ROOT LESION NEMATODE FACT SHEET

NORTHERN
UPDATED OCTOBER 2019

Strategies to help reduce losses caused by root lesion nematodes

KEY POINTS

- Root lesion nematodes (RLN) are species of *Pratylenchus* that feed on the roots of crops and can cause yield loss
- Risk of yield loss caused by RLN can be estimated by determining nematode populations that are in the soil at planting
- Choose varieties with tolerance to maximise yields when RLN are present
- RLN have a wide host range and can multiply on cereals, oilseeds, pulses and pastures as well as on broadleaf and grass weeds
- A PREDICTA® B soil test (SARDI Diagnostic Services) can be used to identify the species and number of nematodes present in a paddock and to monitor population changes in rotations
- Avoiding susceptible crops in rotations will limit the build-up of RLN numbers
- RLN can multiply in summer and winter cereal and legume crops and each nematode species can build-up on different crops or varieties within crops
- Choose rotation crops with high resistance ratings, so that fewer nematodes remain in the soil to infest subsequent crops
- Two or more consecutive resistant crops may be needed to reduce damaging populations

FIGURE 1: Aboveground symptoms of a *Pratylenchus thornei* intolerant variety, Strezlecki (left) next to a tolerant variety, EGA Gregory (right). Distinct yellowing and reduced vigour can be seen in the intolerant variety despite good rainfall.

Introduction

Root lesion nematodes (RLN) are microscopic, worm-like organisms that feed within and damage plant roots, thus affecting crop yield. The key to managing them is to identify paddocks with yield-limiting numbers present, then incorporate tolerant and resistant crops and varieties into rotations to minimise yield losses and reduce their number.

Symptoms

Like many soil-borne diseases, RLN can be difficult to identify in the field and laboratory testing or a PREDICTA® B soil test may be required.

Figure 1 shows aboveground symptoms of RLN in cereals, which can include:

- poor emergence and establishment;
- stunting;
- yellowing of lower leaves;
- poor tillering and reduced biomass; and
- wilting, particularly when the season turns dry.

However, given these symptoms are similar to those of other root diseases or of nutrient constraints, plant roots and soil need to be tested in a laboratory to determine the cause of plant symptoms.

When roots are damaged by RLN, the plants become less efficient at taking-up water and nutrients, and less able to tolerate stresses such as drought or nutrient deficiencies. RLN infestation of intolerant wheat varieties restricts water and nutrient uptake early in the season, which limits aboveground plant development and yield potential. The impact of reduced root function is particularly noticeable around September to October in the subtropical northern grain region as the crop draws on subsoil moisture and nematode populations increase with the rising soil temperatures.

In cereals, nematode-damaged seminal and crown roots may show a general browning and discolouration (Figure 2). There will be fewer and shorter lateral

TABLE 1: Potential wheat yield loss (%) caused by different population densities of the root lesion nematode *Pratylenchus thornei* at planting in the subtropical northern grain region as detected by PREDICTA® B. Estimates of yield loss are given for seasons that are conducive[A], for wheat cultivars ranging from intolerant to tolerant.

Risk category	*P. thornei*/g soil	Yield loss estimates based on variety tolerance		
		Intolerant[C]	Intermediate	Tolerant
BDL[B]	<0.1	0	0	0
Low	0.1–2	0–5	0–2	0
Medium	3-8	5–20	2–10	0
High	>8	20–40	10–20	0

[A] Conducive seasons represent around 70% of seasons whereas intermediate and non-conducive represent around 20% and 10% respectively.
[B] BDL: below detection level.
[C] Greater yield losses have been observed in very intolerant varieties such as Strezlecki.

roots branching from the main roots and a lack of root hairs. The root cortex (or outer root layer) may be damaged and may disintegrate as the season progresses. Chickpea roots can show distinct dark brown-orange lesions at early stages of infection and the lateral roots can be severely stunted and reduced in number. If crown rot is also present, then RLN attack can increase the expression of whiteheads.

Distribution

Root lesion nematodes are found throughout all of the northern grain growing region.

These nematodes are found in 77 per cent of tested paddocks. *Pratylenchus thornei* is more widespread and generally occurs in larger and more damaging populations than *P. neglectus*. *P. thornei* is found in 49 per cent of paddocks and *P. neglectus* in 44 per cent. Note: some paddocks have both species present.

Economic importance

A recent economic study estimated average annual losses of $31 million in wheat due to RLN across the northern region, with losses of $41 million possible during seasons conducive to nematode damage. Losses in individual paddocks can be up to 65 per cent where nematode numbers are high and an intolerant variety is grown.

TABLE 2: Potential wheat yield loss (%) caused by different population densities of the root lesion nematode *Pratylenchus neglectus* as detected by PREDICTA® B. Estimates of yield loss are given for seasons that are conducive for intolerant wheat cultivars. Data is based on estimates from southern region data.

Risk category	*P. neglectus* /g soil	Yield loss %
BDL[A]	<0.1	0
Low	0.1–24	0–5
Medium	25–100	0–20
High	>100	0–40

[A] BDL: below detection level.

FIGURE 2: Relatively healthy wheat plant on the left with numerous tillers and lateral roots compared with a plant heavily infested with *Pratylenchus neglectus* on the right.

Yield loss

The extent of losses from RLN can be estimated by their number in the paddock at planting. Therefore, the first step in managing RLN is to identify those paddocks with a yield-limiting number of nematodes by testing the soil (Box 2: Testing for RLN).

The relationship between pre-planting nematode numbers (based on a PREDICTA® B soil test result) and likely loss in grain yield of wheat in a range of seasons is shown in Tables 1 and 2. These tables show that the extent of yield loss for a given number of nematodes varies based on the RLN species; for *P. thornei* this includes the crops tolerance. For example, a test result of five *P. thornei* per gram of soil is likely to cause yield loss of 5 to 20 per cent in intolerant varieties.

BOX 1: RESISTANCE AND TOLERANCE

Resistant or non-host crops/varieties will not allow nematode numbers to increase during the season. These crops are good options to reduce nematode numbers and therefore yield loss in a subsequent crop.

Susceptible crops allow nematode numbers to increase during the season. These crops can result in higher yield losses in a subsequent intolerant crop because of the higher nematode numbers.

Tolerant crops or varieties will yield well when RLN are present in the soil at damaging levels. A tolerant crop or variety is not necessarily resistant to the nematodes and can yield well even though the nematodes can still reproduce in their roots.

Intolerant crops or varieties will have decreased yields due to RLN infestation of the plant roots.

Resistance/susceptibility and tolerance/intolerance ratings are published in annual crop variety guides (see 'Useful resources') or NVT Online (www.nvtonline.com.au).

BOX 2: TESTING FOR RLN

ON-FARM

Growers are advised to check crops for signs of ill thrift. Soil samples should be sent to PREDICTA® B for DNA-based soil testing to confirm the diagnosis and determine nematode species present (see below for contact details).

TESTING SERVICES

Crop diagnosis is best achieved by sending samples of affected plants and soil to your local plant pathology laboratory. PREDICTA® B is commercially available throughout Australia and growers should contact an accredited consultant or plant pathology section of the local state department of agriculture for advice. A soil corer is used to sample randomly across a paddock to provide a yield risk rating for the whole paddock. The inclusion of plant material is crucial to get accurate results as the test provides risk ratings for multiple soil and stubble-borne diseases. For further information see the PREDICTA® B website (http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b).

FURTHER INFORMATION

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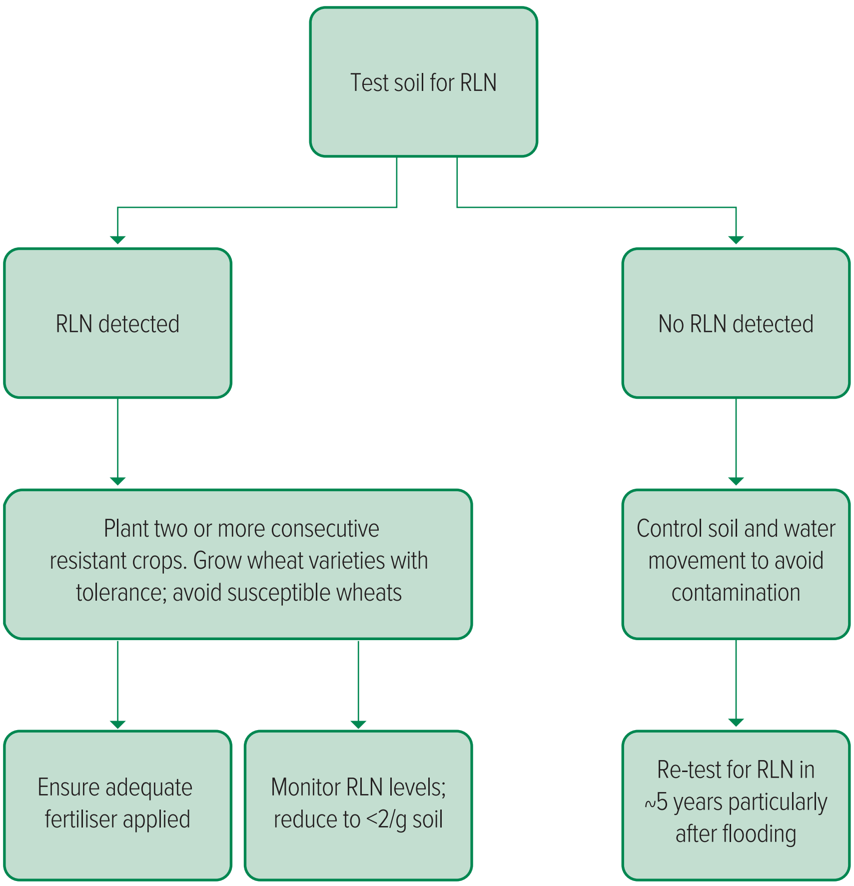

FIGURE 3: Process for managing root lesion nematode in the northern grain region.

Management

Soil testing

The first step in managing RLN is to have soil tested to determine whether the nematodes are present in paddocks. If RLN are detected, the soil test will identify the species and the population level in the paddock (Figure 3).

If RLN are not detected, protect those paddocks from contamination by controlling the movement of soil and water on the farm. Remove soil from machinery before planting or fertilising, and plant RLN-free paddocks first. Consider re-testing in five years, particularly if there has been flooding, because RLN can move in floodwaters and in soil.

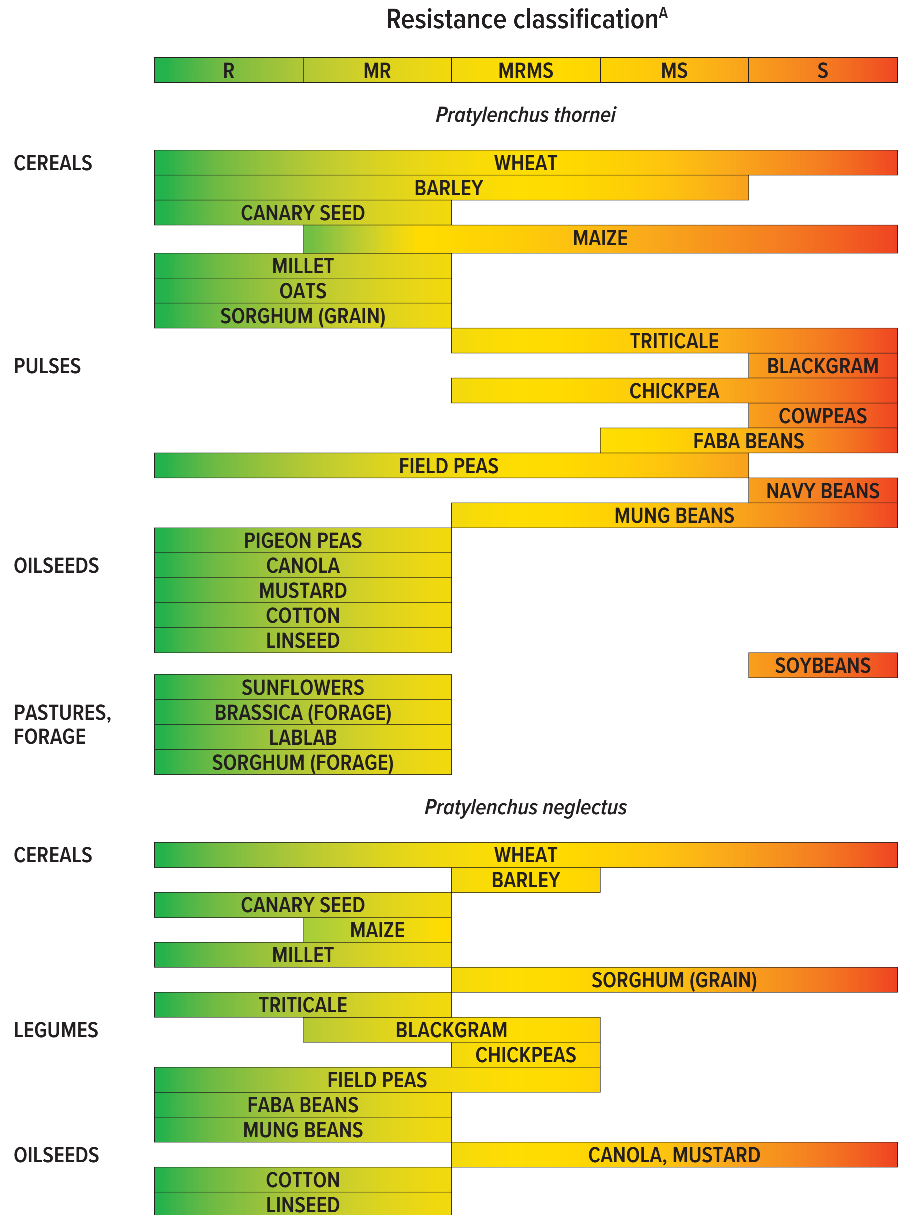

FIGURE 4: Comparison of the resistance of a range of cereals, oilseeds and pulses to root lesion nematode (*Pratylenchus thornei* and *P. neglectus*). In some crops, hosting ability varies between varieties and this is indicated where a range of risk ratings are shown. Therefore, it is important to check a current crop variety guide from your state department of agriculture or NVT Online for current information. New varieties may differ in their risk ratings from the overall rating for a crop species.

[A] R= resistant S= susceptible.

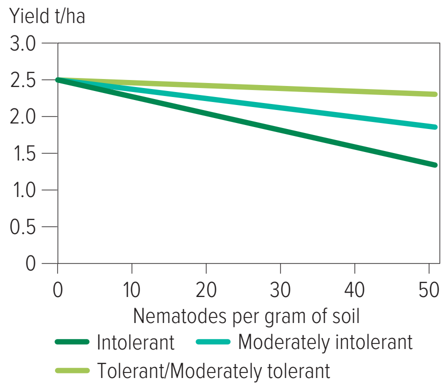

FIGURE 5: The effect of variety tolerance on yield in the presence of *Pratylenchus thornei* in a wheat crop with a 2.5t/ha yield potential. This graph is based on a 2014 trial and demonstrates the effects of variety tolerance on yield performance.

Rotations for nematode management

When RLN are detected, rotations and variety choice are central to successfully reducing RLN populations. Only non-host crops or resistant varieties will minimise the build-up of RLN (see Figure 4). Tolerant crops are able to produce good yields, but if they are susceptible, RLN numbers can still increase. Aim to reduce populations to less than two per gram of soil.

Tolerant crops or varieties can yield well when grown in paddocks where RLN are present in damaging levels (greater than or equal to 1/g soil). In wheat, breeding for tolerance in the subtropical northern grain region has been very successful and most varieties are now rated as tolerant or moderately tolerant to *P. thornei*. Ratings of tolerance for barley and wheat varieties are available at NVT Online (www.nvtonline.com.au). Other crops such as chickpea or mungbean are generally moderately tolerant to *P. thornei*. If an intolerant variety of wheat is planted where *P. thornei* populations are greater than 8/g soil, then yield loss of 40 per cent or more is likely (Figure 5).

A resistant crop or variety will not allow RLN populations to increase; however, it is important to remember that a tolerant variety may not be resistant because they are controlled by separate mechanisms in the plant. For *P. thornei*, resistant or partially resistant crops such as sorghum (grain and forage), cotton, millet, panicum, sunflowers, maize (most varieties), lablab, pigeon peas, canola, canary seed and linseed can be grown in rotations to limit populations. For *P. neglectus*, resistant or partially resistant crops such as cotton, sunflowers, maize, mungbeans, soybeans, cowpeas, lablab, triticale, linseed, and faba beans can be grown.

Among chickpea cultivars, PBA HatTrick and PBA Boundary are rated as moderately resistant to moderately susceptible and moderately susceptible respectively and they present a medium risk for the build-up of *P. thornei*. Kyabra is rated as very susceptible. Other crops such as mungbeans show differences in susceptibility to *P. thornei* between varieties. There are very few differences in soybean varieties, which are very susceptible.

When very high populations of RLN are detected, it may take two or more

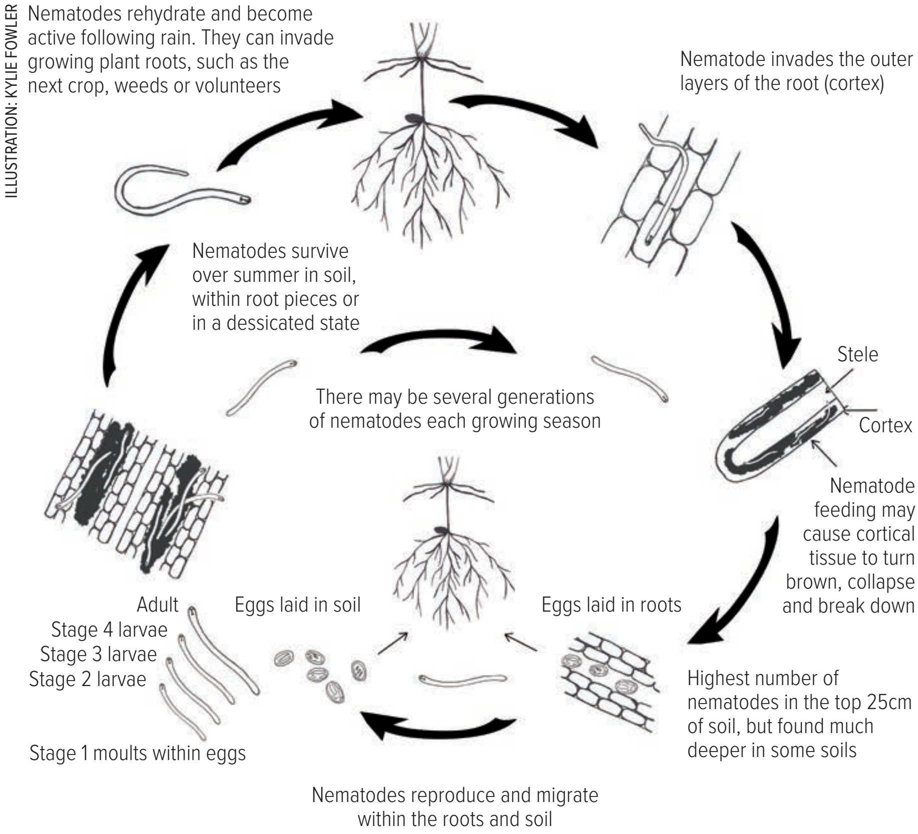

FIGURE 7: Disease cycle of root lesion nematode, adapted from GN Agrios (1997) *Plant Pathology*, 5th edn (Academic Press: New York).

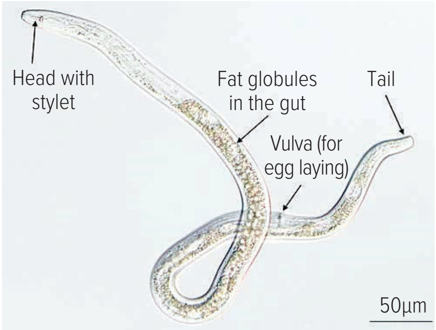

FIGURE 6: A *Pratylenchus thornei* adult female viewed under the microscope.
This nematode is approximately 0.65mm long.

resistant crops grown consecutively to reduce populations. Re-testing of soil after growing resistant crops is recommended, so that crop sequences can be adjusted if populations are still at damaging levels. Avoid very susceptible crops and varieties.

Fertilisers

Ensure that adequate fertiliser is applied (especially nitrogen, phosphorus and zinc) so that tolerant varieties can reach their yield potential; high fertiliser rates do not lead to lower nematode reproduction.

Nematicides

No nematicides or seed dressings are registered for use on broadacre crops in Australia. Experiments with nematicides have shown that they provide poor control of RLN populations deep in the soil profile.

Biology

RLN (*P. thornei* and *P. neglectus*) are worm-like organisms, less than one millimetre in length. They use a syringe-like stylet in their mouthpart to break open root cell walls and feed on the root cell contents (Figure 6).

RLN can complete several generations during the growth of a susceptible crop (Figure 7). The females are self-fertile; males of *P. thornei* and *P. neglectus* are rarely found. Under ideal conditions, the life cycle takes about six weeks for *P. thornei*, depending on the temperature and soil moisture.

As plants and soil dry out in late spring, RLN can enter a dehydrated state called anhydrobiosis. In this state, nematodes can survive high soil temperatures of up to 40°C. RLN can survive many years in a dehydrated state if the soil remains dry.

Populations of RLN increase with each generation; therefore, more plant roots are damaged, which in turns restricts the uptake of water and nutrients from the soil.

Intensive cropping of susceptible crops – particularly wheat – will lead to an increase in RLN levels in the soil, meaning that crop rotation is the key to reducing RLN and the damage caused by this pest.

BOX 3: ROTATIONS FOR THE CONTROL OF RLN – AN EXAMPLE

A grower on the central Darling Downs who knew there was a low level of *P. thornei* in his paddocks was surprised to find that there was a damaging population of *P. thornei* after growing a crop of sorghum that has moderate resistance to *P. thornei*.

A PREDICTA® B test found 10 *P. thornei*/g in the soil. Other soil-borne diseases were found only at low levels.

Looking back at his recent crop sequences, the grower had grown wheat cv. EGA Gregory, chickpea cv. Kyabra, and barley cv. Shepherd followed by sorghum. All of the crops had grown well in the seasonal conditions and wheat cv. EGA Gregory was specifically chosen because it has a high level of tolerance to *P. thornei*.

Unfortunately, all of the crops grown before sorghum ranged from susceptible (chickpea cv. Kyabra) to moderately susceptible (wheat cv. EGA Gregory and barley cv. Shepherd). *P. thornei* had slowly built up with each successive crop and nematode populations had survived fallow periods and carried over into the next crop in the sequence.

At 10 *P. thornei*/g soil, an intolerant wheat variety may lose at least 40 per cent of its yield in a conducive season. By growing a tolerant wheat variety, this yield loss could be reduced to less than five per cent.

Increasing the number of resistant crops and varieties grown consecutively in the sequence will begin to reduce the number of nematodes and limit the potential yield loss. The grower should choose wheat, barley and chickpea varieties that combine the highest level of resistance and tolerance available.

FREQUENTLY ASKED QUESTIONS

What other plant-parasitic nematode species are found in grain crops in the northern grain region?

The stunt nematode (*Merlinius brevidens*) is found widely in the subtropical northern grain region (identified in 73 per cent of tested paddocks). This nematode prefers similar soil conditions to *P. thornei* (alkaline soils with high clay content). The stunt nematode grazes on the surface of plant roots, which causes restricted damage to the surface cells; consequently, it is regarded as less destructive than RLN. Occasionally, very large populations of the stunt nematode are found in the northern region and although wheat yield loss has not been associated with this nematode, there is a suggestion that symptoms of infection by *P. thornei* were greater when the stunt nematode was also present. This nematode species is not detected by current PREDICTA® B tests. Other nematodes in the region include the stubby-root nematode (*Paratrichodorus sp.*) and root-knot nematode (*Meloidogyne sp.*) in lighter textured or sandy soils.

Does timing of sowing help?

Planting wheat within the window for each variety so that roots develop in cooler soil (<15°C) can give the wheat a competitive advantage over RLN and reduce yield loss. *P. thornei* has an optimum temperature for reproduction of 20°C to 25°C. Note that planting too early risks damage to heads from frosting later in the season.

What happens to RLN during fallow periods?

Very large populations of RLN decrease in fallow periods, particularly in the topsoil where rapidly drying soil and temperatures greater that 35°C kill the nematodes. *P. thornei* survives best in cool, moist soil. These effects partly explain why peak populations of *P. thornei* occur in the subsoil rather than in the topsoil in some paddocks.

USEFUL RESOURCES

PREDICTA® B – a soil analysis service provided by accredited agronomists. PREDICTA® B can detect *P. neglectus, P. thornei* and a range of soil-borne diseases. Contact your local agronomist, or to locate your nearest supplier, email your contact details and location to predictab@saugov.sa.gov.au

H Wallwork (2000) *Cereal Root and Crown Diseases* (GRDC and SARDI)

For variety ratings, see state department crop variety and disease guides published annually:

- state department cereal disease guides (https://extensionaus.com.au/field-crop-diseases/cereal-disease-guides)
- National Variety Trials (NVT) Crop Guides (https://grdc.com.au/resources-and-publications/all-publications/crop-variety-guides)
- GRDC update papers with results on summer crops (https://grdc.com.au/resources-and-publications/grdc-update-papers/tab-content/grdc-update-papers/2016/07/summer-cropping-options-to-manage-root-lesion-nematodes)

RESEARCH CODE

GRDC Research Code: DAV00128
National Nematode Epidemiology and Management Program.

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Acknowledgements: Kirsty Owen and John Thompson, USQ; Steven Simpfendorfer, NSW DPI; Luise Sigel and Grant Hollaway, Agriculture Victoria

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