POWDERY SCAB PROJECT UPDATE

POTATO R&D FORUM 2022

If you grow potatoes in Tasmania, you are probably familiar with powdery scab. While sometimes regarded as a southern disease, this devastating pathogen has been detected from Queensland to South Australia, and even parts of Western Australia. Annual losses are estimated to top $13.4 million annually. However, incidence varies hugely by cultivar and area, raising the question – WHY?

Jenny Ekman reports.

Professor Calum Wilson from the Tasmanian Institute of Agriculture (TIA) is a world leader when it comes to managing *Spongospora subterranea*, the cause of powdery scab. He is currently conducting a three-year Hort Innovation project "Mechanisms and manipulation of resistance to powdery scab in potato roots".

Professor Wilson provided an update on the project at the recent R&D Forum in Ballarat.

While the most obvious symptoms of powdery scab are lesions on tubers, the pathogen also causes formation of galls on roots, shoots and stolons (Figure 1).

Figure 1. Galls can form on roots, stolons or shoots. Source: C. Wilson.

However, it is the effects on the roots which have the greatest influence on yield. Symptoms of root infection are not always visible, with the result powdery scab can be an underestimated disease. However, recognition of the importance of this pathogen has been increasing worldwide.

It is also possible that intensification of production, use of susceptible varieties and more frequent irrigation have increased incidence of disease[1].

HOW DOES INFECTION OCCUR?

Infection mainly occurs by zoosporangia binding to and then infecting the root hairs (Figure 2). This early, critical stage can reduce root function by 20% or more, even though no symptoms are outwardly visible. Root infection is often unrelated to the physical symptoms of galls and lesions on tubers and roots. However, it is the most important factor reducing plant growth (Figure 3, Figure 4).

Professor Wilson has therefore focussed primarily on the root hair infection phase, rather than the symptoms on tubers. The aims of the project are to:

- Reduce losses
- Reduce input requirements, including water and fertiliser

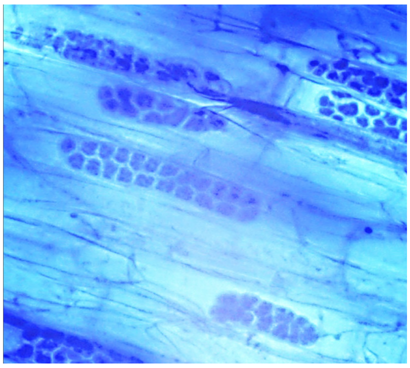

Figure 3. Zoosporangia forming in root cells. Source: C. Wilson.

Figure 4. Healthy potato seedlings (top), compared to seedlings infected with powdery scab (bottom). Although no scab or root galls have formed, there are clear effects on both root and shoot growth of the infected plants. Source: C. Wilson.

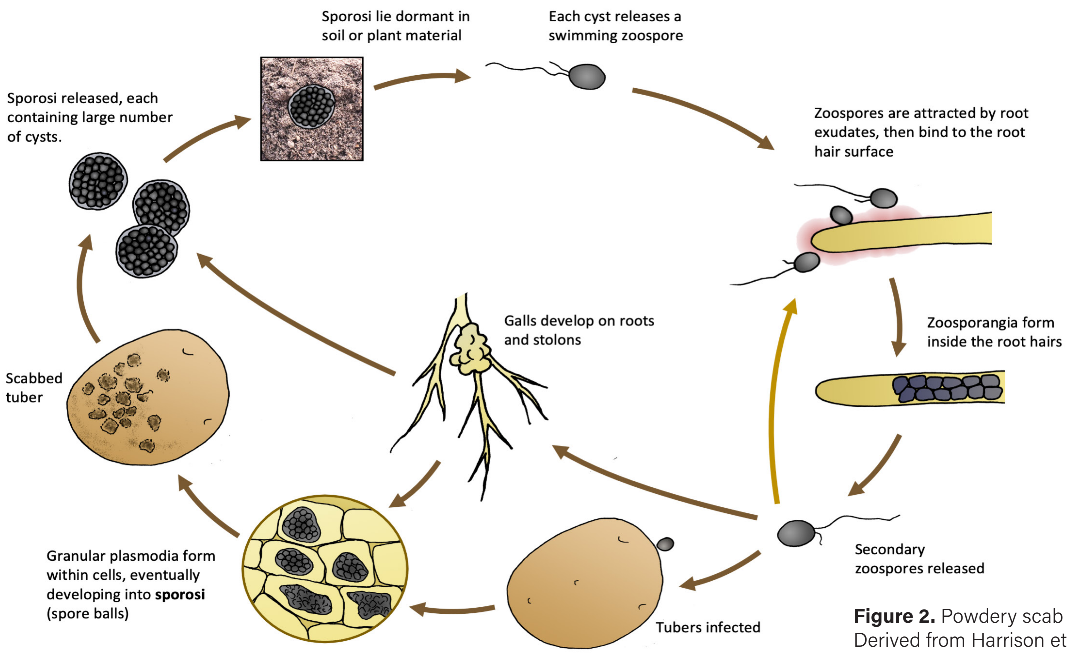

Figure 2. Powdery scab lifecycle. Derived from Harrison et al., 1997 and Falloon et. al., 2015.

- Improve quality and storage life of tubers
- Develop new disease management and resistance screening tools

To achieve this, the project has progressed in a series of activities.

The first was to develop a new way to search for resistant varieties. Traditional screening relies on growing different potato varieties in a glasshouse over many months, then examining root galls and lesions formed on tubers. This is not only time and resource intensive, but may not provide an accurate indication of infection.

Professor Wilson's new method examines the numbers of zoospores able to attach to the potato root hairs. This technique can provide reliable results in as little as 48 hours, potentially allowing hundreds of cultivars to be screened for resistance.

"We wanted to measure how much infection occurs in those roots," said Professor Wilson, "you get varieties where there are almost no symptoms

Table 1. Variety resistance to powdery scab, based on the root attachment assay.

Highly susceptible	Moderately susceptible	Moderately resistant	Good resistance
Nicola	Gold Rush	Russet Burbank	Russet Nugget
Liseta	Yukon Gold	Desiree	Granola
Kranz	Tasman	Dawmore	Tolaas
Shepody	Spunta	Sebago	Tolangi Delight
Shine	Pontiac	Brake Light	
Red Ruby	Frontier Russet	Ruby Lou	
Patrones	Lustre	Fontenot	
Delaware	Wilwash	Purple Congo	
Nooksack	Leven	Cranberry Red	
Coliban	Bintje	Nampa	
Southern Cross	Pentland Dell	Spey	
Kennebec	Mainstay	Banana	
Diment	Cariboo	Pink Eye	
Kipfler	Atlantic	Dutch Cream	
Up-to-Date	Chiefton		
	Sequoia		
	Bismark		
	Yellow King		

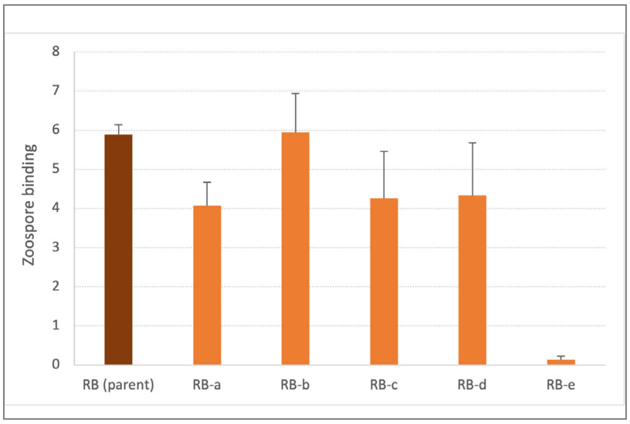

Figure 5. Somaclonal variants, here labelled a to e, were produced from parental line RB. While zoospore binding to most variants was similar to their parent, RB-e was highly resistant.

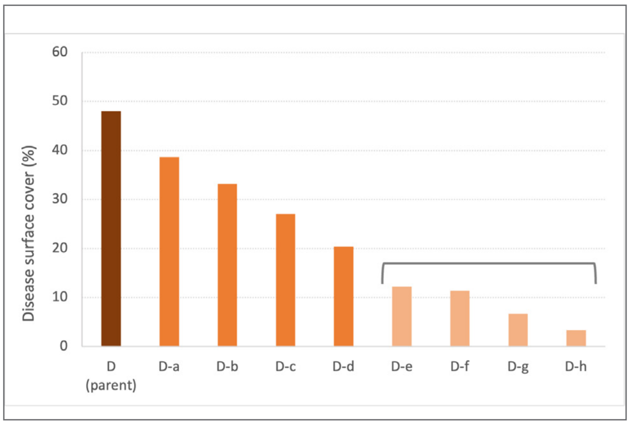

Figure 6. Somaclonal variants (here labelled a to h) that resisted zoospore infection were grown in the glasshouse, then tubers examined for scab. Variants D-e to D-h were significantly different to parental line D.

on the tubers, but very high levels of infection in the roots – and vice versa (Nicola is an example of this). Our screen directly examines that initial stage of root infection."

The results from the root assays can then be used to select potato varieties that resist infection by the *Spongospora* zoospores.

INDUCING RESISTANCE TO ROOT INFECTION

Professor Wilson's team also looked at a novel tecnique that allows selection of resistant variants of existing cultivars. 'Somaclonal variants' are produced by exposing shoot tips to a stress, then growing the young plantlet in tissue culture. The plantlets often look and behave almost identically to the parent plant, but can have tiny genetic changes.

"Using our new assay we can screen for those variants that have altered susceptibility to root infection" explained Professor Wilson.

The TIA laboratory produced a large number of somaclonal variants, exposed them to the *Spongospora* pathogen, and examined infection of the root hairs by zoospores. As shown in Figure 5, while most are similar to the parental line, some variants proved highly resistant to zoospore binding.

The next stage was to conduct greenhouse trials with lines that appeared to have resistance. Plants were grown to maturity and tubers examined for signs of disease.

While there was considerable variability, several of the variants that strongly resisted binding by zoospores also had less physical evidence of powdery scab (Figure 6). Of course, these variants still need to be field tested to examine yield and other agronomic characteristics, but such results are highly promising.

PREVENTING INFECTION

The third phase of the project is finding ways to prevent infection in the first place. "We are interested in just how the pathogen attaches to the roots and how we can basically stop it happening," Professor Wilson commented, "one possibility is to find a receptor, something that the pathogen recognises and allows it to bind."

The team compared resistant and sensitive varieties. Sure enough, they came up with a candidate – a 'glycosolated protein receptor.' When they used enzymes to remove glycosylated proteins from a root hair, zoospores no longer attacked it. "We now have a candidate for where the pathogen binds – if we can knock this out, we could have an immune variety," explained Professor Wilson.

Another avenue is to look at the natural root exudates potato plants produce. These can either attract or repel the swimming zoospores.

"What we found was that the resistant varieties had less of the attractants, and more of the inhibitors, so this

Powdery scab symptoms on a tuber

again could be a really useful screen for resistance."

An Australian Research Council (ARC) grant has enabled the TIA team to examine whether a bacterial inoculant could interfere with this process. The bacteria consume the attractant root exudates, reducing potential infection.

A large number of bacteria have been screened for this ability.

"We got one!" announced Professor Wilson, "and not only did the bacteria digest away the key attractant exudates, it also grew bigger potatoes. It both boosted productivity **and** reduced disease." While the bacteria was not a cure for powdery scab, it meant that susceptible varieties produced a better crop in the presence of the pathogen (Figure 7). If the disease was not present, adding inoculant still produced a bigger crop.

NEXT STEPS

Professor Wilson feels the best option is to target the root receptors. "Potentially, we can use genetic approaches to knock those out, and get an immune variety."

Other good options involve improving root health using beneficial bacteria as a seed dressing, helping the plant tolerate infection. It will also be important to examine interactions between interventions for powdery scab and incidence of other root diseases.

One thing is clear. Powdery scab is both a fascinating and challenging organism. However, with these new management tools, plus a better understanding of how it infects the potato plant, we are now developing a range of innovative options to manage this devastating disease.

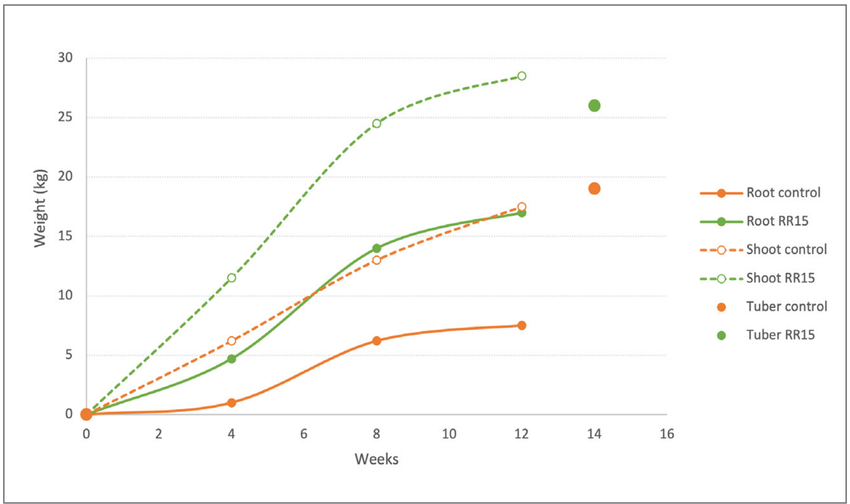

Figure 7. Effect of a bacterial inoculant (RR15) on root growth, shoot growth and tuber weight of potatoes exposed to the powdery scab pathogen. Images at right show the difference between the control (left) and inoculated (right) plants after 12 weeks.

Some of the TIA team

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Hort Innovation Strategic levy investment POTATO – FRESH FUND

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