaving a ragged edged scab more circular than common scab. Non-erupting scabs may develop a surrounding area of discoloured tissue which is variable in size and may be confused with skin spot pustules.



Cankers and cankerous tumours may deform the tubers.



Powdery scab may also be formed on roots and stolons as galls.

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Common scab



Common scab lesions tend to be more corky in appearance and angular in shape. Severe scabs can be raised or pitted.

References

- Wale SJ, van de Graaf P & Lees A (2005) Epidemiology, autecology and control of *Spongospora subterranea*, cause of potato powdery scab. BPC project report.
Buckley et al., (2005) Irrigation Best Practice guide. Defra publication.
Clayton RC, Wale SJ, Blackwood JM & Black S (2001) Potato store hygiene and disinfection to improve seed health and ware quality. BPC project report.
Nolan S, Firman DM & Allen EJ (2000) Production and use of healthier seed in order to improve ware quality. BPC project report.
Stalham MA, Allen AEJ, Gaze SR (1999) Irrigation scheduling and efficient use of water in potato crops. BPC research review.
Parker A, (1984) Cultural control of powdery scab in potatoes. Proceedings of Crop Protection in Northern Britain 1984.
Hilton A, pers com (As part of BPC project R253 Improving decision making for the management of Potato Diseases using real time predictive diagnostics).
Project due to end March 2008.
Other publications
Powdery scab fact file, S Wale, SAC.
Proceedings of the first European powdery scab workshop July 2000.



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