Pink rot of potatoes – impact of soil factors (pH, Ca, physical properties) on disease expression; future challenges and opportunities.

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McCain

Webinar - Overview

- Pink rot
  - Economics and significance
  - Symptoms
  - The causal agent (pathogen)

- Hort Innovation pilot project
  - Key findings
  - Challenges
  - Opportunities

In Tasmania - significant losses to pink rot - particularly over the last 3-4 years

"Some potato paddocks experience a regular substantial yield loss ranging from 5 to 30 per cent even when recommended fungicide treatments are applied,"

"paddocks with high levels of infection could be categorised as unsuitable for cultivation."

Jo Tubb, Simplot Australia potato agricultural manager,
(The Advocate, Aug 2020)

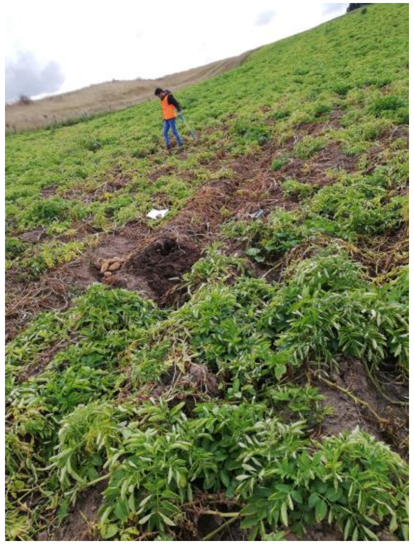
"Some heavily infected paddocks only getting 10t/ac (25t/ha)."

NE grower, May 2021

In Tasmania – why is it a problem?

- Main reasons include
  - Unseasonal rainfall events (environmental)
  - Reduced fungicide efficacy (pathogen) - metalaxyl
  - Susceptible varieties – Russet Burbank (host)
    - Time period in ground
- The pathogen *Phytophthora erythroseptica* can survive for long periods in the soil, like other soilborne pathogens.

Typical symptoms



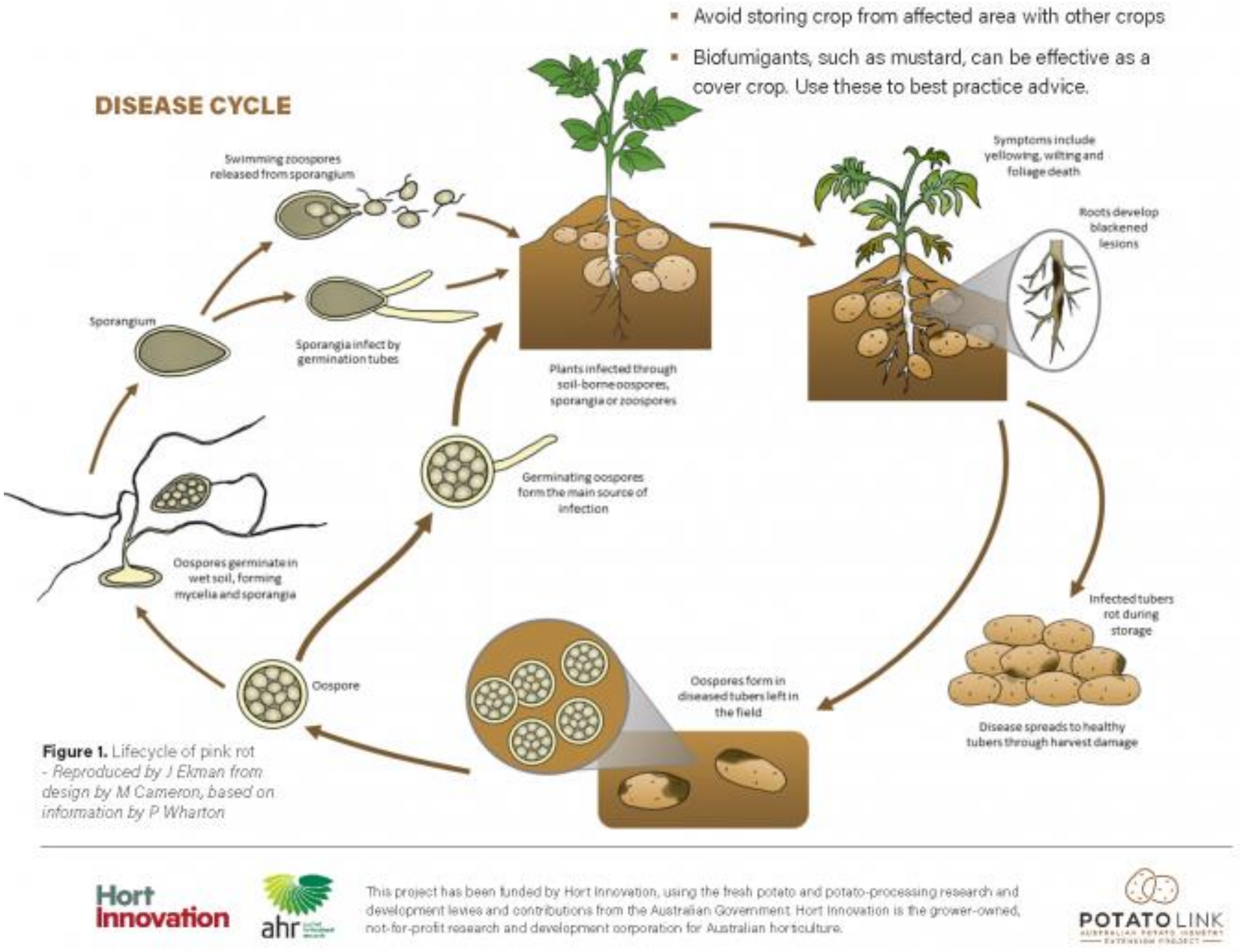
Infested plants may wilt and collapse because of rotting at crown area.

Infected tubers turn pink after cutting.
Distinct, unpleasant odour

Effects leaves, emergence and reduce yields.

Tuber wounding, splitting promotes infection.

The pathogen – Phytophthora erythroseptica



The pathogen - Phytophthora erythroseptica

- Primarily soilborne - can survive for long periods
- most active between 15-25°C
- Key infective structures – germinating oospores, sporangia or zoospores – water films
- Key resting structures – oospores

- Oospores activation → infective structures

Water, soil components, root exudates

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PT19000- Investigating soil pH and nutrition as possible factors influencing pink rot in potatoes – a pilot study

- Investigate impact of soil pH and Ca formulations in field
- Investigate impact of landform and soil structure
- Identify knowledge gaps and opportunities from literature and industry

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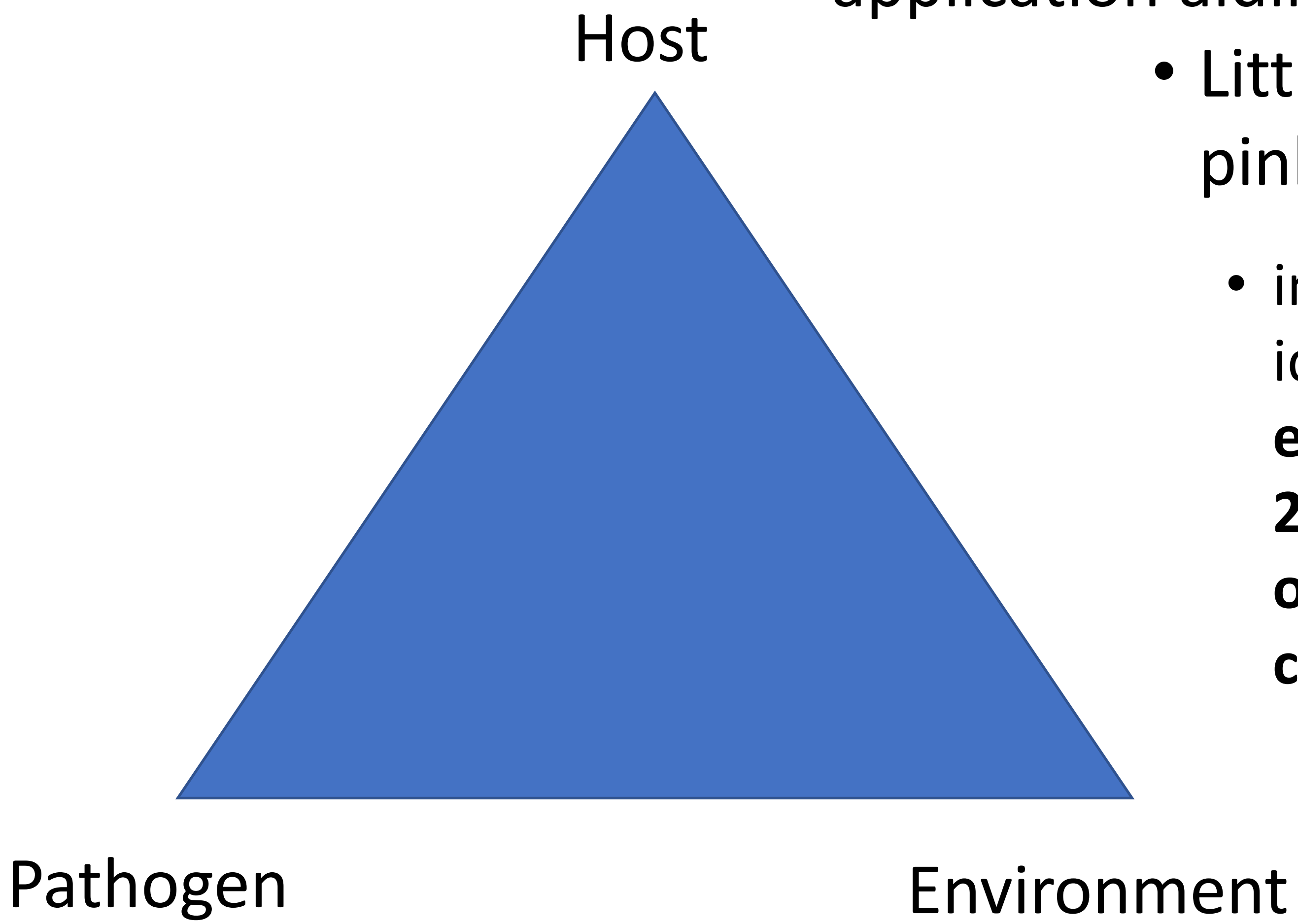
PT19000



- Anecdotal evidence of Ca application aiding plant health.
  - Little work in Australia on pink rot since 2000 (SA)
    - in hydroponics Benson (US researcher) identified some **possible beneficial effects of raising pH ≥7 (Benson et al. 2009a) and added Calcium (independent of pH, Benson et al. 2009b), in negating colonisation of root and stolon tissue**.
      - Whilst this work was preliminary and didn't explore pink rot infection within the tuber, it is worthy of further investigation

Field surveys/field trials

- Season 1 - we **surveyed 11 potato paddocks** from specific zones (sites) known to have a recent history of pink rot (Sisters Beach, Sassafras, Scottsdale & surrounds, Midlands).
- Season 2 – we **surveyed 8 potato paddocks** from the NE region

Surveys:
Preplant and through season:

PreDicta Pt
Soil chemistry
Soil structure/depth variation
disease

Pilot field trials:

All of the above plus Calcium treatments

Field surveys/field trials - pH and Ca impacts

fert application and sampling - Oct 2020

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Region	Field officer	Grower (Property)	Ca (mg/kg) start	end	pH (H20)	end
Sisters Creek	Blanchard	Elphinstone	2576	2050	6.24	6.27
	Blanchard	Lohrey	1643	1658	5.36	5.32
	Blanchard	Van Es	2061	1972	6.08	6.05
Sassafras	Marr	Perry (lower)	1052	1045	5.59	5.15
	Marr	Perry (upper)	562	593	5.24	4.95
Epping Forest	Briggs	Vaucluse (top)	1533	1545	6.43	5.72
	Briggs	Vaucluse (lower)	1672	1606	6.60	5.72
Scottsdale region	Bowe/Dylan	Winnaleah	2170	2356	5.46	5.61
	Bowe/Dylan	Whelan	1404	1354	5.56	5.39
	Bowe/Dylan	Smith (gr Brick)	1508	1317	5.68	5.46
	Bowe/Dylan	Coates	2005	1924	5.51	5.37

pH decline through season from control plots

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Region	Field officer	Grower (Property)	Ca (mg/kg) end	+ nanocal/cal	pH (H20)	+ nanocal/cal
Sisters Creek	Blanchard	Elphinstone	2050	2520/2595	6.27	6.23/6.27
	Blanchard	Lohrey	1658	1570/1650	5.32	5.29/5.49
	Blanchard	Van Es	1972	1850/2236	6.05	5.60/6.00
Epping Forest	Briggs	Vaucluse (top)	1545	1644/1750	5.72	5.63/6.09
	Briggs	Vaucluse (lower)	1606	1665/1712	5.72	5.93/6.10
Scottsdale region	Bowe/Dylan	Winnaleah	2356	2668	5.61	5.71
	Bowe/Dylan	Whelan	1354	1427	5.39	5.40

Do Ca applications alter Ca levels and pH

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Region	Field officer	Grower (Property)	Pink rot	Pink rot (%)
Sisters Creek	Blanchard	Elphinstone	Nil -minor	0.0 – 0.5
	Blanchard	Lohrey	Moderate, sporadic	0.0 -17.0
	Blanchard	Van Es	Moderate, sporadic	0.0 – 19.0
Sassafras	Marr	Perry (lower)	In spring area	15.0-17.0
	Marr	Perry (upper)	nil	0.0
Epping Forest	Briggs	Vaucluse (top)	Mod/sporadic	0.0-20.0
	Briggs	Vaucluse (lower)	Mod/sporadic	0.0-20.0
Scottsdale region	Bowe/Dylan	Winnaleah	Sporadic/mino	0.0 – 6.0
	Bowe/Dylan	Whelan	sporadic	0.0-40.0
	Bowe/Dylan	Smith (gr Brick)	Sporadic/entry	0.0-15.0
	Bowe/Dylan	Coates	major	25.0-40.0

Variable pink rot levels – nil, minor, moderate, major

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Summary - calcium impacts on pink rot

Region (field officer)	Grower (Property)	Variety	Pink rot (% incidence)		Hollow heart (% incidence)	
			control	Calc treatment	control	Calc treatment
Sisters Creek (Blanchard)	Elphinstone	Barossa	0.0	0.0	2.0	0.0
	Lohrey	R. Burbank	0.4	1.6	4.7	12
	Van Es	R. Russet	12.6	6.2*	0	0
Epping Forest (Briggs)	(upper)	R. Burbank	tbc	tbc	tbc	tbc
	(lower)	R. Burbank	tbc	tbc	tbc	tbc
Scottsdale region (Bowe/Wise)	Winnaleah	R. Burbank	0.0	0.9	18.7	14.0
	Whelan	R. Burbank	1.3*	10.3	0.0	0.6

Yield work
(10 plant plots)

	Van Es	Lohrey
control	21.05	19.75
transformer	19.17	19.05
nanocal + transformer	20.08	23.32

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Scottsdale

- Did higher levels of Ca/higher pH levels at the Win site reduce pink rot?

Bowe/Dylan	Win	2170	2356	5.46	5.61	0.0 – 6.0
Bowe/Dylan	Wh	1404	1354	5.56	5.39	0.0-40.0
Bowe/Dylan	S (gr Brick)	1508	1317	5.68	5.46	0.0-15.0
Bowe/Dylan	C	2005	1924	5.51	5.37	25.0-40.0

- Pot trials will see larger modifications in pH levels tested in the future
- Sandy loam – pH 6.4 – up to 7.4 with 4t/ha calciprill.
- Ferrosol – pH 5.5 – up to 7.4 with 17t/ha calciprill (realistic?)
- Different buffering capacities.

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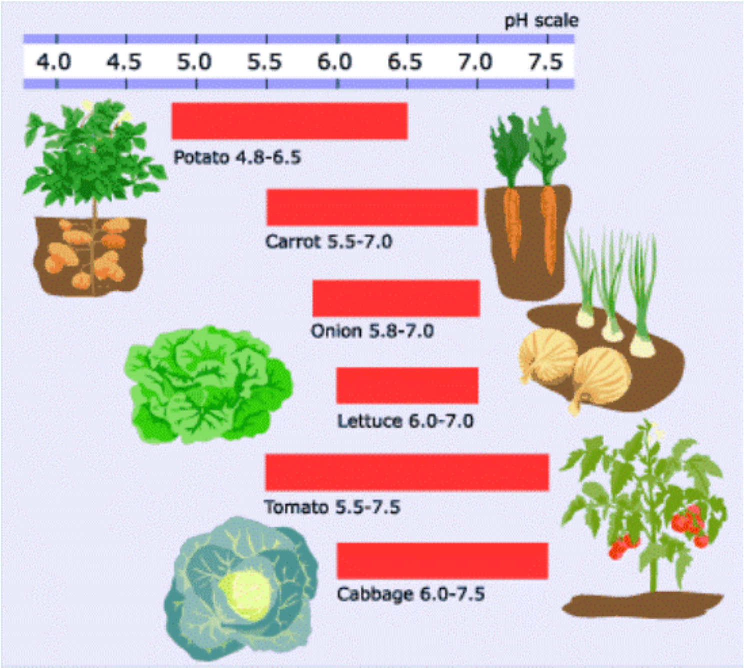
Soil pH and Ca

Optimal soil pH



http://www.agroconection.com/soil/soil-ph-an-overview/

Key results

From 19 field sites over 2 years:

- pH ranged from 5.2 – 6.6 at planting
- At harvest pH had dropped in most soils by 0.1 – 0.6 units.

- Where Ca (nanocal, calciprill, etc.) was applied pH was maintained or slightly raised – however no reduction in pink rot was recorded

- Calcium applications/or raising pH are not a silver bullet
    - Not that practical in highly buffered soils (ferrosols)
    - They may offer general soil health benefits.

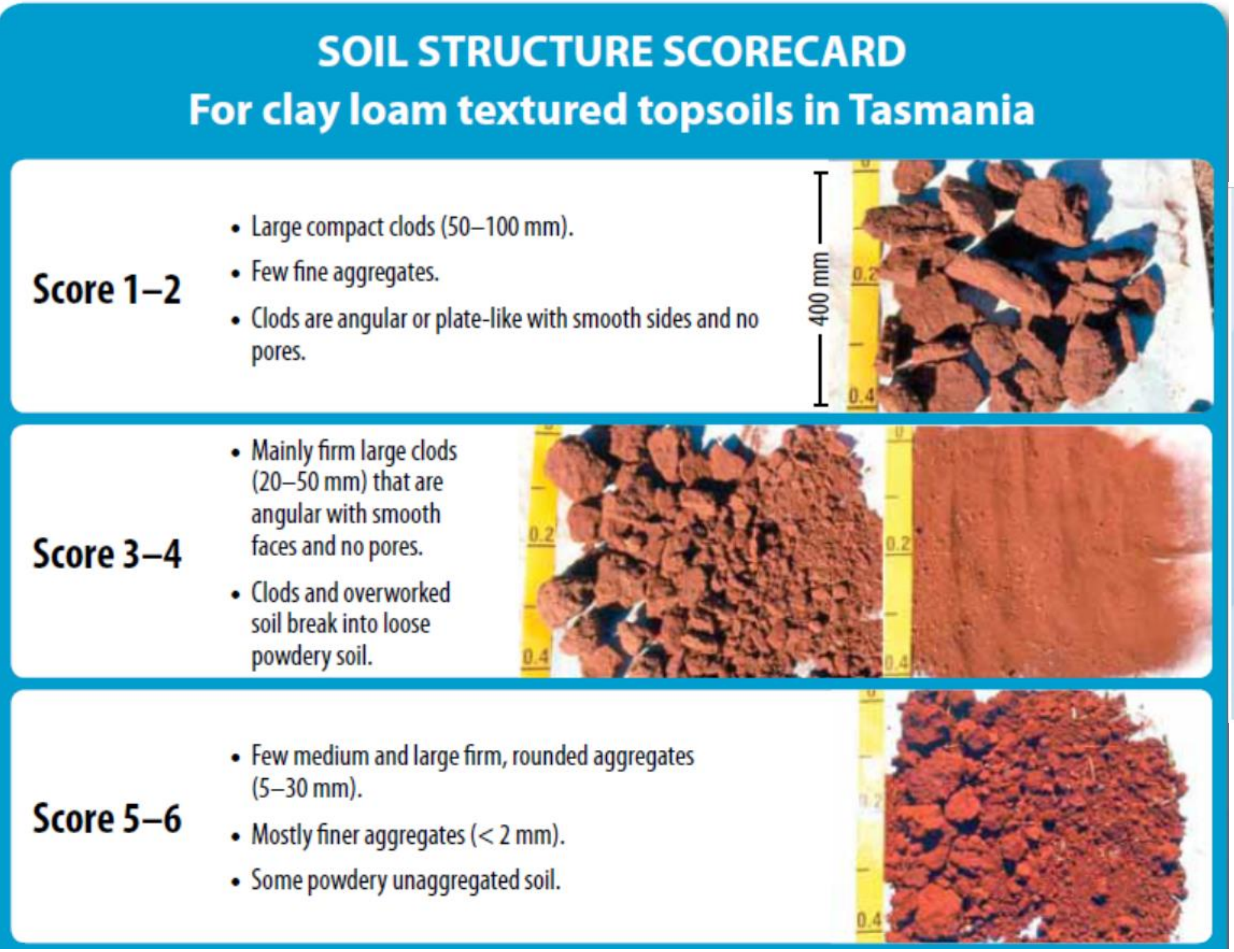
Measuring soil health

- Chemical, physical and biological properties
- Often looked at separately
- But these properties are interconnected
- Look, dig, feel, smell, measure

Figure 1: Assess soil structure by digging holes.

From: Cotching, Soil Quality Pty Ltd, 2019.

Measuring soil health – physical properties

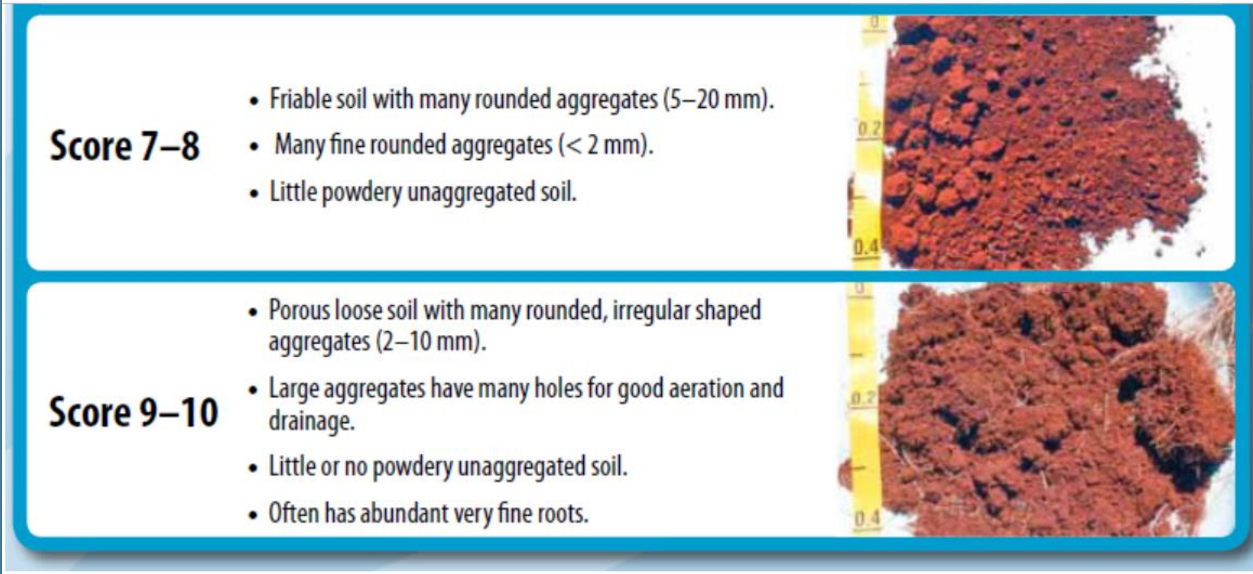


SOIL STRUCTURE SCORECARD
For clay loam textured topsoils in Tasmania

Score 1–2
- Large compact clods (50–100 mm).
- Few fine aggregates.
- Clods are angular or plate-like with smooth sides and no pores.

Score 3–4
- Mainly firm large clods (20–50 mm) that are angular with smooth faces and no pores.
- Clods and overworked soil break into loose powdery soil.

Score 5–6
- Few medium and large firm, rounded aggregates (5–30 mm).
- Mostly finer aggregates (< 2 mm).
- Some powdery unaggregated soil.



Score 7–8
- Friable soil with many rounded aggregates (5–20 mm).
- Many fine rounded aggregates (< 2 mm).
- Little powdery unaggregated soil.

Score 9–10
- Porous loose soil with many rounded, irregular shaped aggregates (2–10 mm).
- Large aggregates have many holes for good aeration and drainage.
- Little or no powdery unaggregated soil.
- Often has abundant very fine roots.

From: Cotching, Soil Quality Pty Ltd, 2019.

http://soilquality.org.au/factsheets/soil-structure

Topography and landscape influence – N. Scottsdale

Preplant

Harvest

- Hill (1/20 plots with pink rot)
- Base (5/20 plots with pink rot)

Topography and landscape influence – Cuckoo

Unsuitable planting site – boggy

Topography, soil depth and quality – Sisters Creek

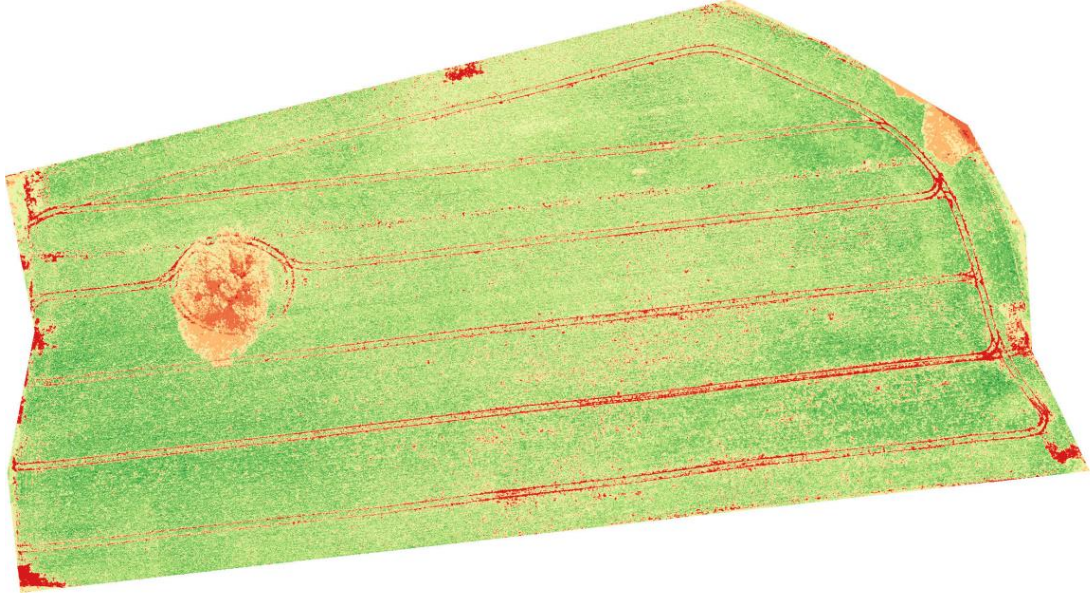
Site No.	Landscape position	Topsoil depth (cm)	Soil structure score	Soil order
1	flat (concave)	32	5-6	Ferrosol
2	midslope (convex)	28	8	Ferrosol
3	crest (convex)	26	5-6	Ferrosol
4	flat (concave)	40	8	Ferrosol
5	hillslope	27	5	Ferrosol
6	headland (near gate)	25	3-4	Ferrosol

- Topsoil depth/slope and soil structure a useful guide for assessing where pink rot is likely to occur
- Typified by disease in headland etc..

Topography and soil depth – Sisters Creek

34 DAP

118 DAP



- Greater topsoil depth (22-26cm)

less topsoil, high slope (18cm)

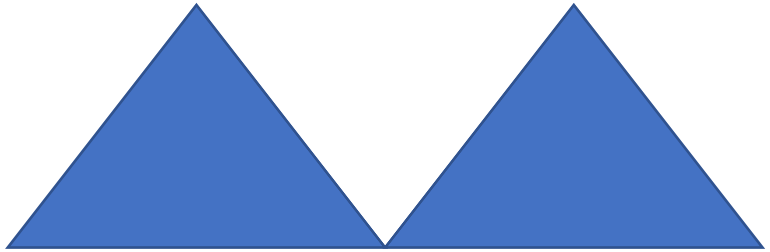
Pathogen identified in early December; PreDicta Pt; in slope area

Pink rot disease was more related to topography – earlier dieback

Images Supplied – Ed Blanchard - Simplot

Mound (Hill) depth consistency and orientations

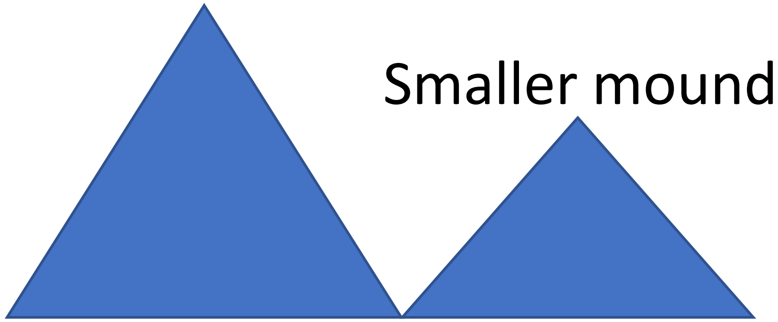
Equal consistent twin rows



Less likelihood of pink rot

Inconsistent twin rows

Smaller mounds



Greater likelihood of pink rot

Orientation changes in rows

Rows 90° to each other

Greater likelihood of pink rot from where downward rows cross into headland rows.

Some key disease findings from field trials

- Soil water and topography is obviously a key issue but other soil factors important:
  - Topsoil depth
  - Topsoil quality (fit for purpose)
  - Ca and pH (maybe less important)

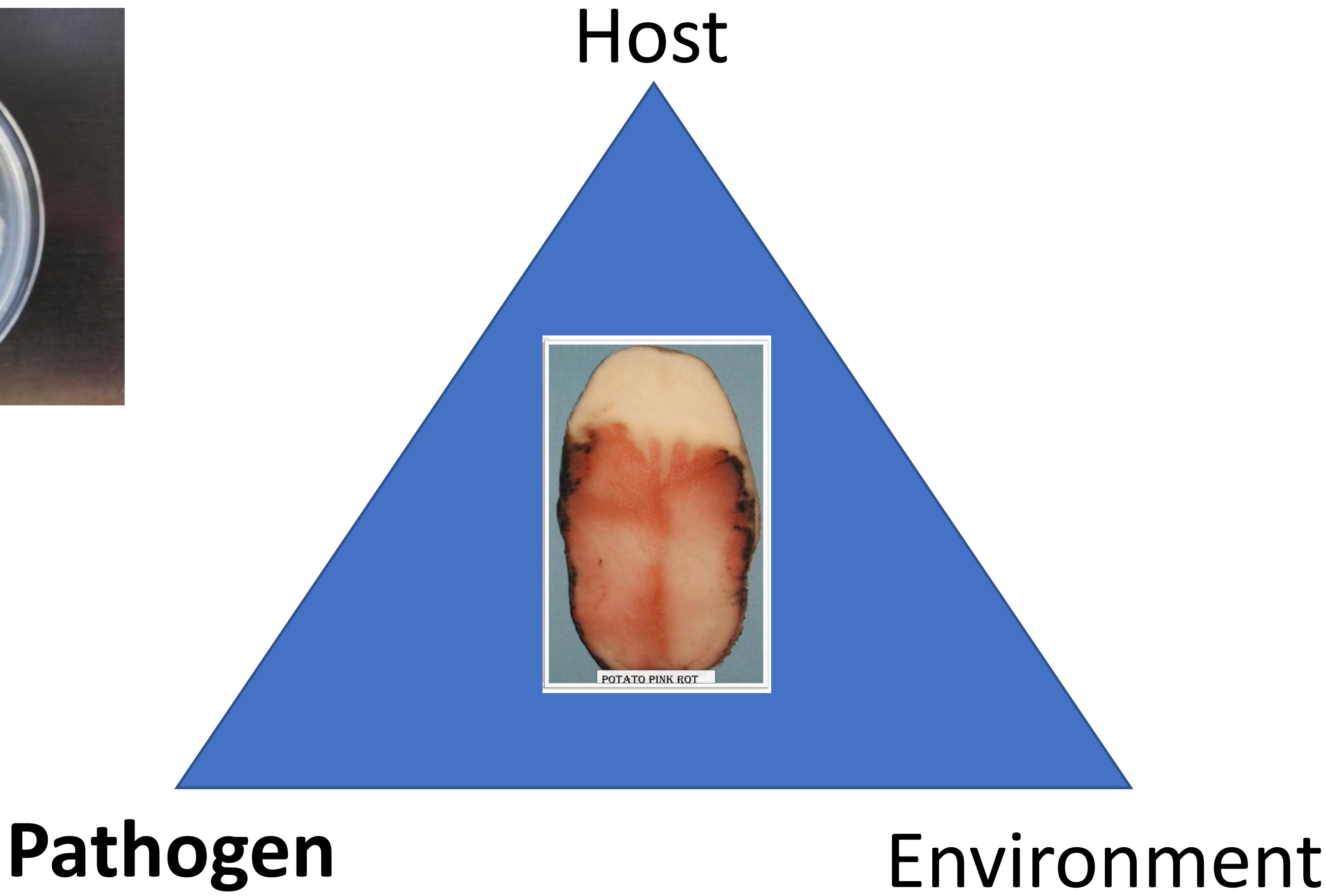
- Other physical interactions
  - Irrigator/tractor run damage - ↑ likelihood of pink rot
  - Wind damage - ↑ likelihood of pink rot
  - Headland damage (compaction) - ↑ likelihood of pink rot
  - Mould depth and orientations

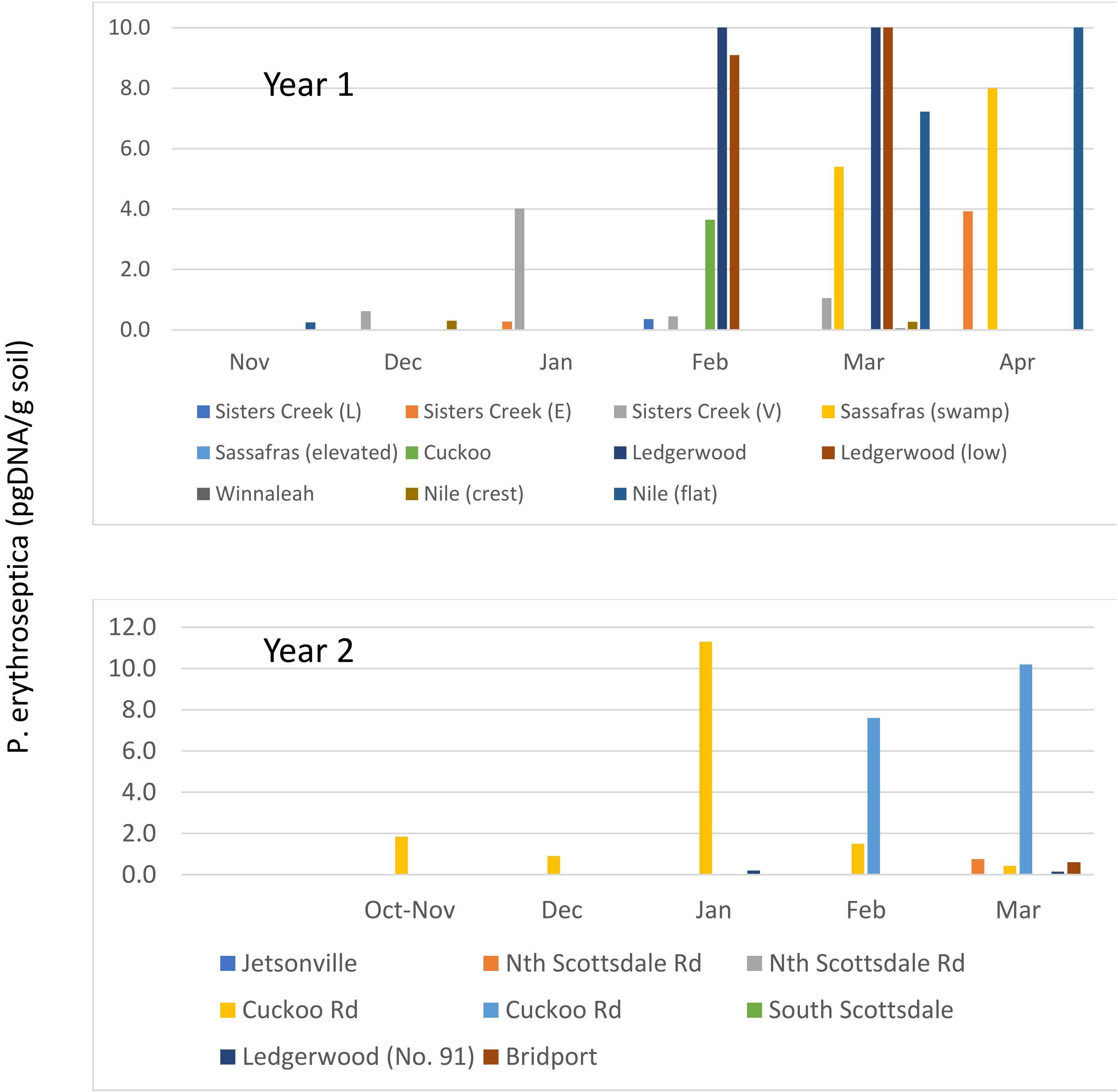
- Some factors can be controlled (irrigation), some we can't (rainfall)

Pathogen detection – Phytophthora erythroseptica

Detection (PreDicta Pt) from soil:

- Sampling density
- Environmental impacts
- Useful risk assessment

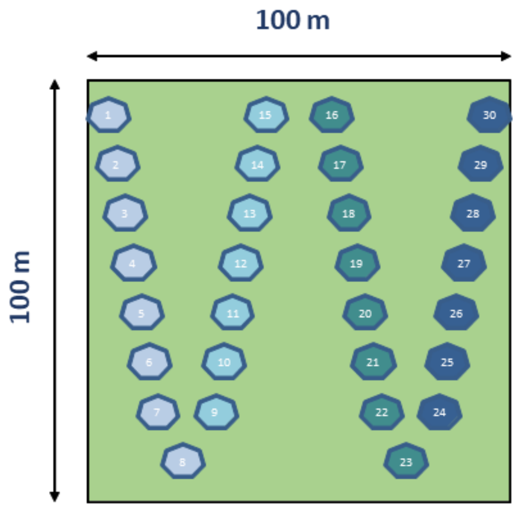


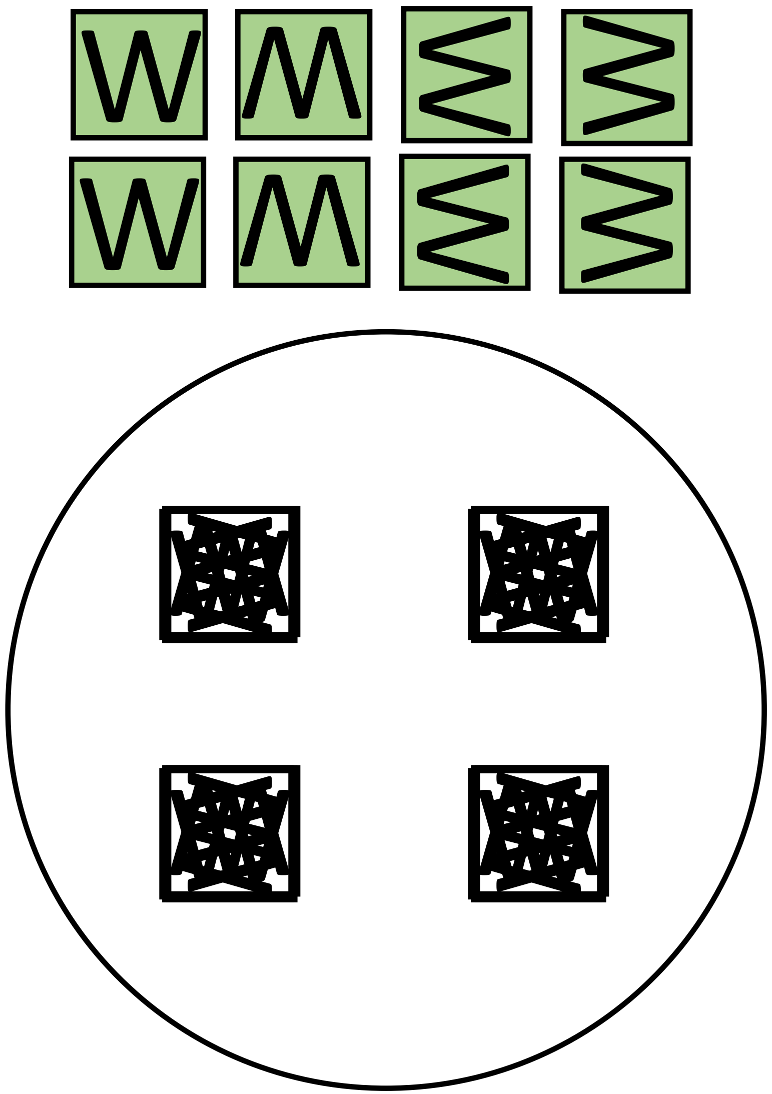


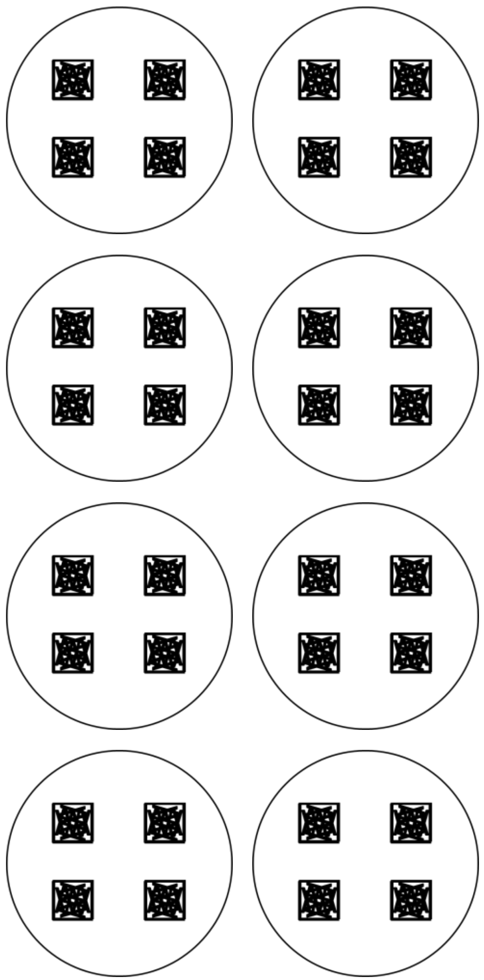
- Pre-plant soil-borne inoculum detection is extremely difficult
- Important levels may be below detection limit
- Inoculum levels dynamic through season
- Sampling strategy (where and when) will be critical

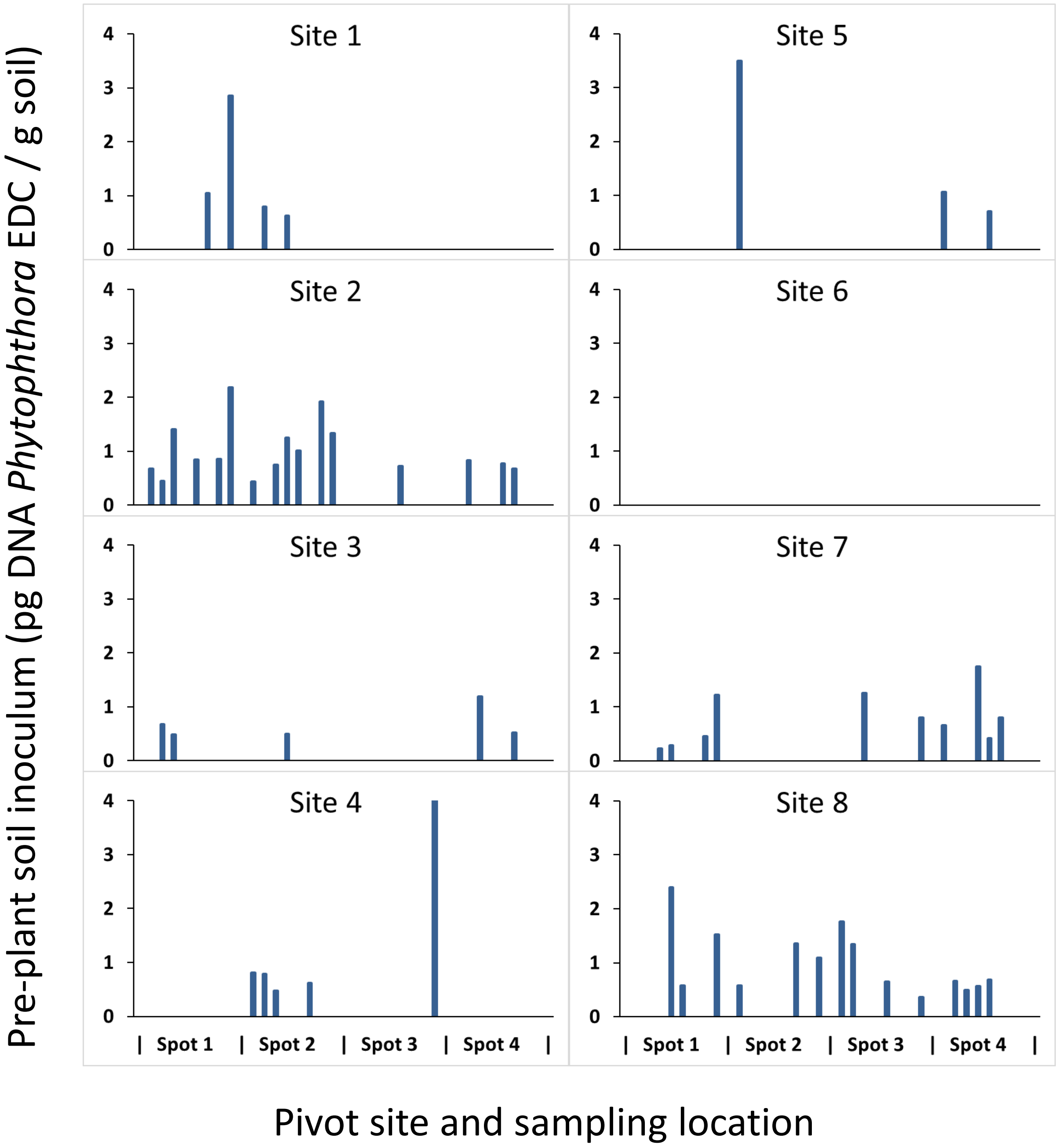
Individual test
PREDICTA Pt sampling

30 cores (1 cm by 15 cm)
Approximately 500g







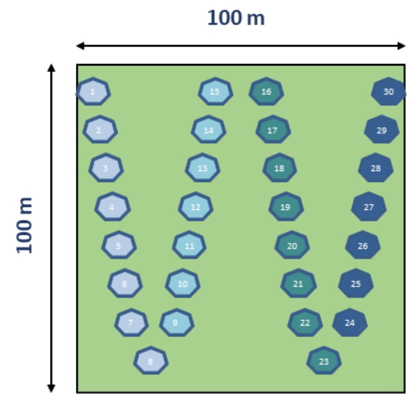


Intensive sampling required when low levels of inoculum can pose a substantive disease risk

Samples required in a paddock for detection at varying degrees of confidence		
80%	90%	95%
7	10	12

Current PREDICTA Pt sampling advises 4 samples in a paddock larger than 10 ha

Research gap - Optimising detection of P. erythroseptica for improved risk detection

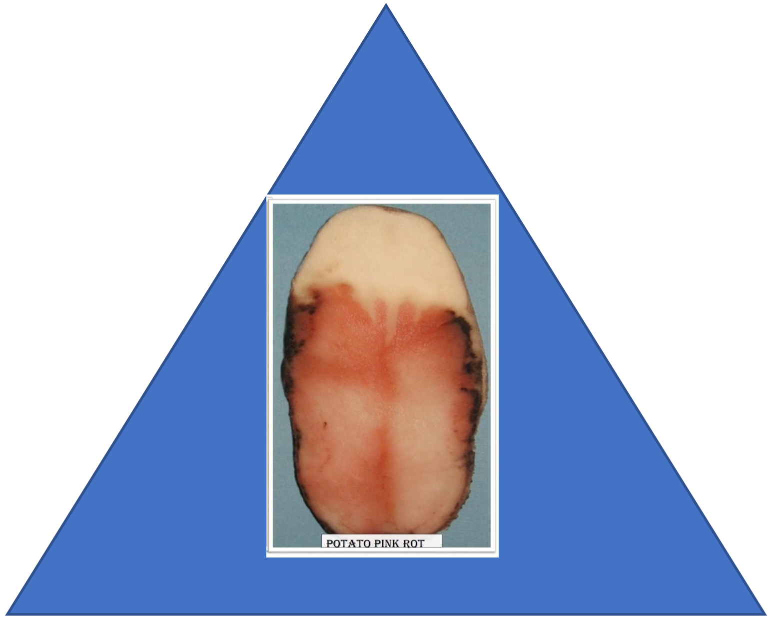


What is the best soil sampling density, what is economical

When is the best time to sample (seasonal)

Should we enrich the soil sample

Host



Pathogen

Environment

Research gap - Alternate hosts and volunteers

- What other crops/weeds/pasture species support the full lifecycle of P. erythroseptica

- Carrots/cereal/ryegrass
  - But are these true hosts that will exacerbate pink rot in a subsequent potato crop??

- Volunteers – why have a rotation gap if we can't control volunteers
  - A major issue in cool temperate areas

Interactions (with other pathogens)

Root galling (Spongospora)

Pink rot (Phytophthora)

Sclerotinia

Rhizoctonia (canker)

Issues – symptom identification and multiple rot interactions

Textbook symptoms

Research gap
- understanding pathogen interactions

- Powdery scab (weakened root system) - ↑ likelihood of pink rot
- Rhizoctonia (aerial tubers/canker) - ↑ likelihood of pink rot
- Sclerotinia (stem damage) - ↑ likelihood of pink rot
- Likely to be interactions with other pathogens:
  - e.g. Nematodes, Verticillium, black dot …..etc,..
- Rot interactions (bacterial/water rots) with pink rot

Searching the literature

Table 21.1 The major fungal and fungal-like soilborne pathogens and diseases of potato and the number of articles that studied these pathogens/diseases in the decade 2011–2021

Potato pathogen species	Disease	Number of WoS articles (2011–2021)[a]
Colletotrichum coccodes	Black dot	53
Fusarium spp.	Fusarium dry rots	85
Helminthosporium solani	Silver scurf	41
Phytophthora erythroseptica	Pink rot	26
Pythium ultimum var. *ultimum*	Leak	22
Rhizoctonia solani	Black scurf/stem canker	117
Sclerotium rolfsii	Stem rot	33
Spongospora subterranea	Powdery scab (PMTV vector)	98
Synchytrium endobioticum	Wart	35
Verticillium dahliae and *V. albo-atrum*	Verticillium wilt	184

[a]Number of articles was determined using Web of Science search for disease and/or pathogen in title and/or abstract from 2011 to 2021

Limited active research on many soilborne diseases, especially pink rot

Most on fungicide resistance (USA)

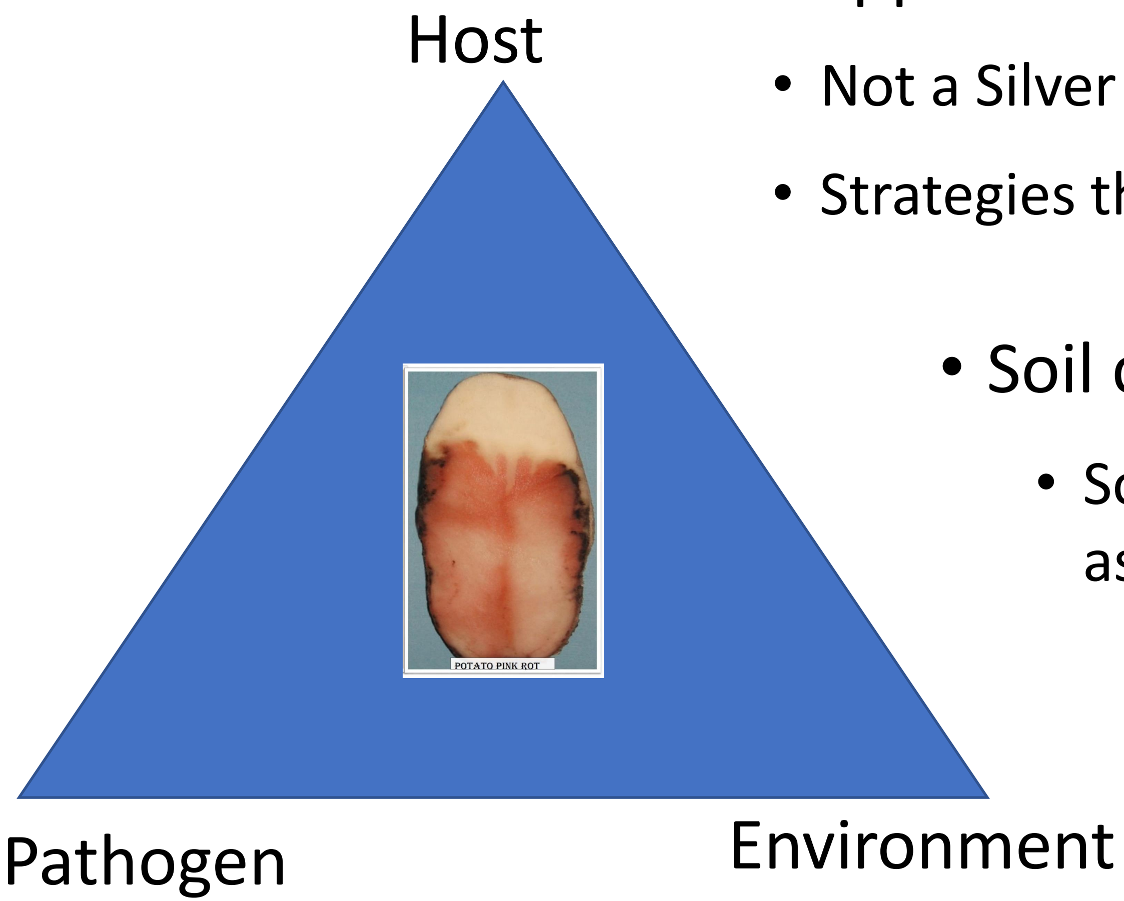
Summary – further R&D needs

Improved detection and management of pink rot

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

Understanding interactions between soil-borne potato diseases, physical factors and disease management practices

Conclusions



- Ca applications/pH modification for pink rot control
  - Not a Silver bullet
  - Strategies that provide insight into soil health are still useful.

- Soil characterisation/site analysis
  - Soil quality/landform/slope/aspect associated with pink rot in some cases.

- Identified many research gaps and opportunities for future investment