SoilWealth | ICP
nurturing crops · protecting crops

The role of soil DNA and traditional pathology.

– how is it being used and what can it do for you?

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Hort Innovation
ahr applied horticultural research
RMCG

Soilborne disease diagnostics

Traditional **Molecular**

Traditional	Molecular
Strengths	**Strengths**
Can identify wide range pathogens / disorders	Highly specific
Does not always require specialist equipment	Quantification (including beneficials)
Can incorporate other factors	Test for many pathogens at once
Limitations	**Limitations**
Requires knowledge, experience and skill	Requires specialist equipment
Time consuming and soilborne diseases can be challenging	New pathogen tests require validation (long process)
Accuracy	Relies on accuracy and availability of DNA sequence for pathogens

Investigative

Post mortem to inform future decisions

Predictive (risk)

Inform decisions to avoid a post mortem

Investigative diagnostics – Uses

- **New problem**
  - ❑ **Identification of cause**

- Problem that increasing
  - ❑ Identification of cause
  - ❑ Assessment of resistance to controls

- Industry unsure or questioning the cause

- Identification required for regulatory/market reasons

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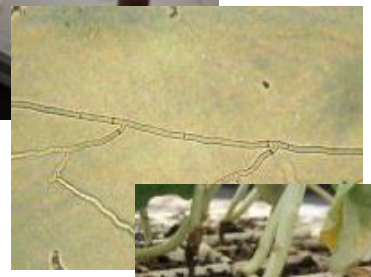
Investigative diagnostics the process

Visual examination

Microscopic observation / Test kits

Isolation of pathogen



Identification

Pathogenicity test

(Nematodes are normally quantified)

What pathogens are in this root system?

Pathogen	Disease
Plasmodiophora brassicae	Club root
Rhizoctonia solani (AG 2.1, 4)	Rhizoctonia
Plasmodiophora brassicae	Club root
Verticillium dahliae	Verticillium wilt
Leptosphaeria maculans	Blackleg
Pythium (Clade F, Clade I)	Pythium
Pratylenchus spp.	Root lesion nematodes
Meloidogyne spp.	Root knot nematodes

Report on pathogen levels

Pathogen	Disease	Detection	
Plasmodiophora brassicae	Club root	High	9780126 kDNA
Rhizoctonia solani (AG 2.1)	Rhizoctonia	High	27711 pgDNA
Rhizoctonia solani (AG 4)	Rhizoctonia		Below detection
Verticillium dahliae	Verticillium wilt		Below detection
Leptosphaeria maculans	Blackleg	High	20408 pgDNA
Pythium (Clade F)	Pythium	Low	54 pgDNA
Pythium (Clade I)	Pythium	Mod	1043 pgDNA
Pratylenchus spp.	Root lesion nematodes		Below detection
Meloidogyne javanica/incognita/arenaria	Root knot nematodes	Low	14 pgDNA

Investigative diagnostics – Utilisation

- Most state agencies and several specialist laboratories offer diagnostic services
- Most samples from commercial horticulture operations are the difficult ones or disease complexes
- Critical part of research and development projects

If do not know the cause and contributors to risk – how can it be managed

Disease risk assessment – Uses

Testing services

- Identify disease risk prior to planting
- In crop monitoring
- Assess storage potential
- Monitor impact changed practices

Identify disease risk prior to planting

Traditional

- Seed testing
- Soil baiting
- Water testing
- Nematode counts
- Sieving / Floatation / Extraction and quantification
- Bioassay

Low availability of disease risk assessment based on traditional techniques

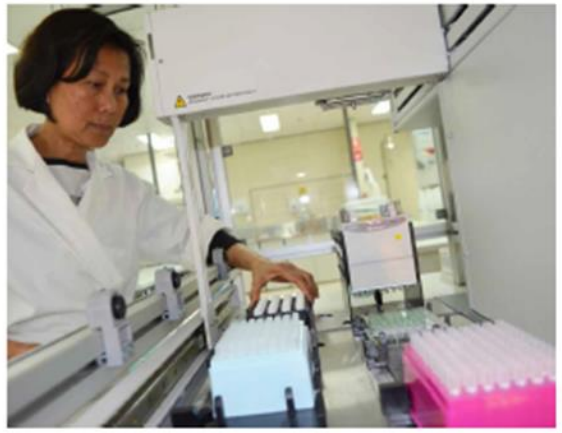
Exception is pre-plant nematode testing

- Established techniques for nematode counting
- Established relationships between pre-plant nematode population and risk of crop damage

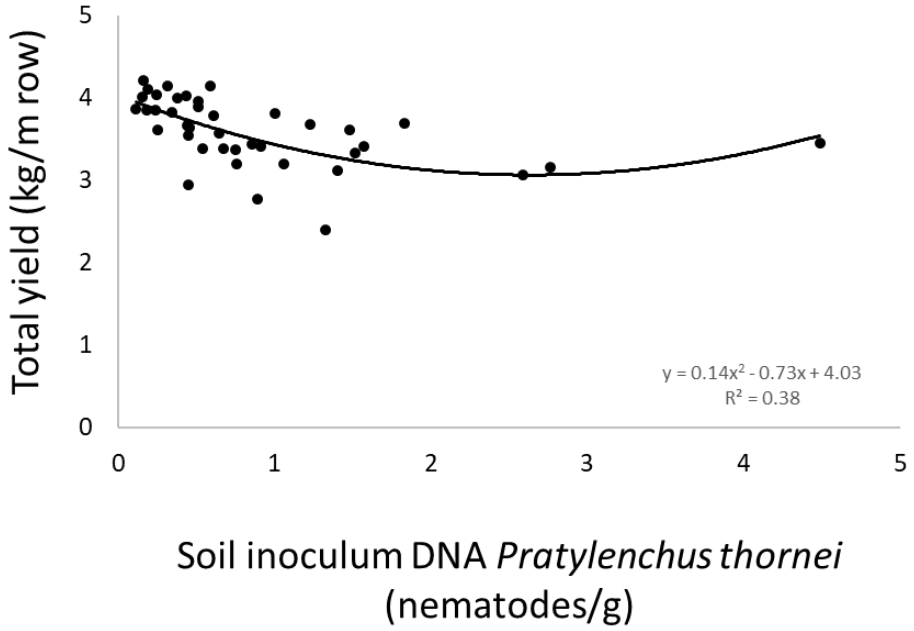
Identify disease risk prior to planting

Molecular

- Relatively fast
- High throughput
- Assess multiple targets
- Quantitative



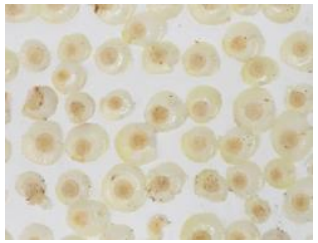
Identify disease risk prior to planting



Yield loss in carrots

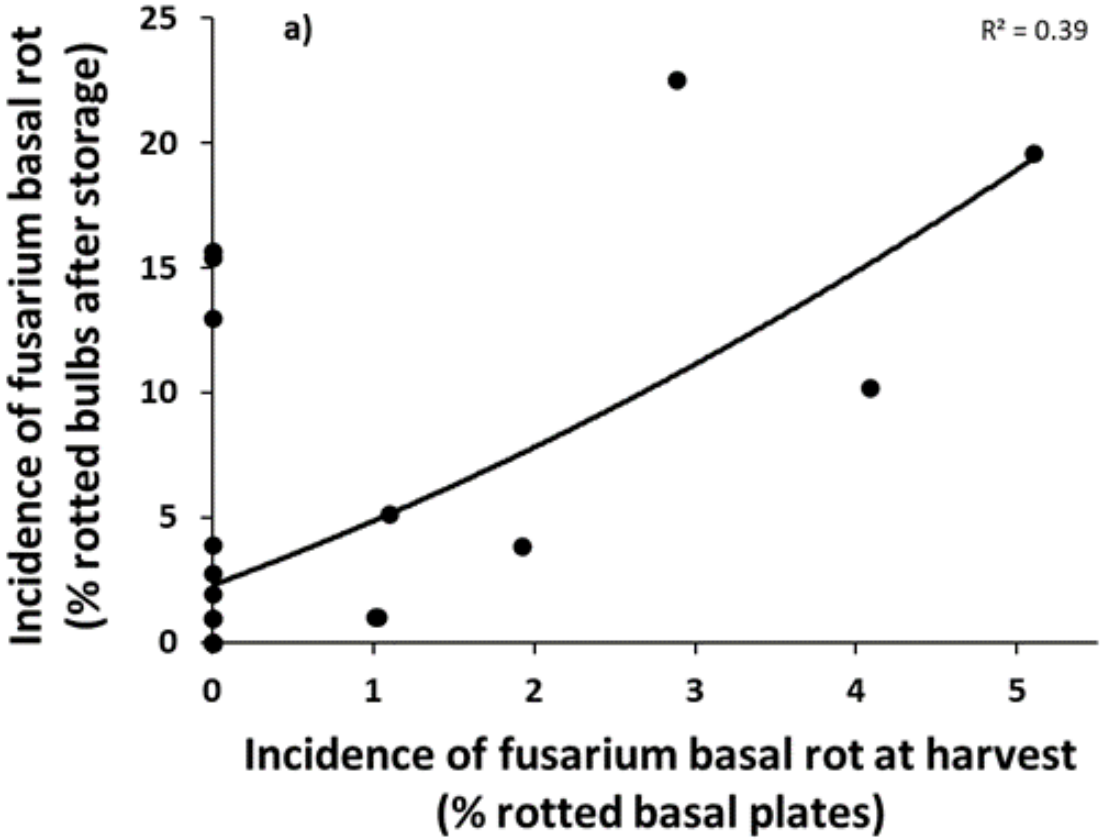
Relatively low populations of root lesion nematodes associated with loss of yield

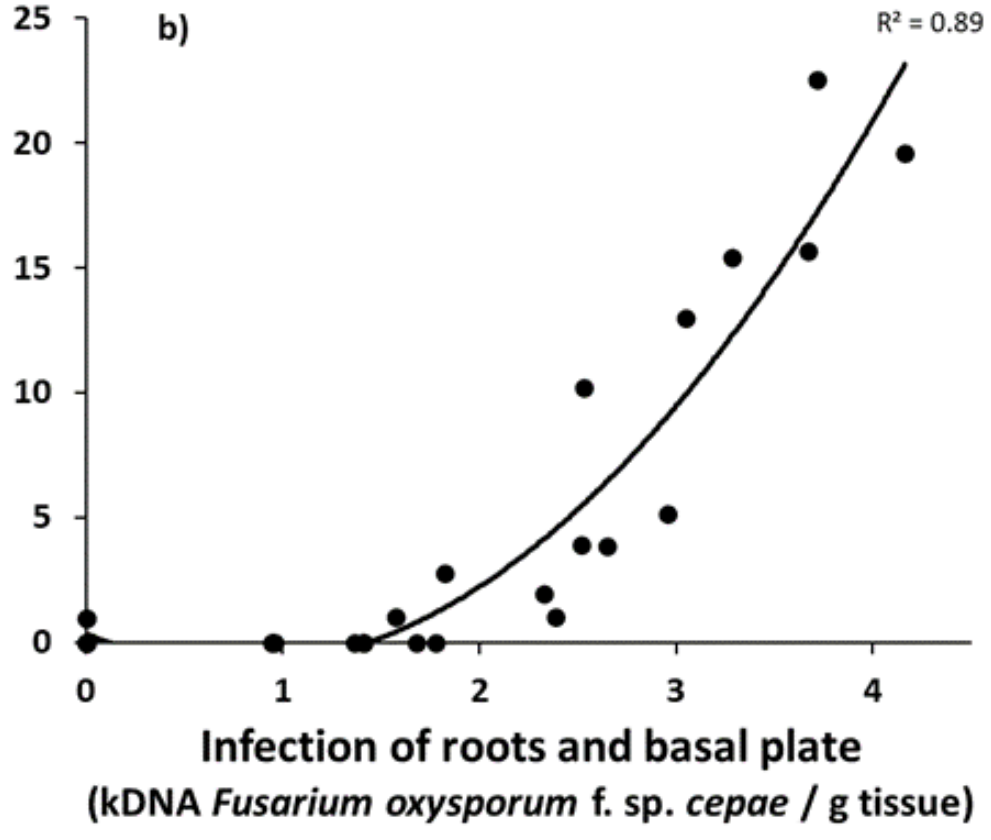
Assess storage potential



Visual observation

DNA testing





What can we detect – Hort Veg DNA tests

NEMATODES	FUNGI	BACTERIA	OTHER
Root knot (5 species)	***Rhizoctonia* (5 tests)**	***Streptomyces* (1 test)**	***Plasmodiophora* (1 test)**
Root lesion (5 species)	***Pythium* (4 tests)**		
Stem (1 species)	**Other (10 species)**		
Free living (15 tests)	**Beneficial (8 tests)**		

Tests relevant to vegetable industry

http://www.pir.sa.gov.au/research/services/molecular_diagnostics

Commercial service - Potato

PREDICTA Pt
DNA Soilborne disease tests

Molecular Diagnostic Centre
Gate 2A, Hartley Grove
URRBRAE SA 5064
P 08 8429 2284

Sample: APA

Grower:
Paddock:
Sample point:
Nearest town:

Report date:
Date sampled:
Dry weight (g): **436**
Sample condition: **Damp**
Sample no.: **1 of 1**
Sample taken: **Pre-plant Not cultivated**
Order No.:

Paddock history **Years since last potato crop** **5 Years**

TEST	RESULT		DISEASE RISK* Not Detected / Low / Med / High
Colletotrichum coccodes	2.0	log(pg DNA/g soil)	
Verticillium dahliae	<0.1	log(pg DNA/g soil)	
Spongospora subterranea	1.5	log(pg DNA/g soil)	
Meloidogyne fallax	2.3	log(pg DNA/g soil)	
Meloidogyne javanica/incognita/arenaria	<0.1	log(pg DNA/g soil)	

*Risk categories should be used as a guide only, may be subject to regional and seasonal differences, and may be revised over time.

UNDER EVALUATION

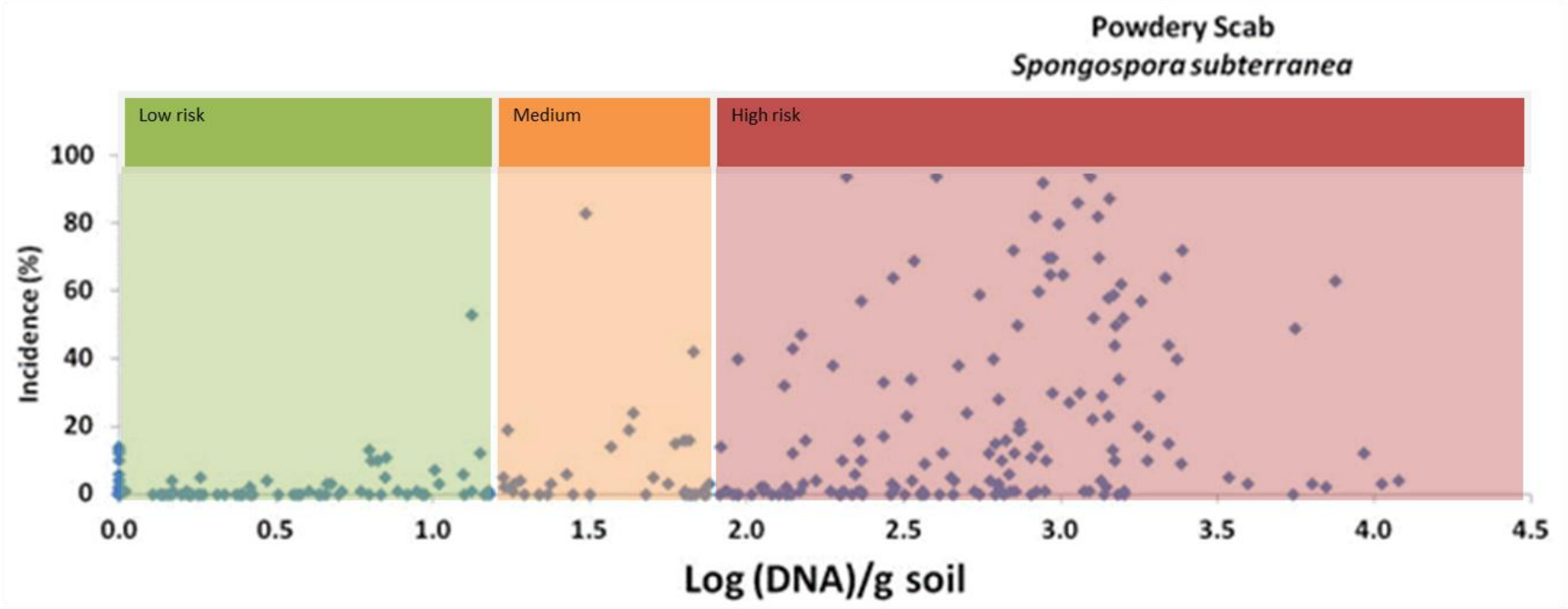
TEST	RESULT		POPULATION DENSITY** Not Detected / Low / Med / High
Helminthosporium solani	<0.1	log(kDNA copies/g soil)	
Rhizoctonia solani AG2.1	1.5	log(pg DNA/g soil)	
Rhizoctonia solani AG3	<0.1	log(pg DNA/g soil)	
Rhizoctonia solani AG4	<0.1	log(pg DNA/g soil)	
Sclerotinia sclerotiorum/S. minor	0.5	log(kDNA copies/g soil)	
Phytophthora erythroseptica	<0.1	log(kDNA copies/g soil)	
Pythium clade I	0.4	log(pg DNA/g soil)	
Streptomyces txtA gene	<0.1	log(pg DNA/g soil)	
Pratylenchus crenatus	<0.1	nematodes/g soil	
Pratylenchus neglectus	1.2	nematodes/g soil	
Pratylenchus penetrans	<0.1	nematodes/g soil	
Meloidogyne hapla	<0.1	log(pg DNA/g soil)	

**Population densities are based on the pathogen levels detected in PREDICTA samples across the potato industry. These are not disease risk categories.

Commercial service

PREDICTA Pt
DNA Soilborne disease tests

Relating pre-plant soil DNA levels to disease incidence



PREDICTA Pt
DNA Soilborne disease tests

Understand drivers of disease

Apply management to reduce risk

Disease: Powdery Scab
Causal Agent: *Spongospora subterranea*

Powdery Scab

Lower	Risk of powdery scab	Higher
Soil temperature > 15°C at tuber initiation	Environment	Soil temperature 12-13°C at tuber initiation
		High soil moisture
		Extended tuber initiation period
Paddock never grown potatoes	Management	Last potato crop infected
Long rotation		Persistence of blackberry nightshade
Absence of hosts		Persistence of volunteer potatoes
		Poor drainage and/or soil compaction
		Frequent cycles of wet and dry
Variety with resistance	Variety	Highly susceptible variety
Below detection	Pathogen level SOIL	Medium to high
Low	Pathogen level SEED	High

• Greater importance should be placed on highlighted text.

What do you do with the results?

- Paddock selection
- Crop scheduling
- Varieties
- Paddock and crop rotation
- Cover crop selection
- Soil amendments
- Irrigation
- Crop nutrition
- Fallowing
- Bio-fumigation
- Chemical treatments

Additional information to inform, assess and refine disease management strategies

To minimise cost soilborne diseases

Growers need to:

- Know which pathogens pose significant risk
- Have management options
- Implement strategy before planting crop

Management of most soilborne diseases requires that decisions are made and implemented prior to planting