ROOT LESION NEMATODE FACT SHEET

GRDC
GRAINS RESEARCH & DEVELOPMENT CORPORATION

SOUTHERN
UPDATED OCTOBER 2019

Strategies to help reduce losses caused by root lesion nematodes

KEY POINTS

- Root lesion nematodes are species of *Pratylenchus* that feed on the roots of crops and can cause yield loss
- The yield loss caused by RLN is related to their number in the soil at planting
- Losses are more likely to occur when September and October maximum daily temperatures are above average and moisture is limited
- RLN have a wide host range and can multiply on cereals, oilseeds, pulses and pastures as well as on broadleaf and grass weeds
- The main RLN species in the southern region are *Pratylenchus neglectus* and *P. thornei*
- When RLN species are present in a paddock, this affects management practices, particularly the selection of rotational crops. This is because crops and varieties can vary in their resistance or susceptibility to each nematode species
- A PREDICTA® B test conducted prior to sowing can identify the number and species of nematodes present in the soil and thereby inform management practices
- Crop rotations using resistant crops/varieties are recommended to reduce RLN population densities and minimise yield losses in subsequent crops

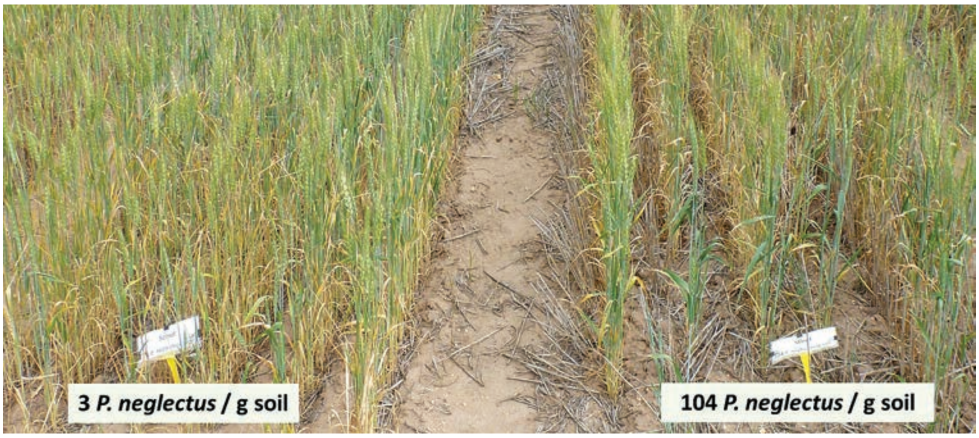

FIGURE 1: The effect of high (104 *P. neglectus*/g soil: right) numbers of RLN compared with low (3 *P. neglectus*/g soil: left) present at planting on wheat (cv. Scout) growing at Pinery, SA during 2018.

Introduction

Root lesion nematodes (RLN) are microscopic, worm-like organisms that feed within and damage plant roots, thus reducing crop yield. The key to managing RLNs is to identify paddocks with yield-limiting numbers present, then incorporate resistant crops and varieties into rotations to reduce their number (see Box 1, page 2).

Symptoms

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

Figure 1 above 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.

Given these symptoms are similar to those of other root diseases or nutrient constraints, plant roots need to be examined for symptoms of nematode damage.

To inspect root systems for disease, plants should be dug from the ground using a shovel, not pulled up, so that the whole root system is maintained, as diseased roots can easily break and remain in the soil. Roots must be carefully washed to remove soil, then floated in a white tray of water to observe symptoms of root damage. Compare the roots of plants growing in a healthy-looking crop with those of an unhealthy crop to help identify the affected roots.

In cereals, nematode-damaged seminal and crown roots will show a general browning and discolouration. There will be fewer and shorter lateral roots branching from the main roots and a lack of root hairs (Figure 2, see page 2). The root cortex (or outer root layer) may be damaged and 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.

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TABLE 1: Potential yield loss (%) caused by increasing numbers of root lesion nematodes (*Pratylenchus neglectus* and *P. thornei*) as detected by PREDICTA® B with associated risk categories in seasons that range from conducive to yield loss to non-conducive to yield loss in intolerant wheat varieties grown in the southern region.

	Yield loss %				
	Nematodes/g of soil		Seasonal conditions and frequency[A]		
			Conducive	Intermediate	Non-conducive
	Pratylenchus neglectus	*Pratylenchus thornei*	40%	30%	30%
BDL[B]	<0.1	<0.1	0	0	0
Low	0.1-24	0.1-14	0–5	0–2	0
Medium	25-100	15-60	5–20	2–10	0
High	>100	>60	20–40	10–20	0

[A] Conducive seasons are those favourable for yield loss by RLN. The historical frequency of these occurrences are provided.
The conditions that favour yield loss are not understood

[B] BDL: below detection level

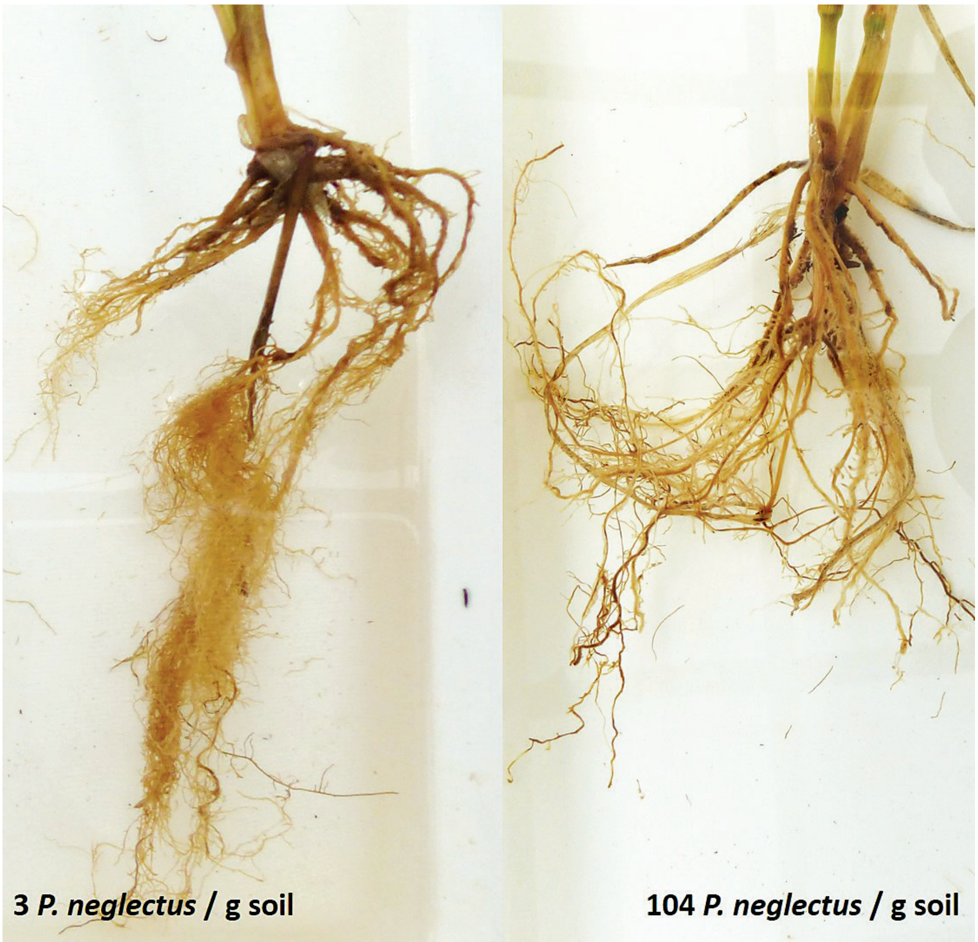

FIGURE 2: Symptoms of RLN on wheat roots; low level of RLN, 3 nematodes/g of soil (left) and high level of RLN, 104 nematodes/g of soil (right).

Distribution

A recent study of 2000 paddocks in the southern region detected RLN in 92 per cent of tested paddocks, with the two main species being *P. neglectus* (90 per cent) and *P. thornei* (29 per cent). *Pratylenchus penetrans, P. quasitereoides* and *P. crenatus* have also been reported in the region, but are rare.

Economic importance

A recent study estimated average annual losses of $16 million in wheat alone due to RLN across the southern region, with losses of $30 million possible during seasons conducive to nematode damage. Even though wheat losses from RLN across the whole southern region were generally less than one per cent, losses in individual paddocks can be greater than 10 per cent where nematode numbers are high.

Yield loss

The extent of losses from RLN is related to their number in the paddock at planting (Figure 3). Therefore, the first step in managing RLN is to identify those

BOX 1: RESISTANCE AND SUSCEPTIBILITY

Resistant or non-host crops/varieties will reduce nematode numbers during the season. These crops are good options to reduce nematode numbers and yield loss in a subsequent crop.

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

Resistance and susceptibility ratings are published in annual crop variety guides (see ‘Useful resources’ below) or NVT Online (www.nvtonline.com.au).

RESISTANCE RESEARCH

In the southern region, assessment of resistance of cereals and pulses to RLN is ongoing. Results currently show that although nematode multiplication rates changed between sites and seasons, the rankings of varieties for resistance were highly correlated. Field trials showed that the number of RLN at planting influences the ability of resistant varieties to reduce nematode numbers during the growing season. Multiplication is greater when initial, pre-sowing nematode numbers are low (Figure 8, see page 5).

paddocks with a yield-limiting number of nematodes present by testing the soil prior to planting (Box 2: Testing for RLN).

The relationship between pre-planting nematode numbers (based on a PREDICTA® B soil test result) and likely loss in wheat grain yield in a range of seasons is shown in Table 1. This table shows that the extent of wheat yield loss for a given number of nematodes varies based on: (a) RLN species, (b) how conducive the season is to nematode damage, and (c) the frequency of the seasonal occurrences. For example, a test result of 30 *P. thornei* per gram of soil will cause a yield loss of about 10 per cent in four out of 10 years and not cause yield loss in three out of 10 years.

Management

Where high numbers of RLN are identified in a paddock, the best control strategy is to rotate to a resistant crop/variety (Figure 4). Resistant crops reduce nematode numbers and, therefore, yield loss in the subsequent crop. In selecting resistant crops to reduce nematode numbers, it is important to know the dominant species of nematode present in a paddock as determined from soil tests (Box 2: Testing for RLN), as the nematode species can differ in their host range (Figure 5, see page 4).

For example, canola is a good option in paddocks with high *P. thornei,* but not in those with high *P. neglectus* (Figure 5). Conversely, chickpeas and faba beans are good options in paddocks with high *P. neglectus*, but not in those with high *P. thornei*. Triticale, field pea, lentil, durum wheat and lupins can all be used to reduce densities of either species or in paddocks where both species of nematode are present.

In most crops, such as wheat and barley, there is variation from one variety to another, so it is important to consult a current crop variety guide (see 'Useful resources') once a paddock has been identified as having an RLN issue.

Other strategies to reduce losses from RLN are to grow healthy crops and avoid late sowing. Heathy crops with adequate nutrition (especially nitrogen, phosphorus and zinc) will help reduce yield losses. Losses from RLN are higher in later-sown crops, so affected paddocks should be sown early in the cropping program.

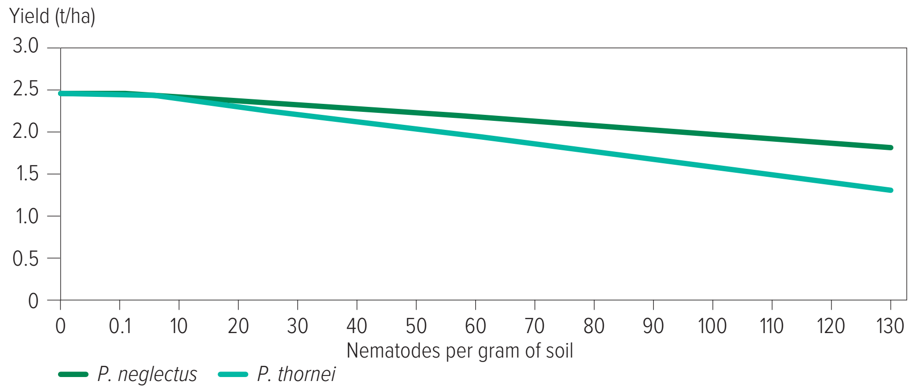

FIGURE 3: The effect of increasing numbers of RLN (*P. neglectus* and *P. thornei*) on the grain yield of wheat in a season conducive to yield loss in the southern region.

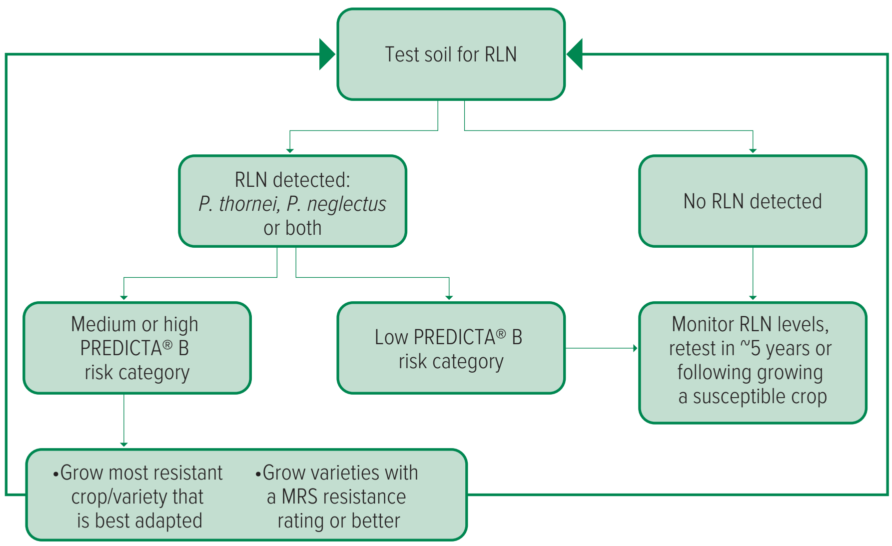

FIGURE 4: Process for managing RLN in the southern region.

BOX 2: TESTING FOR RLN

SOIL TESTS

Australian grain growers have access to world-leading testing services through the PREDICTA® B DNA-based soil test. This test can determine both the number and species of RLN in a soil sample. It can also detect a wide range of other important soil-borne pathogens such as: CCN, take-all, Rhizoctonia and crown rot. PREDICTA® B is available nationally through accredited agronomists (see below for contact details).

PRE-SOWING

A PREDICTA® B test taken prior to planting enables paddocks at risk of having a grain yield loss to be identified, thus enabling appropriate management strategies to be implemented. This is especially important since there are no in-crop management options available for RLN or many of the other soil-borne pathogens detected by PREDICTA® B. When collecting soil for a test, it is important to follow the paddock sampling recommendations provided on the PREDICTA® B website. See Useful Resources for details.

IN-CROP

Growers are advised to inspect crops for signs of ill thrift. To check the roots for symptoms caused by RLN, carefully dig them up and wash the soil off by soaking them in a bucket – overnight if needed – then carefully rinse them. Inspect the roots by floating them in water in a white tray. If the root symptoms are consistent with those described above, it is wise to use PREDICTA® B, a DNA-based soil-testing service, to confirm the diagnosis and determine the species present

FURTHER INFORMATION

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Biology

Root lesion nematodes (*P. thornei* and *P. neglectus*) are worm-like organisms, less than one millimetre in length, which use a syringe-like stylet as their mouthpart to break open root cell walls and feed on the root cell contents (Figure 6). They are migratory plant-parasitic nematodes, meaning they migrate freely within roots and between roots and soil if the soil is moist.

As plant roots and soil dry out in late spring, RLN enter a dehydrated state called anhydrobiosis and can survive high soil temperatures of up to 40°C and desiccation over summer. They can survive many years in this dehydrated state if the soil remains dry. The life cycle of RLN continues after the opening rains in autumn. Juvenile and adult nematodes rehydrate, become active and invade plant roots, where they feed and multiply as they move through the root (Figure 7).

As the nematodes feed on root cells and reproduce, brown lesions form in the root cortex and lateral roots decline in number.

Eggs are laid within the root or soil, with the first larval stage and moult occurring within the egg. Second-stage larvae emerge from eggs and undergo three more moults before reaching adulthood. They develop from egg to adult in 40 to 45 days (approximately six weeks) depending on soil temperature and host (Figure 7).

There may be three or four cycles within the plant each growing season, depending on soil temperature and moisture and length of the growing season. Multiplication is slow during winter; optimum temperature is between 20°C and 25°C. Under these conditions, one life cycle is generally completed in six weeks.

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, nutrient deficiencies or other soil-borne diseases. Depending on the extent of damage and the growing conditions, affected plants may partly recover if the rate of new root growth exceeds the rate at which nematodes damage the roots.

PHOTO: KIRSTY OWEN (UNIVERSITY OF SOUTHERN QUEENSLAND)

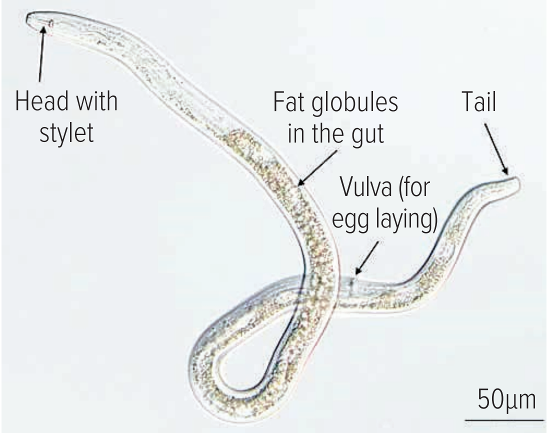

FIGURE 6: ***Pratylenchus*** **nematodes are microscopic, worm-like organisms, less than 1mm in length. They feed on and in root tissues using a syringe-like stylet to enter the roots and extract nutrients.**

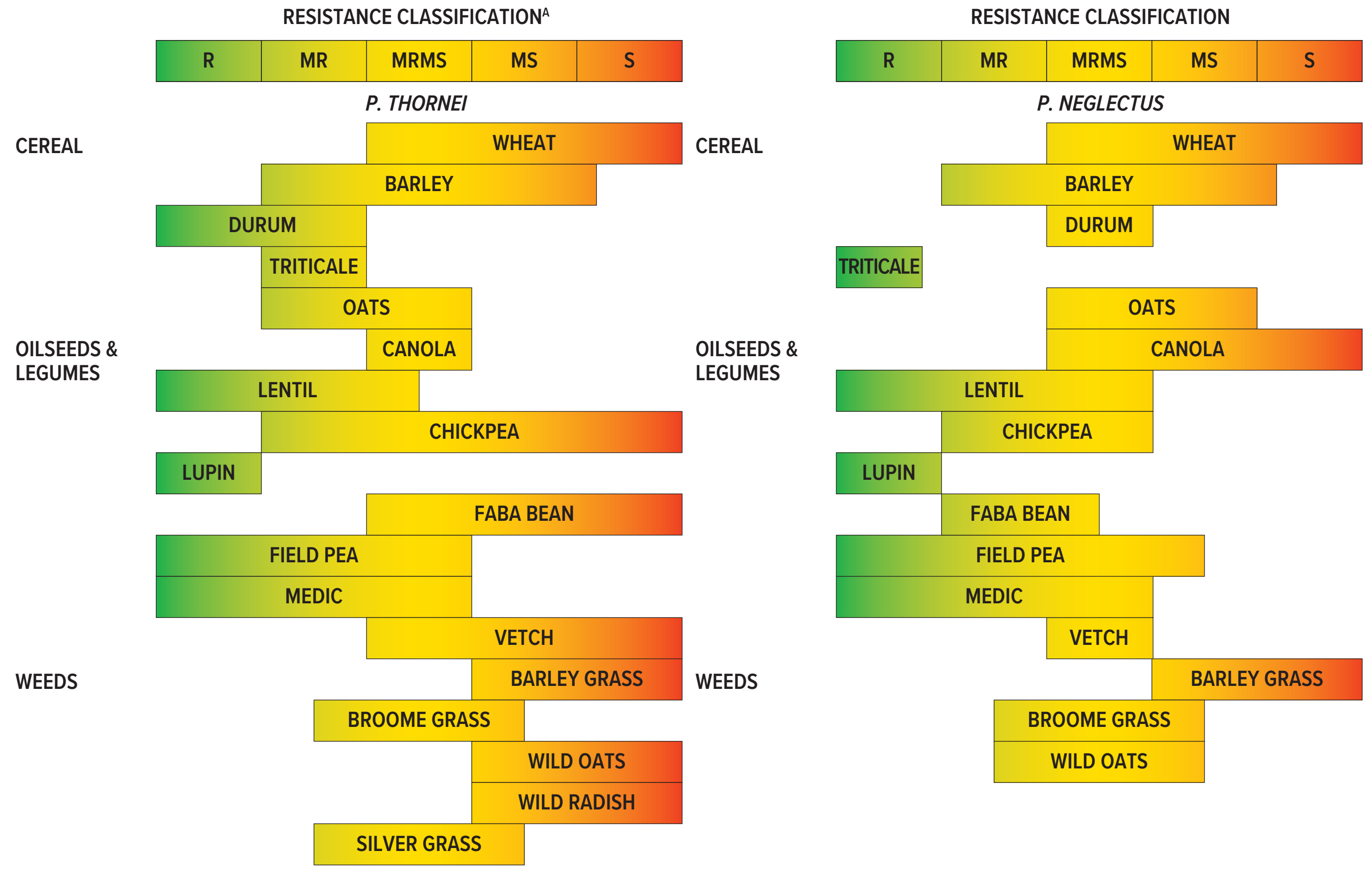

FIGURE 5: Comparison of the resistance of a range of cereals, oilseeds and pulses to RLN (*P. thornei* and *P. neglectus*). In some crops, hosting ability varies between varieties, as indicated where a range of risk ratings is shown. Therefore, it is important to check a current crop variety guide for your state (see 'Useful resources' page 6). New varieties may differ in their risk ratings from the overall rating for a crop species. [A] R= resistant S= susceptible

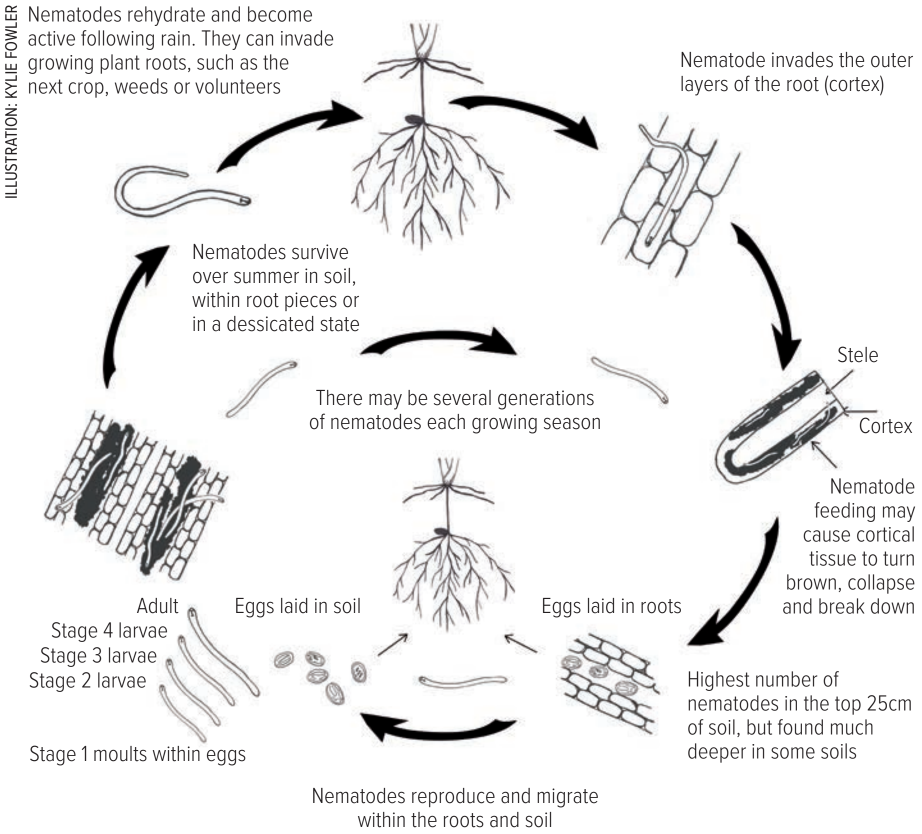

FIGURE 7: Disease cycle of RLN, adapted from GN Agrios (1997) *Plant Pathology*, 5th edn (Academic Press: New York).

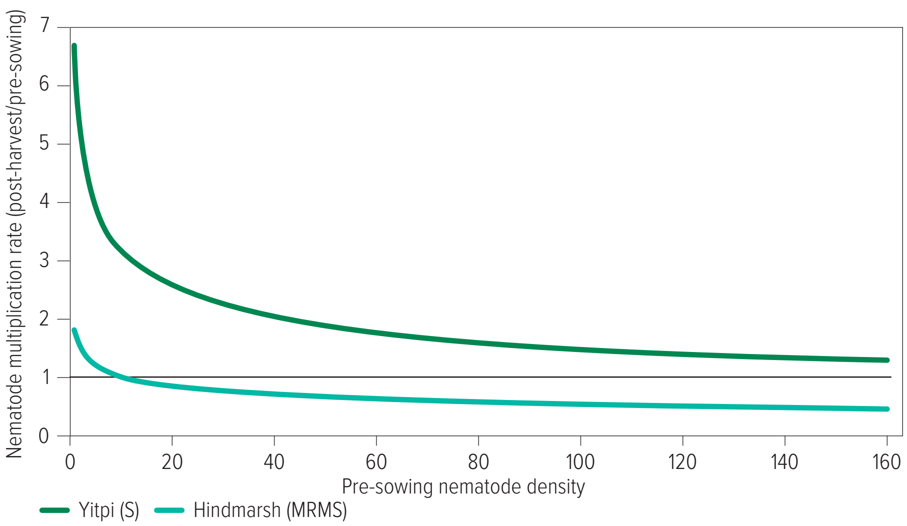

FIGURE 8: *P. thornei* multiplication is greater when initial pre-sowing nematode densities are low for a moderately resistant to moderately susceptible (Hindmarsh) and a susceptible (Yitpi) variety. A multiplication rate above 1 means nematode densities are increasing.

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

A Wimmera grower who had grown chickpea then wheat noticed the last wheat crop did not meet expectations. A subsequent PREDICTA® B test showed that the paddock had 70 *P. thornei*/g of soil but was free of other important soil-borne pathogens. This high nematode density is a likely cause of the poor crop performance and in a season conducive to nematode damage could reduce wheat yield by 20 per cent (Table 1, see page 2).

To reduce nematode numbers and subsequent yield loss, growing a resistant crop is recommended. By growing a resistant crop such as field pea (for example, PBA Percy, moderately resistant to moderately susceptible) or lentil (for example, PBA Jumbo 2, moderately resistant to *P. thornei*) in the year after the poor crop performance, followed by a moderately resistant barley (for example, Compass, moderately resistant to *P. thornei*), the nematode densities are likely to reduce from 70 to less than 15, making the paddock suitable for growing wheat again.

If a grower continued to grow susceptible crops, nematode numbers would remain high with possible yield losses of 20 per cent where a season is conducive to nematode damage. Figure 5 provides a comparison of the resistance of a range of cereals, oilseeds and pulses to RLN.

FREQUENTLY ASKED QUESTIONS

Why is my resistant cereal showing RLN root damage?

Resistant cereals sown into a paddock with RLN will be attacked and penetrated at a similar rate to a susceptible variety, causing the same damage. However, resistant cereals suppress the development of RLN in the root, so very few nematodes mature.

Does timing of sowing help?

Trials in northern and southern Australia have shown that later-sown wheat crops can be more severely affected than those sown early in the cropping program, so where high nematode numbers are present these paddocks should be sown early.

What other plant-parasitic nematode species are found in the southern region?

Cereal cyst nematode (CCN; *Heterodera avenae*) is a damaging pathogen of broadacre cereal crops in South Australia and Victoria. It affects wheat, barley, oats and triticale, and can cause yield losses of up to 80 per cent. The damage caused by the feeding nematode results in a proliferation of roots at the feeding site, forming a knot in the root and giving the plant symptoms characteristic of CCN. CCN has been successfully managed by growing resistant cereal varieties. See the CCN fact sheet for more information (https://grdc.com.au/TT-cereal-cyst-nematode).

Stem nematode (*Ditylenchus dipsaci*) occurs in many parts of the southern region. The main hosts are susceptible oat, faba bean and lucerne varieties. Symptoms include stunted plants and the bases of each tiller becoming swollen. Other crops such as field peas, chickpeas, canola and lentils are damaged extensively by stem nematode when they are seedlings. Symptoms include stunted and distorted leaves and stems. As crops mature, they become both resistant and tolerant. The PREDICTA® B soil test can detect stem nematode (Box 2: Testing for RLN).

USEFUL RESOURCES

PREDICTA® B – a soil analysis service provided by accredited agronomists. PREDICTA® B can detect *P. neglectus, P. thornei* and a range of other soil-borne diseases. Contact your local agronomist, or to locate your nearest supplier, email your contact details and location to russell.burns@sa.gov.au or nigel.percy@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)
- NVT crop variety guides (https://grdc.com.au/resources-and-publications/all-publications/crop-variety-guides)
- NVT Online (www.nvtonline.com.au)

MORE INFORMATION

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