Testing for seedborne and soilborne pathogens

POTATOES

PREDICTA Pt
DNA Soilborne disease tests

How PREDICTA®Pt can support your disease risk management decisions

Hort Innovation

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SARDI
SOUTH AUSTRALIAN RESEARCH AND DEVELOPMENT INSTITUTE

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Disclaimer
The information in this manual is only intended to be general background technical information to support the awareness of **PREDICTA®Pt** testing in the potato industry. It is not intended to be exhaustive and readers may need to refer to other technical literature and information and/or seek independent professional advice.

While we have made every effort to ensure that the information is accurate and up to date at the time of preparation, we do not warrant or make any representation regarding the use, or results of the use, of the information contained herein as regards to its correctness, accuracy, reliability and currency or otherwise.

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Overview

Soilborne and seedborne diseases pose a significant risk to potato cropping in Australia. They cause yield losses and downgrading or rejection of harvested product.

Most decisions to reduce the risk of soilborne and seedborne diseases need be made before the crop is planted. This means the pathogens that pose a significant risk to the crop must be identified before this time.

SARDI offers the PREDICTA®Pt service to identify disease risk using DNA-based tests for major soilborne and seedborne pathogens and parasitic nematodes that affect potatoes. PREDICTA®Pt test results can help growers make informed decisions to manage multiple diseases and get the best result possible out of the paddocks and varieties grown.

Know before you plant

- Pre-planting soilborne disease assessment is critical to make informed decisions, implement cost-effective disease control strategies and reduce potential losses.
- Crop loss from soilborne disease can be substantial. Soilborne diseases can cause crop failure resulting in substantial financial loss as well as failure to supply the market.
- Knowing the level of risk and being able to monitor changes in this risk through cropping cycles provides the greatest opportunity to manage soilborne diseases successfully.

Soilborne and seedborne pathogens and diseases

Soilborne and seedborne diseases can have a serious impact on potato quality and yield. Productivity losses can occur through:

- Lower yields
- Reduced marketability
  - Downgrading and reduced packout
  - Increased wastage
  - Rejection of seed for certification
- Longer rotations required
- Reduced variety options
- Increased input requirements
- Limited water and nutrient uptake

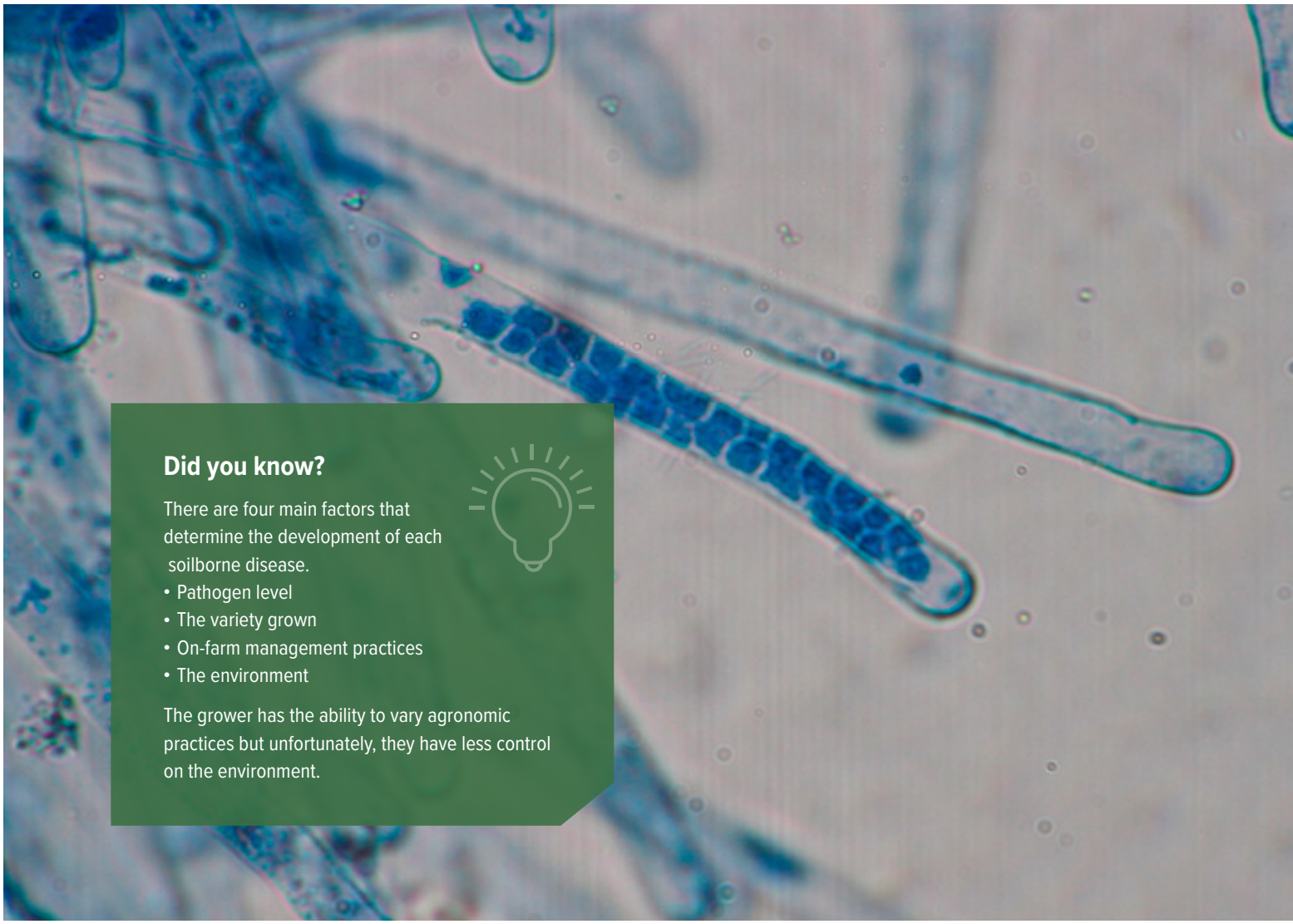
The pathogens that cause soilborne diseases survive in the soil and seed waiting to infect potato crops. For some pathogens, the quantity of inoculum in the soil and/or seed is strongly related to disease risk.

Definitions

PATHOGEN – organism (e.g. plant parasitic fungus, bacteria or nematode) that infects plant to cause disease

INOCULUM – parts of pathogen that reside in the soil or on seed and can infect plants or tubers

DISEASE – expression of symptoms that negatively affect yield and/or quality of potato crop (i.e. symptoms caused by the pathogen)



Did you know?

There are four main factors that determine the development of each soilborne disease.

- Pathogen level
- The variety grown
- On-farm management practices
- The environment

The grower has the ability to vary agronomic practices but unfortunately, they have less control on the environment.

PREDICTA®Pt fast facts

Did you know PREDICTA®Pt testing can ...

- ✓ Detect low levels of specific pathogens in soil or on seed (or other sample types)
- ✓ Quantify specific pathogens in a sample
- ✓ Test multiple pathogens on the same sample
- ✓ Deliver sample results relatively quickly when compared to traditional inoculum measurement techniques
- ✓ Quantify pathogen levels both prior to planting and at any stage of the cropping cycle

PREDICTA®Pt allows growers and advisers to:

- ✓ Conduct pre-plant assessments of disease risk
- ✓ Conduct in-crop testing of soil or plant samples
- ✓ Monitor and understand pathogen level changes in cropping systems
- ✓ Evaluate management practices and their effect on pathogen inoculum levels
- ✓ Investigate causes of disease
- ✓ Select on-farm trial sites
- ✓ Improve outcomes and knowledge gain from on-farm trials
- ✓ Implement better management decisions, such as seedlot and variety selection
- ✓ Minimise losses from soilborne disease

PREDICTA®Pt pathogen testing

Growers can use PREDICTA®Pt to understand pathogen levels.

PREDICTA®Pt testing can provide an indication of the risk or probability of some soilborne diseases occurring. This is possible for pathogens where the inoculum level in the soil or on seed – measured as the concentration of DNA by PREDICTA®Pt – is strongly linked to the likelihood of disease occurring. Higher levels of DNA indicate higher levels of disease risk.

PREDICTA®Pt test results can tell a grower which diseases are of greatest concern, allowing a suitable management plan to be implemented which considers variety choice, seed selection, rotations, crop agronomy, chemical management, tolerance of the market or whether or not to even plant a specific paddock.

Testing allows growers to optimise paddock management to minimise current and future productivity losses.

Disease risk thresholds

Establishment of disease risk thresholds requires field validation of the probability of disease occurring at different levels of inoculum in the soil and/or seed for a specific variety and production environment.

- At low or non-detectable levels of inoculum, the risk of disease is low.
- At high levels of inoculum, occurrence and severity of disease depends on susceptibility of the variety, conduciveness of the environment and effectiveness of management options applied.
- High levels of inoculum do not mean disease will occur, but that there is a high risk if conditions are favourable for disease development.

If available, disease risk categories should be used as a general guide only. Other factors such as climate, management practices, soil type, variety and seasonal conditions should be considered in interpreting PREDICTA®Pt results and assessing disease risk.

After repeated use of PREDICTA®Pt tests within a cropping system, patterns observed in pathogen levels and disease occurrence can be used to refine interpretation.

Population density categories

Risk categories have not been established for all pathogens that are reported. Tests without a risk category are reported with a population density to benchmark to other potato paddocks or seedlots. Population densities are based on the distribution of pathogen levels detected in PREDICTA®Pt samples over several years. They are not disease risk categories.

Interpretation of disease risk is not available for all tests.

For some pathogens, the level of inoculum that poses a disease risk is lower than what can be detected. PREDICTA®Pt testing is not a useful tool for assessing the risk of disease for these pathogens.

These tests can still be powerful tools for monitoring and decision making as they provide quantitative data on pathogen levels in cropping systems where infection and/or disease is occurring. Some examples of this include providing early warning of pathogen build-up and infection in a crop, assessing rotation crops as non-host break crops and evaluation of management strategies on infection levels and changes in inoculum.

What PREDICTA®Pt testing does not do

PREDICTA®Pt testing does not:

- Indicate the presence of pathogens that are not specifically included in testing. For example, *Fusarium oxysporum* will not be detected, as a test has not been developed for that pathogen
- Confirm whether disease will occur, as pathogen inoculum will only cause disease if conditions are favourable
- Confirm the disease will not occur, as a pathogen below detection limits may still cause disease if the conditions are favourable

Pathogen DNA tests

PREDICTA®Pt Soil

Provides a risk assessment for:

- Powdery scab
- Black dot
- Root-knot nematode
- Verticillium wilt

PREDICTA®Pt Peel

Provides a risk assessment for:

- Common scab
- Silver scurf
- Rhizoctonia

Tests without a risk category are reported with a population density to benchmark to other potato paddocks or seedlots.

TABLE 1: Pathogen DNA tests reported by PREDICTA®Pt Soil and Peel services

	Pathogen	Disease
Fungi	*Colletotrichum coccodes*	Black dot
	Helminthosporium solani	Silver scurf
	Rhizoctonia solani AG2.1	Rhizoctonia
	Rhizoctonia solani AG3	
	Rhizoctonia solani AG4	
	Sclerotinia sclerotiorum, S.minor	Sclerotinia stem rot
	Verticillium dahliae	Verticillium wilt
Oomycetes	*Phytophthora erythroseptica, P. crytogea, P. dreschleri*	Pink rot
	Pythium clade I	Leak rot
Phytomyxea	*Spongospora subterranea*	Powdery scab
Bacteria	*Streptomyces* txtA gene	Common scab
Nematodes	*Meloidogyne arenaria, M. incognita, M. javanica*	Root-knot nematode
	Meloidogyne fallax	
	Meloidogyne hapla	
	Pratylenchus crenatus	Root lesion nematode
	Pratylenchus neglectus	
	Pratylenchus penetrans	

List is subject to change – for updated list and other available pathogen DNA tests
https://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_pt

New PREDICTA®Pt tests only become available after a process of test design and verification

Additional tests available

Potato cyst nematode
PREDICTA® technology can quantify the level of golden potato cyst nematode (*Globodera rostochiensis*) and pale potato cyst nematode (*Globodera pallida*) in samples.

Soil health
PREDICTA® technology can quantify the level of Free Living Nematodes (FLN) in the soil that can be used to monitor soil health.

Types of samples that can be tested

Soil

Soil is the most common sample type tested by PREDICTA®Pt.

Soil samples weighing up to 500 grams (dry weight) can be tested.

Peel

Peel samples weighing up to 250 grams (fresh weight) can be tested.

Plant tissue

- Specialist testing of plant tissue samples is available.
- Testing can include plant root systems, plant stem sections and peels.

Discuss options, sample preparation and handling with the laboratory before sampling.

Sampling for PREDICTA®Pt testing

Correct sampling is critical to obtaining meaningful results from PREDICTA®Pt soil and seed DNA testing

Pathogens are not evenly distributed throughout paddocks and seedlots. Inadequate sampling will most certainly either overestimate or underestimate the level of pathogen inoculum in a paddock.

SARDI provides equipment, training and accreditation to agronomists to collect soil and peel samples for PREDICTA®Pt testing.

PREDICTA® Pt Soil corer

General sampling guidelines

Soil

Sample handling

- If the sample is moist, keep it cool (below 10°C) until dispatch.
- Deliver samples to the testing laboratory within 1-2 days.
- Avoid leaving samples in plastic bags exposed to the sun (i.e. on the dash board of a car or ute).

Individual samples

- Collect 30 individual cores using a soil corer with a 15 cm depth by 1 cm diameter tip (sample weight should not exceed 500 g if the correct corer tip used – avoid subsampling).
- Sample in W pattern across a 1 hectare area.
- Target productive cropping areas, avoiding the edge of paddocks, atypical small patches and low waterlogged areas or areas too close to trees.

Number of samples required per paddock

- The number of samples required per paddock depends on:
  - Size and shape of the paddock.
  - Variability of soils and conditions within the paddock.
  - Uniformity of past cropping history.
  - Differences in past disease incidence.
  - Pathogen that is the main target of sampling.
  - At least 4 sampling areas are recommended for paddocks over 10 hectares.
  - Sampling areas must be aligned with variations in soil conditions and past history.

Seedlots

Sample handling

- Seed tubers should not be washed.
- Sample prior to seed cutting.
- Whole seed can be stored at 4°C until peel preparation for sending.
- Peel samples must be sent in PREDICTA®Pt peel bags.
- Dispatch samples by overnight courier or Express Post on the day of preparation.
- PREDICTA®Pt peel samples must reach SARDI within 2–3 days.

Individual samples

- Collect 100 representative tubers per test.
  - For example, 10 tubers from each 10 separate bins/bags of seed.
- From each tuber, remove a 2 cm wide strip of peel 8–10 cm long.
  - Where possible, ensure the peel from each tuber includes the stolon end.
  - Obvious symptoms on tubers should be included (avoid taking extra peel from tubers that have observed symptoms).
- As a guide, total weight of fresh peel from 100 tubers should be between 150 and 225 grams.

Number of samples required per seedlot

- Each batch of seed (seedlot) must be sampled and tested individually.
- Minimum of two PREDICTA®Pt peel tests per seedlot.
- Additional tests are recommended for seedlots over 20 tonnes.

Did you know?

Targeted samples taken from a defined area can be used if soilborne diseases are suspected to be a problem at that location.

Important note

When using PREDICTA®Pt to enhance outcomes and findings from on-farm trials or ongoing monitoring of the cropping system, specific advice should be obtained on best sampling strategies to maximise the value of the data collected.

What actions can be taken based on test results?

Knowing the risk of soilborne and seedborne disease prior to planting maximises the range of management options available. It enables the implementation of a soilborne and seedborne disease management strategy appropriate to the level of risk.

Depending on the production system and environment, management options may include:

- Not planting in paddocks where risk is unmanageable
- Extending the length of the rotation
- Including non-host crops in the rotation
- Including a non-host cover crop in the rotation
- Choosing a tolerant or resistant variety
- Choosing or matching seedlots to avoid infecting clean paddocks
- Not planting seed where risk is unmanageable
- Appling seed treatments
- Adjusting planting depth or hill formation
- Applying in-furrow treatments
- Changing paddock scheduling to avoid growing in a high-risk timeslot
- Applying soil amendment before planting
- Applying mulch or organic matter
- Adjusting tillage practices
- Utilising growth promotants or biological products
- Applying soil treatment
- Optimising nutrition to lower disease risk
- Optimising irrigation to lower disease risk
- Improving drainage
- Adjusting harvest scheduling to lower disease risk
- Avoiding ground storage in high-risk paddocks
- Avoiding long term storage of tubers from high-risk paddocks and crops

Disease tests

- Powdery scab
- Black dot
- Root-knot nematodes
- Pink rot
- Verticillium wilt
- Silver scurf
- Common scab
- Rhizoctonia
- Root lesion nematodes
- Leak rot
- Sclerotinia stem rot

Powdery scab

Caused by the obligate parasite *Spongospora subterranea*

The disease causes scabby pustules on the tubers as well as root infection and galling on roots.

Impact

- Scabby pustules reduce the marketability of tubers.
- Root infections can reduce plant growth and yield.

Where damage is most likely

- Paddocks where powdery scab on tubers or root galling previously occurred.
- Poor control of volunteer potatoes and nightshade weeds between crops.
- Susceptible varieties grown.
- Cool wet conditions during crop establishment and tuber initiation.

Source of inoculum

- Soil inoculum is the main contributor to disease risk.
- The importance of soil inoculum level varies with conditions:
  - Where conditions are favourable, an initial low level of soil inoculum at planting can multiply through root infections to produce high inoculum levels by the critical tuber initiation period.
  - Where conditions are unfavourable for powdery scab from planting until tuber initiation, risk of tuber infection is more dependent on the level of inoculum already present in the soil at planting.
- Seed potatoes can introduce the pathogen.
- When susceptible varieties are grown under conducive conditions, inoculum on seed can pose a risk of powdery scab occurring on harvested tubers, even in the absence of inoculum in the soil.

The following factors support reduction of inoculum in the soil:

- Long rotation between potato crops.
- Good control of host weeds and volunteer potatoes.
- Use of bio-fumigation crops (e.g. Indian mustard) in rotations.

PREDICTA®Pt powdery scab test measures the concentration of *Spongospora subterranea* DNA.

- Soil testing can provide an indication of risk of powdery scab.
- Peel testing can assess inoculum level on seed.

A pre-plant soilborne disease assessment underpins informed decisions on paddock selection, variety choices and implementation of disease control strategies, including irrigation management.

Powdery scab: mature pustules bursting through skin.

Microscopic image of *Spongospora subterranea* zoosporangia within root hairs not visible to the naked eye.

Powdery scab pathogen: variations in colour of galls on potato roots as they mature.

Black dot

Caused by the fungus *Colletotrichum coccodes*

Black dot: premature death of plants.

Black dot occurs in all potato growing regions of Australia, causing skin blemishes on tubers and the premature decline of plants.

All varieties are susceptible to black dot infection and some late maturing varieties are highly susceptible to tuber symptoms.

Impact

- Reduced yields by 12–30%.
- Reduced marketability of tubers for the fresh washed market.
- Increased water loss from tubers in storage.

Where damage is most likely

- Paddocks where black dot has previously occurred.
  - Short rotation between potato crops.
  - Volunteer potatoes and host weeds not controlled between crops.
- Infected seed potatoes planted.
- Summer crops.
  - Seasons with warm, wet conditions.
  - Temperatures in mid to high 20°s.
- Plants suffering from:
  - Water or nutrient stress.
  - Infection by other pathogens.
- Tubers ground stored before harvest.

Sources of inoculum

- Soil inoculum is the main contributor to disease risk.
- Inoculum from seed can cause substantial infection and symptoms.
- Risk from both sources must be managed.

The following factors support reduction of inoculum in the soil:

- Long rotations of more than 4 years.
- Absence of host weeds or volunteer potatoes.
- Use of non-host rotation crops (e.g. cereals).

PREDICTA®Pt black dot test measures the concentration of *Colletotrichum coccodes* DNA.

- Soil testing can provide an indication of disease risk.
- Peel testing can assess inoculum level on seed.

Black dot: irregular shaped discoloured patches with characteristic black dots.

Symptoms become more obvious after tuber stored in bag at home.

A pre-plant soilborne disease assessment underpins informed decisions on paddock selection and scheduling, variety choices, seed selection, irrigation management and the implementation of disease control strategies.

Root-knot nematodes

Meloidogyne species

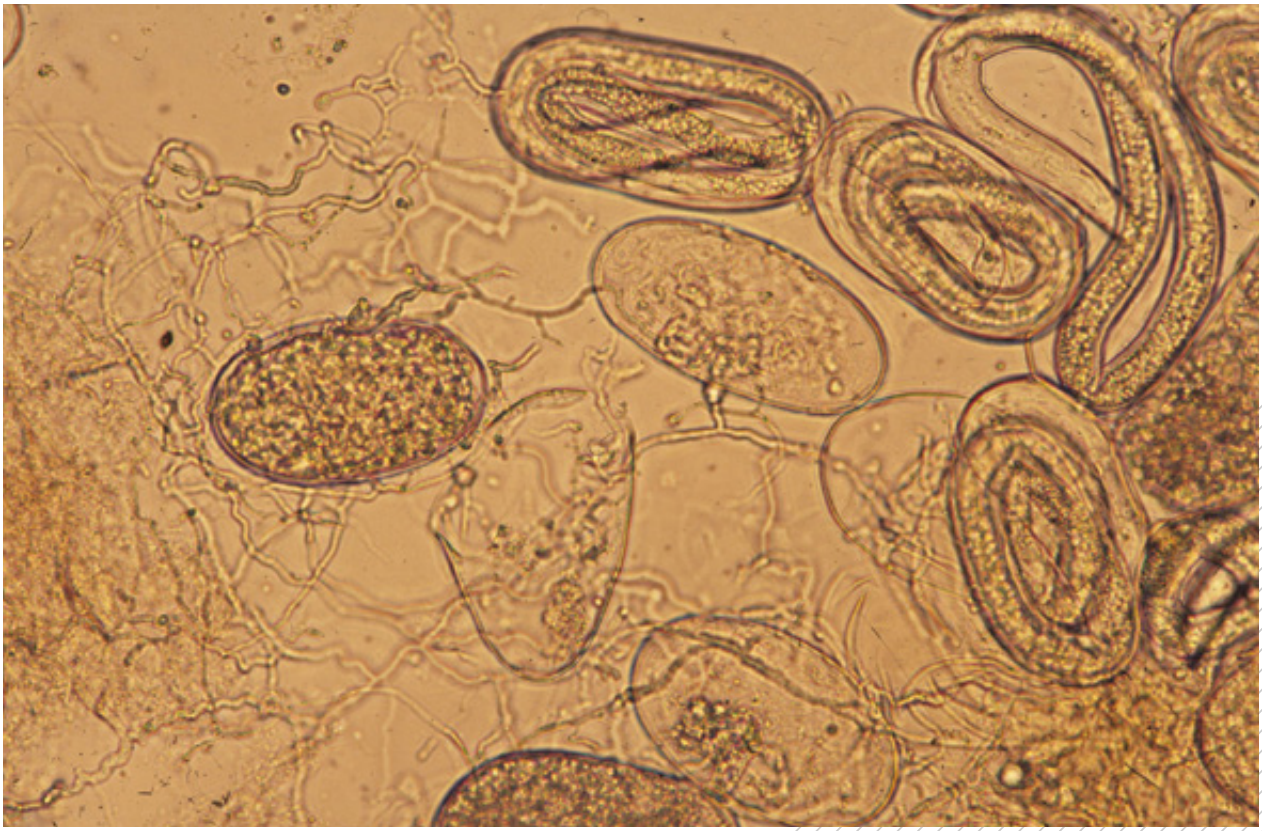
Root-knot nematodes infest potato roots and impact plant growth, yield and tuber quality. Galling on tubers is mostly associated with *M. fallax* in southern production regions, *M. javanica* or *M. incognita* in northern regions, and *M. fallax* or *M. javanica* in inland regions.

Impact

- Severely infected tubers can be downgraded or rejected.
- Galling on tubers reduces marketability.
- Brown spots in tuber flesh reduce cooking and processing quality.
- Heavily infested seed has reduced vigour.

Where damage is most likely

- Specific regions with history of root-knot nematode damage.
- Where potatoes are grown intensively or rotated with other susceptible crops.
- After continuously irrigated pasture that includes host species.
- Previous crop a host species.
- On sandy soils (although infestation can still occur in well-structured, heavy textured soils).
- Persistent warm, dry conditions during the growing season.



Microscopic image of *Meloidogyne* spp. eggs and juveniles.

Source of inoculum

- Soil inoculum is the main contributor to the risk of tuber galling caused by root-knot nematode.
- Seed infection will introduce root-knot nematodes into clean paddocks.

The following factors support reduction of inoculum in the soil:

- Growing non-host crop(s).
- Including a long fallow period in rotation.

Three separate and species-specific PREDICTA®Pt root-knot nematode tests measure the concentration of *Meloidogyne fallax*, *M. hapla* and *M. javanica/M. incognita/M. arenaria* DNA.

- Soil testing can provide an indication of risk of tuber galling.
- Peel testing can assess infection level of seed.

Severe root-knot nematode damage can occur in small patches of paddocks where conditions are favourable, such as dry sandy rises.

When inoculum is present at low levels, the probability of detection prior to planting is increased by targeted sampling of these areas.

Root-knot nematodes: bumps on tubers and underlying flesh discolouration.

A pre-plant soilborne disease assessment underpins informed decisions on seed and variety selection, paddock selection, pre-planting and in-crop treatments and crop rotation strategies.

Pink rot

Caused by the oomycete *Phytophthora erythroseptica*

Occasionally caused by *P. crytogea* and *P. dreschleri*

Pink rot: external symptoms of darkened skin and uninfected tissue delineated by a dark line on infected tuber

A pre-plant soilborne disease assessment underpins informed decisions on paddock selection, variety choices, seed selection and implementation of disease control strategies.

Characteristic pink discolouration that develops in 20-30 minutes when infected tuber cut open. (IMAGE: ROBERT TEGG)

Rotting of tubers is the most obvious and damaging symptom of pink rot. When infected tubers are cut, the exposed surface turns a salmon pink colour after 20 to 30 minutes.

Impact

- Causes substantial yield loss when conditions are favourable.
- Harvest can be uneconomical in paddocks with high levels of infection.
- If left unmanaged, can cause substantial tuber rot in storage.

Where damage is most likely

- Paddocks with a long history of potatoes grown in short rotations.
- Seasons with intense rainfall or flooding events.
- Areas with poor drainage, including low spots and eroded hills with shallow topsoil.
- Soil that has poor structure or heavy texture.
- Warm to hot (18-28°C), wet conditions near maturity.
- Cycles of wet and dry conditions towards end of crop.
- Poor ventilation and high humidity during storage.
- Storage temperatures above 10°C.

Sources of inoculum

- Inoculum in the soil is the main source of infection.
- Inoculum on seed can result in sporadic infected plants in the crop.

The following factors support reduction of inoculum in the soil:

- Long rotation between potato crops.
- Good control of volunteer potatoes.
- Growing non-host crops.

PREDICTA®Pt pink rot test measures the combined concentration *P. erythroseptica, P. crytogea* and *P. dreschleri* DNA.

- Detection in soil indicates an elevated risk of pink rot.
- Peel testing can assess inoculum level on seed.

Paddocks where pink rot occurred in the last potato crop should be considered at high risk in the next planting, especially in short rotations, irrespective of the soil DNA test result.

Paddock drainage is an important consideration in assessing the risk of pink rot. Presence of wet spots can lead to high levels of infection in these areas, irrespective of whether the pathogen was below the level of detection prior to planting, or if control treatments are applied.

The risk of pink rot is low when potatoes are grown in regions with non-conducive conditions, such as well drained sandy soils and no history of pink rot occurring.

Verticillium wilt

Caused by the fungus *Verticillium dahliae*

Verticillium wilt: Plant dying.

Verticillium wilt of potatoes in Australia is predominately caused by the fungus *Verticillium dahliae*. Verticillium wilt results in the early decline of crops and is often referred to as potato early dying. Infection and yield loss can be heightened by interaction with root infesting nematodes, especially root lesion nematodes (*Pratylenchus* spp.).

Impact

- Yield losses of up to 40%.
- Yield reduction varies and is dependent on the variety, growing conditions and strain of pathogen.

Where damage is most likely

- Paddocks where verticillium wilt has previously occurred.
  - Short rotations between potato crops.
  - Volunteer potatoes and host weeds not controlled between crops.
- Following wet conditions early in the growing season.
- Root lesion nematodes present.
- Black dot or Pectobacteria present.
- Plants suffering stress from:
  - Heat.
  - Under or over irrigation.
  - Nutrient deficiency.
- Crop maturing in warm dry growing conditions.
- More severe in sandy soils but may occur in any soil type.

Source of inoculum

- Soil inoculum is the main contributor to disease risk.
- There is limited evidence that inoculum of *V. dahliae* on seed tubers is a contributor to yield loss.

The following factors support reduction of inoculum in the soil:

- Long rotation between potato crops.
- Good control of volunteer potatoes and weed hosts.
- Periods of hot, dry conditions.

PREDICTA®Pt verticillium wilt test measures the concentration of *Verticillium dahliae* DNA.

- Soil testing can provide an indication of the risk of yield reduction from verticillium wilt.
- Peel testing can assess inoculum level on seed.

V. albo-atrum (not detected by the *V. dahliae* DNA test) can also cause verticillium wilt. Seed inoculum is the main contributor to disease risk for *V. albo-atrum*.

Vascular infection reducing water movement to plant top.

A pre-plant soilborne disease assessment underpins informed decisions on paddock and variety selection, disease control strategies and if soil treatment or other inoculum reduction strategies are justified.

Silver scurf

Caused by the fungus *Helminthosporium solani*

Microscopic image of tree like structure (conidiophores with spores) of *Helminthosporium solani*.

The disease causes blemishes on the skin with a silvery sheen that can become thick and leathery in storage. Symptoms are more obvious on smooth-skinned washed potatoes and red skinned varieties. Tubers may be infected in the field or in storage.

Impact

- Skin blemishes reduce the marketability of tubers.
- Increased weight loss in storage.
- Infected tubers are more susceptible to decay.

Where damage is most likely

- When infected seed is planted and no seed treatments applied.
- Potatoes planted within 2 years of previous crop.
- Persistence of volunteer potatoes.
- Long season varieties.
- Ground stored tubers.
- Wet soil conditions after vine decline.
- Tubers stored for extended periods after harvest.
- Postharvest storage at above 3°C with high humidity (> 90%).

Source of inoculum

- Seed inoculum is the main contributor to disease risk.
  - Infected seed at planting has been linked to an elevated risk of infection in daughter tubers.
- Testing of seed at harvest can indicate a requirement for seed treatment prior to storage.
- In short rotations, inoculum in the soil may contribute to disease risk.

The following factors support reduction of inoculum in the soil:

- Planting seed free of inoculum.
- Rotations > 3 years.
- Good control of volunteer potatoes.

PREDICTA®Pt silver scurf test measures the concentration of *Helminthosporium solani* DNA.

- Detection in soil indicates the risk of tuber infections.
- Peel testing of seed can indicate risk of infection to daughter tubers.

Silver scurf.

A pre-plant soilborne disease assessment underpins informed decisions about seed selection and seed treatment. Paddock selection is important if potatoes have been grown in the last 3 years.

Common scab

Caused by pathogenic *Streptomyces*

Common scab is caused by several pathogenic species of the soilborne actinobacterium *Streptomyces*. Common scab symptoms vary with the environment, potato variety, time of infection and pathogenic strain present.

Impact

- Scabs and craters reduce marketability.

Where damage is most likely

- Paddocks where the disease has occurred in the past.
- Seasons with hot, dry weather.
- Dry soil conditions during early tuber development.
- Poor control of volunteer potatoes in short rotation.
- Continuous livestock production between potato crops.
- Susceptible varieties grown.
- Infected seed planted.
- Uneven irrigation.

Source of inoculum

- Inoculum from the seed or soil can cause common scab infection and symptoms. Risk from both sources must be considered and managed.

The following factors support reduction of inoculum in the soil:

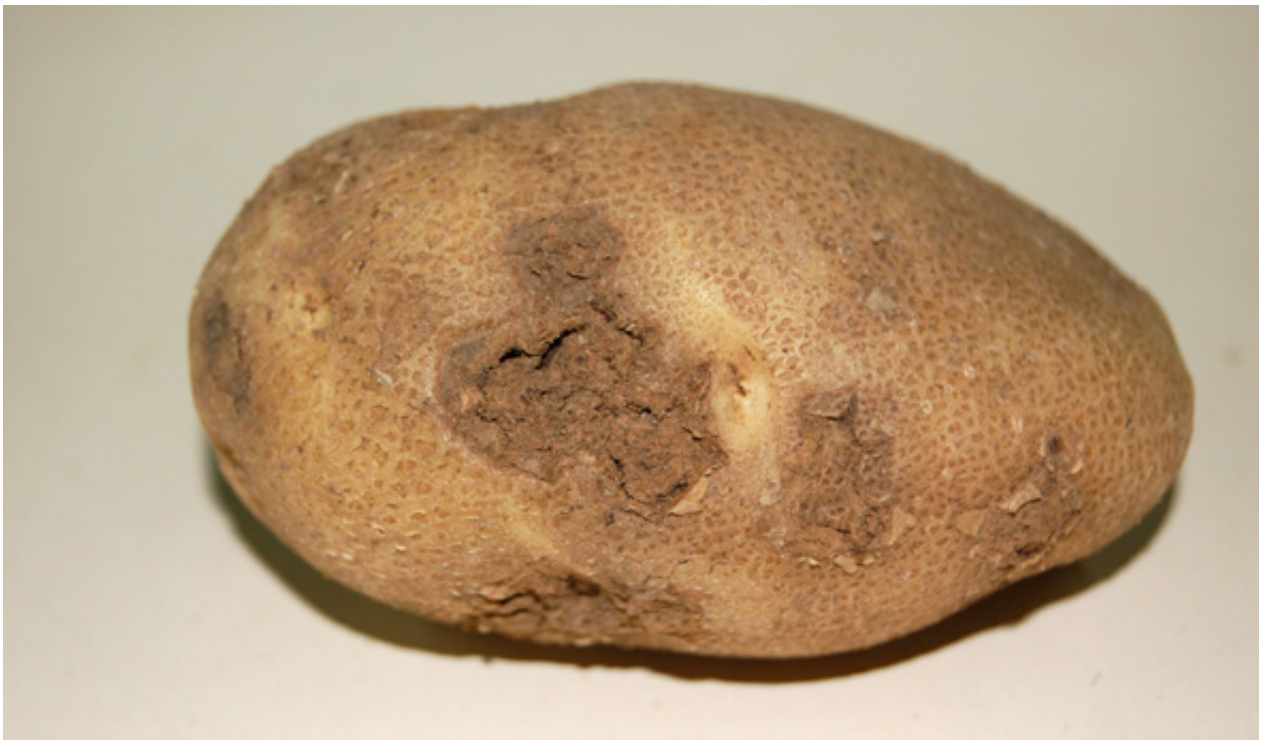
- Planting seed free of inoculum.
- Controlling volunteer potatoes.

PREDICTA®Pt common scab test measures the concentration of *Streptomyces* txtA gene DNA.

- Detection in soil indicates an elevated risk of common scab.
- Seed peel testing can provide an indication of disease risk.

Severe disease has occurred on occasions when no *Streptomyces* txtA gene DNA has been detected by soil or seed testing.

Paddocks where a high incidence of common scab has occurred in the past should be considered to have a high risk of common scab occurring in subsequent plantings, irrespective of the soil DNA test result.



Common scab: Severe pitted scab lesions.

Common scab.

A pre-plant soilborne disease assessment underpins informed decisions on variety choices and seed selection, paddock selection, as well as for implementing disease control strategies and managing irrigation.

Reduced and delayed emergence caused by rhizoctonia disease.

Rhizoctonia disease

Caused by the fungus *Rhizoctonia solani*, notably strains AG3 and AG2.1

Rhizoctonia disease encompasses a wide range of symptoms, including black scurf on tubers and stem canker (causing burn-off of sprouts prior to emergence; delayed emergence; lesions on underground stems, stolons and roots; aerial tubers).

Some potato varieties are more susceptible to tuber symptoms.

R. solani AG3 is the main cause of black scurf on potatoes in Australia, with AG2.1 less common. Both *R. solani* AG3 and AG2.1 can cause sprout burn off, stem cankers, stolon pruning and deformed tubers.

Impact

- Black scurf, tuber deformation and scarring on tubers reduce marketability.
- Yield loss of up 30%.
- Increased variation in tuber size.

Where damage is most likely

- Paddocks where rhizoctonia disease previously occurred.
- Poor control of volunteer potatoes.
- Short rotations between potato crops (AG3).
- Host crops grown prior to potatoes (AG2.1).
- Infected seed planted.
- Fresh crop residues present at planting.
- Risk of stem canker increases with slow emergence due to:
  - Planting in cool, wet conditions.
  - Planting too deep.
  - Planting low vigour seed tubers.
- Ground storage increases risk of black scurf.

Source of inoculum

- Inoculum on seed or in the soil can cause *R. solani* infection and symptoms. Risk from both sources of inoculum must be managed.

The following factors support reduction of inoculum in the soil:

- Long rotation between potato crops and good control of volunteer potatoes (*R. solani* AG3).
- Use of non-host crops in the rotation in combination with good control of volunteer potatoes and weed hosts (*R. solani* AG2.1).

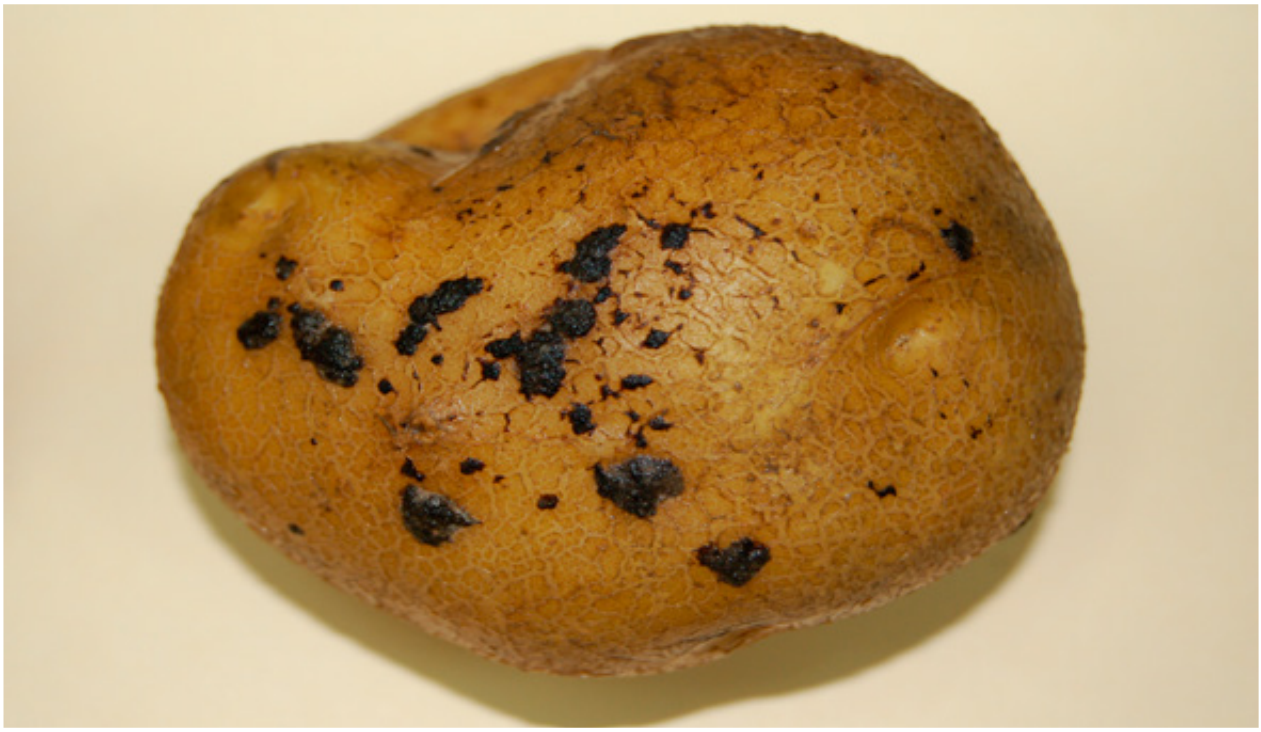
PREDICTA®Pt rhizoctonia tests measure the total concentration of *R. solani* AG3, AG2.1 and AG4 DNA, with each test being specific to an AG strain.

- Detection in soil indicates an elevated risk of rhizoctonia disease.
- Seed peel testing can provide an indication of risk for specific rhizoctonia disease symptoms.

Paddocks where a high incidence of rhizoctonia disease occurred in the last potato crop should be considered to have a high risk in the next planting, especially in short rotations.

A pre-plant soilborne disease assessment underpins informed decisions on seed and at planting treatments, disease mitigation management and crop rotation strategies.

Stem canker.



Black scurf.

Root lesion nematodes

Pratylenchus species

Damage to potato root system caused by *Pratylenchus penetrans*. (IMAGE: MARIA VIKETOFT, SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES)

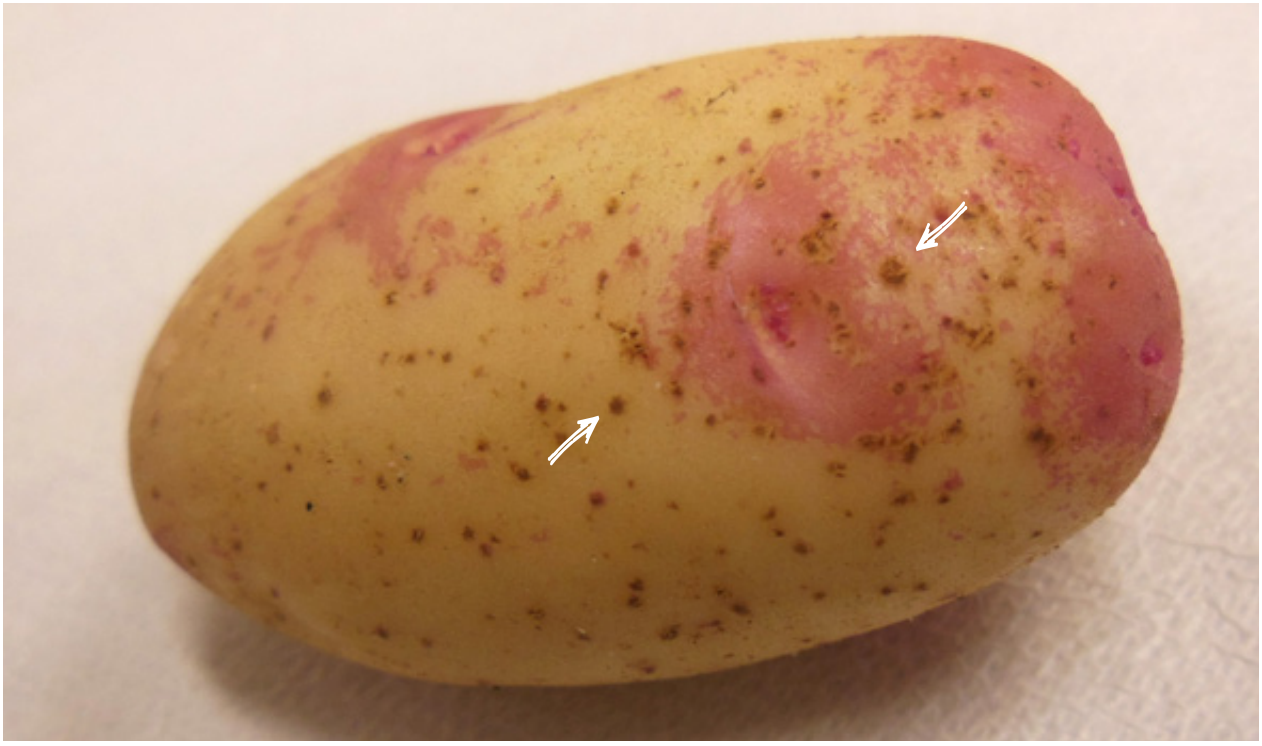
Root lesion nematodes are soil dwelling, worm-like organisms that feed on plant roots. The main species in Australia that infect potatoes are *Pratylenchus penetrans, P. crenatus* and *P. neglectus.*

Impact

- Yield loss.
- Increased risk of infection by other soilborne pathogens (e.g. *Verticillium dahliae*).
- Brown lesions on tubers, reducing marketability of fresh washed potatoes.

Where damage is most likely

- Multiple previous potato or other host crops grown in paddock.
- Poor control of volunteer potatoes and persistence of weed hosts.
- When *V. dahliae* is also present.
- When the plant is suffering from stress (e.g. heat, water or nutrient).
- Varieties with weak root systems are more susceptible to yield loss.



Lesions on tubers caused by *Pratylenchus penetrans*. (IMAGE: MARIA VIKETOFT, SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES)

Source of inoculum

- The level of potato root system infection is related to the pre-planting population of root lesion nematodes in the soil.
- There is little evidence that seed tubers infested with root lesion nematodes result in substantial disease in the current potato crop.
- Seed infection will introduce root lesion nematodes to clean paddocks.

The following factors support reduction of inoculum in the soil:

- Growing non-host crops in rotation, in combination with good control of volunteer potatoes and weed hosts.
  - There are many species of root lesion nematodes. Each species has a different range of hosts, making it important to know which species are present when choosing break crops.
- Wet and warm to hot soil conditions with no hosts.
- Cultivation and soil disturbance.
- Biologically active soil with nematophagous fungi.

Species-specific **PREDICTA®Pt root lesion nematode tests** measure the concentration of *Pratylenchus crenatus, P. neglectus* and *P. penetrans* DNA.

- Soil testing can provide an indication of infection risk.
- Peel testing can assess the infection level of seed.

A pre-plant soilborne disease assessment underpins informed decisions on seed selection, soil treatments, crop disease management practices and crop rotation strategies.

Leak rot

Caused mainly by the oomycete *Pythium ultimum*

Field infection of tuber resulting in internal rot with cavity in centre. Outer shell of tuber mostly unaffected.

Leak rot causes internal rotting of tubers, sometimes with minimal external symptoms. Most losses occur after harvest but can also occur in the field.

Impact

- Affected tubers break down rapidly.
- High incidence can result in loads being rejected for processing.

Where damage is most likely

- Warm and/or wet growing conditions.
- Short rotation since preceding potato crop.
- High levels of wounding/tuber damage during harvesting and handling, particularly with:
  - Tuber pulp temperatures of 16°C to 32°C.
  - Moist soil conditions and/or humid weather.
- Disease progresses rapidly if pulp temperatures remain above 21°C.

Sources of inoculum

- Inoculum in the soil is main source of *P. ultimum* infection in potato crops.
- Seed can carry inoculum.

PREDICTA®Pt *Pythium* clade I test detects several *Pythium* species, including *P. ultimum, P. debaryanum, P. splendens* and *P. heterothallicum.*

- Detection in the soil is associated with an elevated risk of leak rot.
- Peel testing can assess inoculum level on seed.

P. aphanidermatum (not detected by the *Pythium* clade I test) can also cause leak rot.

Development of leak rot on tubers that were infected during harvest and left in ambient conditions. (IMAGE: JOHN DUFF, QLD)

A pre-plant soilborne disease assessment underpins informed decisions on paddock selection, implementation of field disease control strategies and harvest, transport, and storage management.

Infection of potato stem at branch attachment point.

Sclerotinia stem rot

Caused by soilborne fungi *Sclerotinia sclerotiorum* and *S. minor*

Sclerotinia stem rot of potato, also known as white mould, primarily affects the stems of the potato plant, ultimately causing decay of the stem and death of the plant.

The fungus survives as sclerotia in the top 5 cm of soil for approximately 4 years, or up to 10 years if buried deeper.

Impact

- Yield loss.
- Areas of dead plants.
- Can progress quickly if conditions are supportive.

Where damage is most likely

- Moist, humid growing conditions.
- Optimal temperature range of 15-25°C.
- Varieties which produce a thick canopy.
- Regular overhead irrigation maintaining moist humid conditions.
- Crop rotations that include susceptible hosts.

Dying patch in potato crop caused by *Sclerotinia*.

Source of inoculum

- Inoculum in the soil is the main source of *S. minor* infection in potato crops.
- Inoculum of *S. sclerotiorum* in soil of surrounding paddocks can be a source of disease risk if conditions are favourable to the formation of apothecia, which release airborne spores.
- Production of airborne spores is rare for *S. minor.*
- Detection of either species on seed tubers is rare.

The following factors support reduction of inoculum in the soil:

- Avoid growing host crops in rotation.
- Good control of volunteer potatoes and host weeds.
- Control of disease in host crops if grown.
- Stubble removal of diseased rotation crops.

The PREDICTA®Pt sclerotinia stem rot test measures the combined concentration of *Sclerotinia sclerotiorum* and *S. minor* DNA. The test does not distinguish between the two species.

- Detection in soil indicates an elevated risk of sclerotinia stem rot.

Knowing which species are present in the region will help to assess risk.

A pre-plant soilborne disease assessment underpins informed decisions on paddock selection, paddock scheduling and implementation of field disease control strategies.

Examples of grower use of PREDICTA®Pt:

- To improve the percentage of seed crops meeting certification, by avoiding paddocks where PREDICTA®Pt has detected a risk of powdery scab.
- To avoid growing highly susceptible fresh market varieties in paddocks with risk of powdery scab. Growers of these varieties had previously lost crops because of powdery scab.
- To assess the risk of black dot in paddocks and then schedule planting time and variety selection, in combination with disease management practices, to lower the overall risk of black dot.
- To decide if nematicide should be applied to control root-knot nematode. The high cost of treatment is justified when the risk is substantial.
- To monitor root-knot nematode decline in fallow paddocks and determine when it is safe to plant for a successful crop.
- To decide when to apply soil treatments for control of verticillium wilt where the disease had reduced yields to uneconomic levels in previous crops. Testing successfully identified other paddocks with high levels of inoculum, and crops performed well in treated areas compared to untreated strips.
- To monitor pathogen levels and inform decisions within a seed production operation to better meet customer needs.
- To monitor root lesion nematode populations before and after rotation crops. Testing identified rotation crops that were increasing the population of root lesion nematode, and those crops were replaced with better options.
- Monitoring pathogen levels in the soil, root systems and tubers after application of soil treatments and biologicals, in order to evaluate treatments for reducing the severity of black dot on fresh market tubers.

Further information

https://pir.sa.gov.au/research/services/molecular_diagnostics

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