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TIA is a joint venture of the University of Tasmania and the Tasmanian Government

Mechanisms & manipulation of resistance to powdery scab in potato roots

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6th October 2022 - AUSPICA Potato Conference, Ballarat

Our powdery scab team

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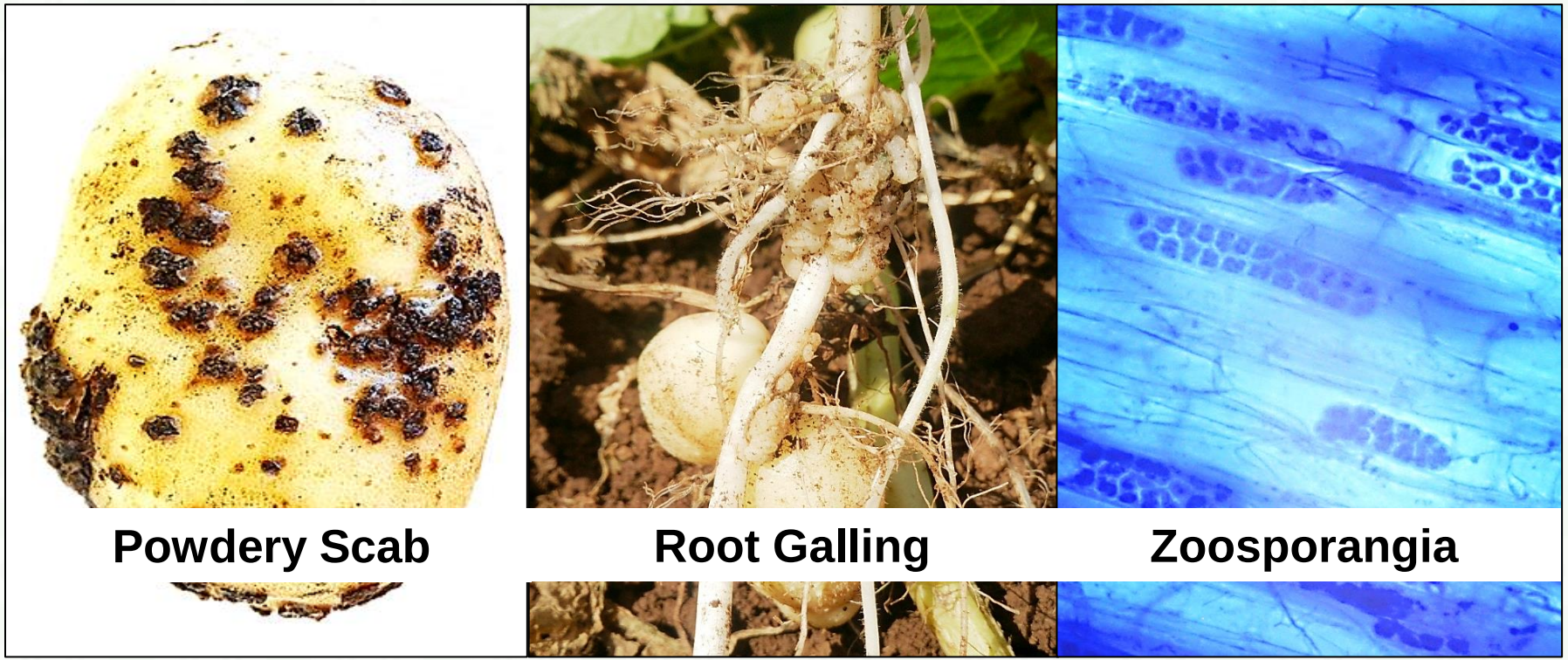
Australian Research Council

Hort Innovation

Powdery Scab



Estimated Australian losses - AUD$13.4 M p.a.

Wilson CR (2016). Acta Hort. 1123: DOI 10.17660/ActaHortic.2016.1123.2

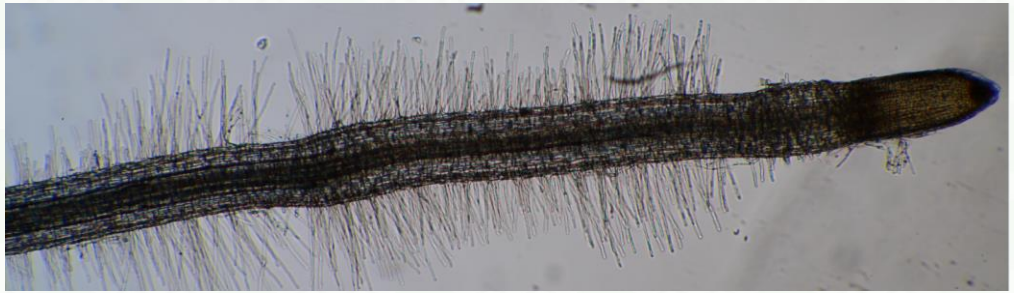
Adversely impacts root function & plant growth

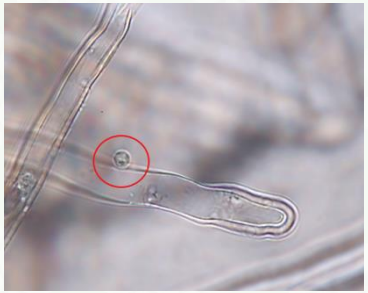
Susceptible potato cv. Iwa

Project global goals

- Reduce losses due to root disease caused by infections with *S. subterranea*
- Reduce requirements for agronomic inputs needed to compensate for reduced root function in diseased plants and greater quality produce with better storage capability
- New disease management and resistance screening tools

Project research goals





New rapid resistance screen

- *In vitro* assay for varietal resistance with reliable results in less than 1 week
- Generate a resistance listing of potato varieties
- Identify gene markers associated with resistance to root binding

New resistant varieties

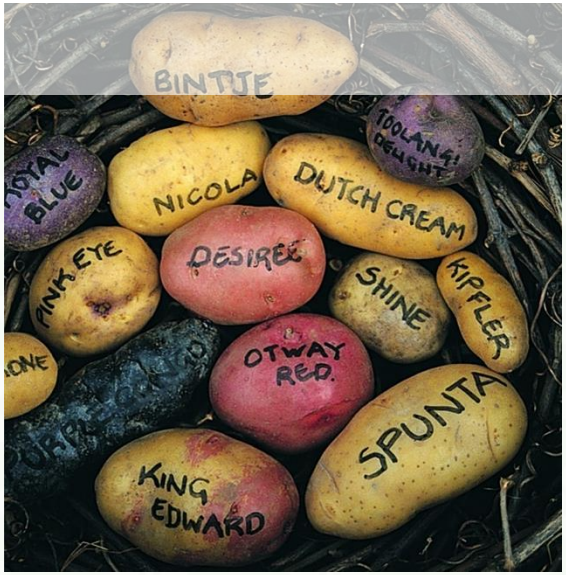
- Using our rapid screen, select for variants with enhanced resistance to root binding

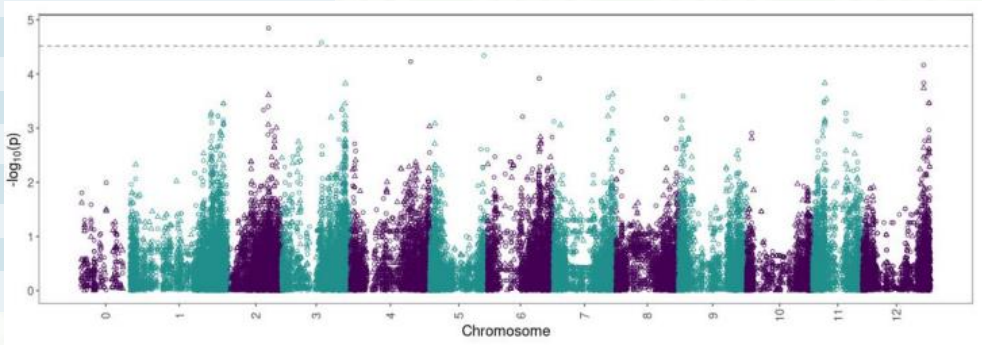
New controls targeting root binding

- Where on potato roots do zoospores bind?
- Can we interfere with these binding sites?

New rapid cultivar screen

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		



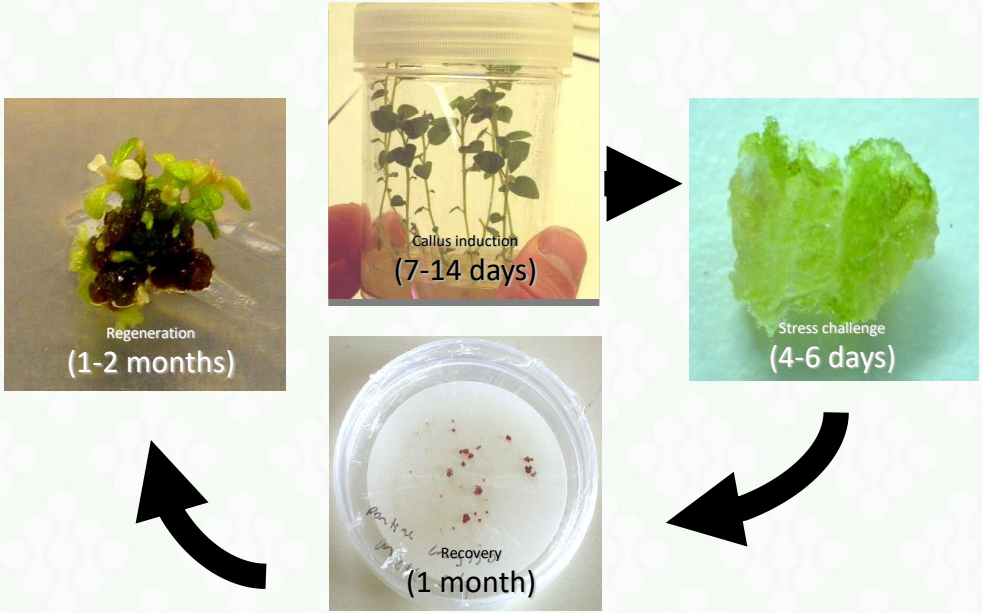


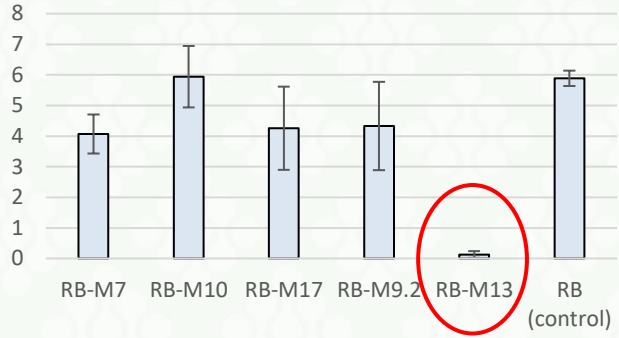
Variety resistance rankings (select public varieties) based on the novel root attachment assay.

New resistant varieties

Somaclonal selection

- 6 varieties were subject to somaclonal selection





Screen for zoospore attachment

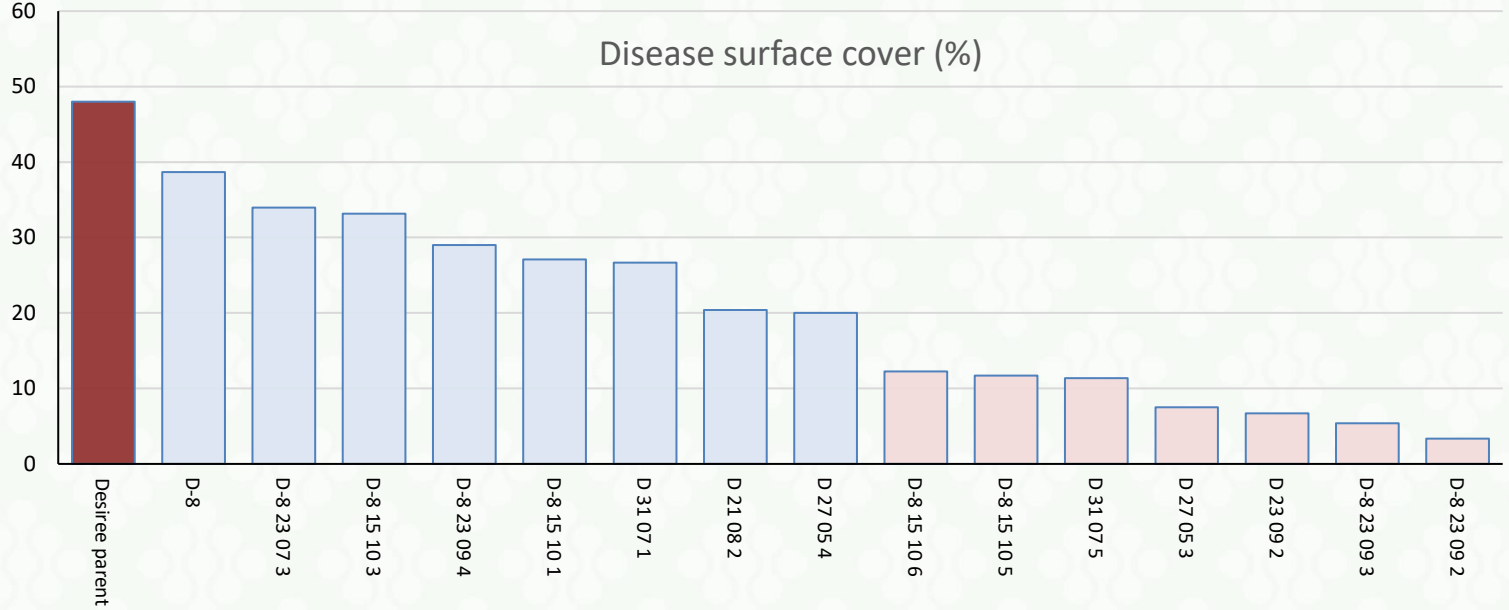
- All varieties showed variation with some somaclonal lines showing greatly reduced root attachment

Wilson et al 2009. Plant Pathology 58: 137-144.

New resistant varieties

Glasshouse screening

- Those showing reduced zoospore attachment generally also showed less disease in glasshouse challenge



Testing of Desiree somaclones that showed reduced root zoospore binding

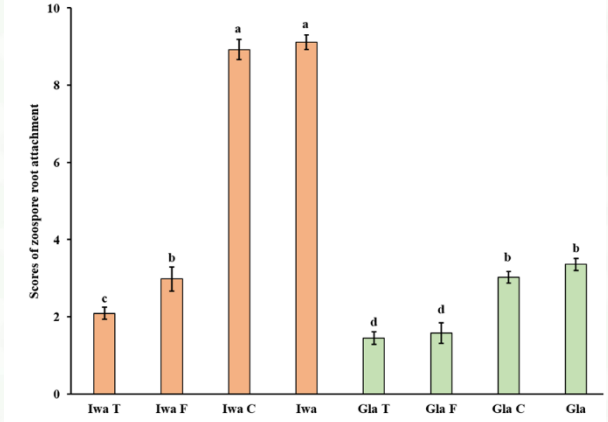
New controls targeting root binding

Target root surface proteins

- Trypsin shaving technique
- Strip only surface exposed proteins
- Candidate receptor proteins identified

Disrupting root binding

- Enzymes targeting proteins reduced zoospore attachment suggesting removal of glycosylated protein receptor



Non-trypsin treated Iwa root hairs incubated with Spongospora zoospores

Key project outcomes

We now have:

- A rapid variety screen for root attachment/infection
- Varietal variants that have enhanced disease resistance
- Candidate targets for pathogen binding sites (receptors) on roots

Some other interesting things we are doing

Potato root exudates attract or repel the pathogen

- Attractants and repellents have been identified
- These are associated with cultivar resistance
- These make interesting breeding markers

Chemotaxis attractants
Tyramine
Glutamine
Proline
Pinatol
Trehalose
Raffinose
Asparagine
Serine
Chemotaxis inhibitors
Spermine
Choline

Australian Government
Australian Research Council

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Merz U. (1997)

Bacterial rhizosphere root inoculant

- Selected to interfere with root signals to pathogen and reduce infection when applied as a seed dressing

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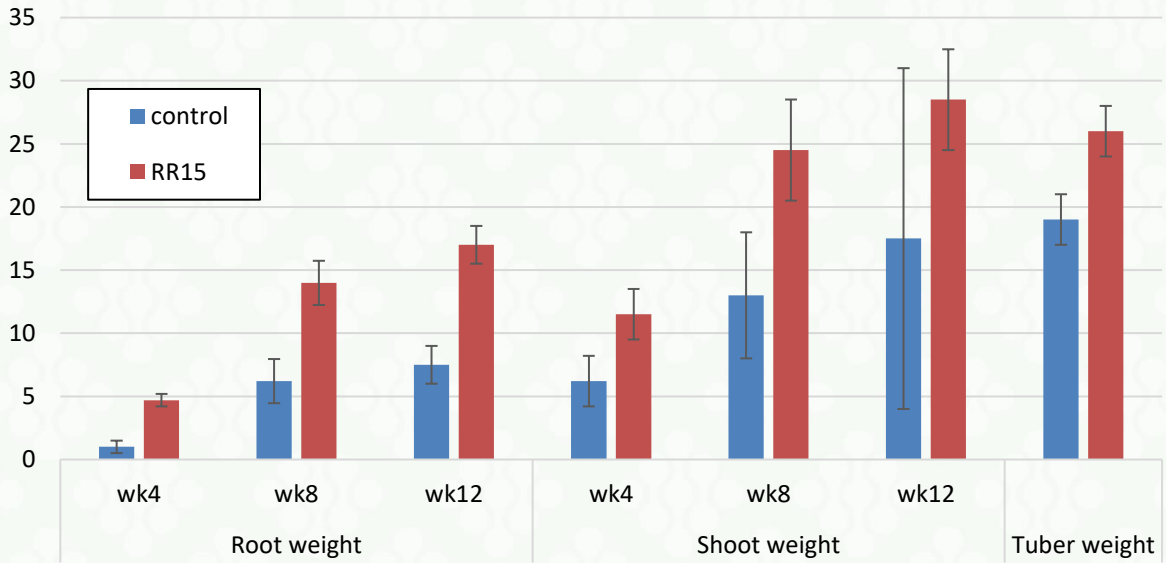
Bacterial root inoculant

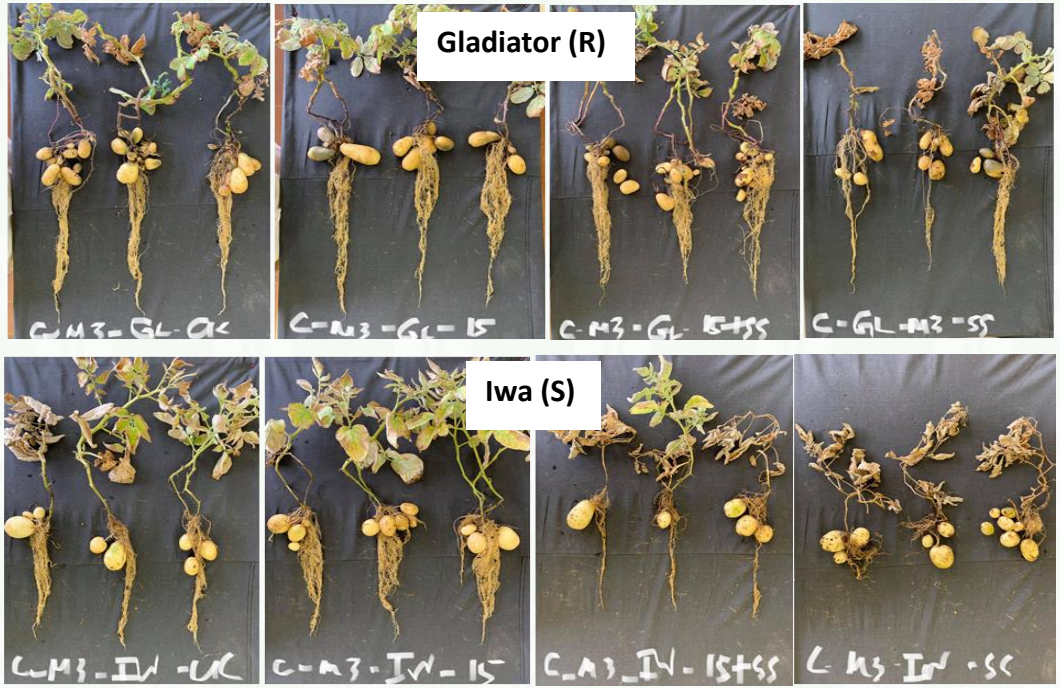
Increased potato root growth and tuber yields

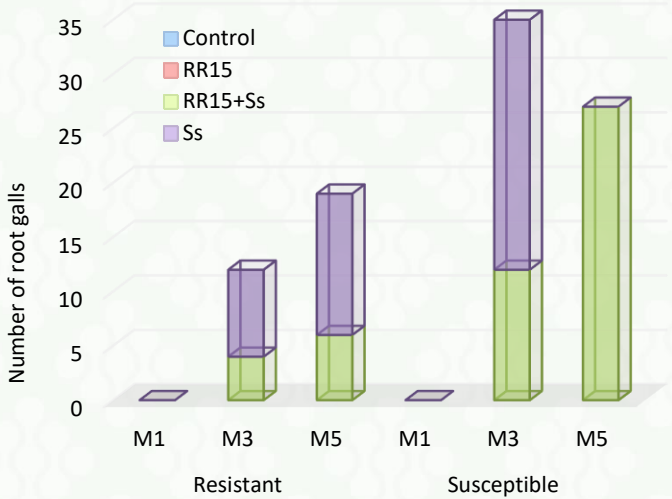


Bacterial root inoculant

Reduced root disease and impact on root damage

Control **RR15** **RR15 + Ss** **Ss**





What next – further R&D needs

Target putative root receptors for zoospore binding and/or develop somaclonal variants to generate highly resistant varieties

- Remove these receptors through conventional breeding or CRISPR to generate extreme resistance

What next – further R&D needs

Stimulation of a larger more robust root system that can resist and/or tolerate root infections for greater yields

- Application of beneficial rhizosphere bacteria as seed dressings
- Plant growth promotors
- Plant defense activators

What next – further R&D needs

Understanding interactions between soil-borne potato diseases and their management practices

- How do different potato diseases encourage or inhibit infections by other pathogens
- How does management interventions (fungicides, irrigation etc) affect other diseases
- What resistance factors might be linked/enhanced/inhibited

What next – further R&D needs

Determining the role of alternative hosts and volunteer potatoes in maintenance of soil-borne pathogen populations

- A rotation isn't a rotation with volunteers – but how many are needed to cause a problem
- What rotational crops will encourage (or inhibit) powdery scab

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