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GRDC GROWNOTES™

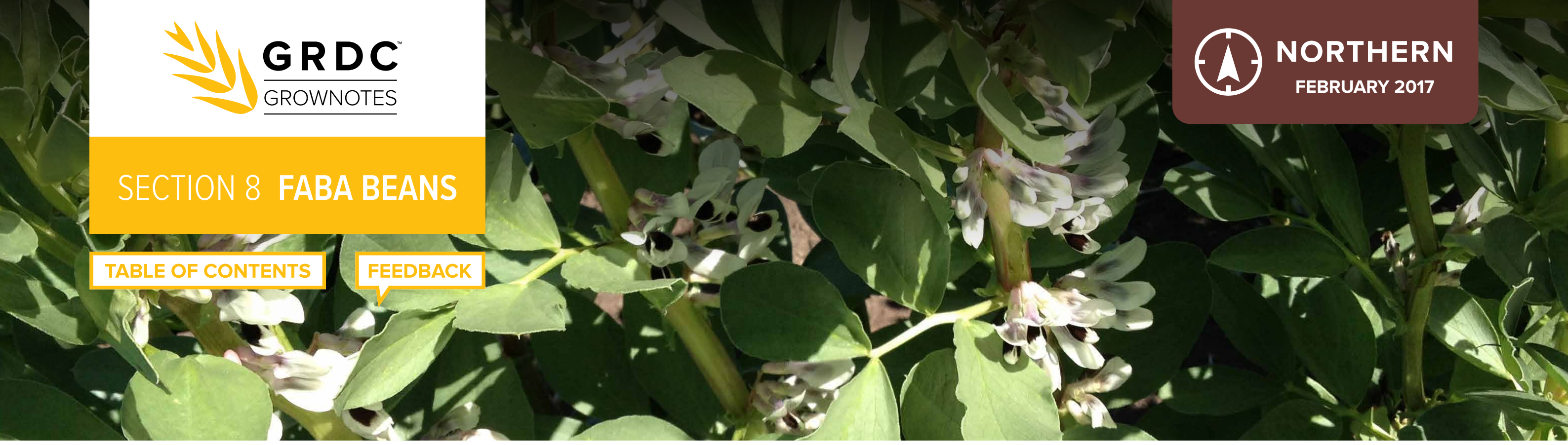
GRDC™ GRAINS RESEARCH & DEVELOPMENT CORPORATION

FABA BEAN

SECTION 8

NEMATODE MANAGEMENT

BACKGROUND | SYMPTOMS AND DETECTION | MANAGEMENT | DAMAGE CAUSED BY PEST | REFERENCES



Nematode management

8.1 Background

Root-lesion nematodes (*Pratylenchus thornei* and *P. neglectus*) are worm-like organisms, less than 1 mm in length, which feed inside plant roots. RLN use their head and a syringe-like stylet in their mouthpart to break open cell walls and feed on the contents of root cells (Figure 1). [1]

Root-lesion nematodes can complete several generations during growth in a susceptible crop. RLN develop from an egg and pass through four juvenile stages to become an egg-laying female. The females are self-fertile and males are rarely found of *P. thornei* and *P. neglectus*. Under ideal conditions, the life cycle takes about 6 weeks for *P. thornei*, depending on the temperature. 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 (see Figure 2).

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.

Studies have shown that the extent of yield loss caused by *P. thornei* and *P. neglectus* is related to the populations present at planting. In the northern grain region, *P. thornei* at two nematodes per gram of soil anywhere in the soil profile is considered a damaging population, causing yield loss of up to 70% in wheat and 20% in chickpeas.

Faba bean is resistant to *P. neglectus*. There are variable reports about the response of faba beans to *P. thornei* (Pt), but in terms of usefulness as a break-crop for Pt, the crop is generally rated as 'susceptible'.

1 GRDC Tips and tactics, Root-lesion nematodes. Northern region, https://grdc.com.au/Resources/Factsheets/2015/03/Root-Lesion-Nematodes

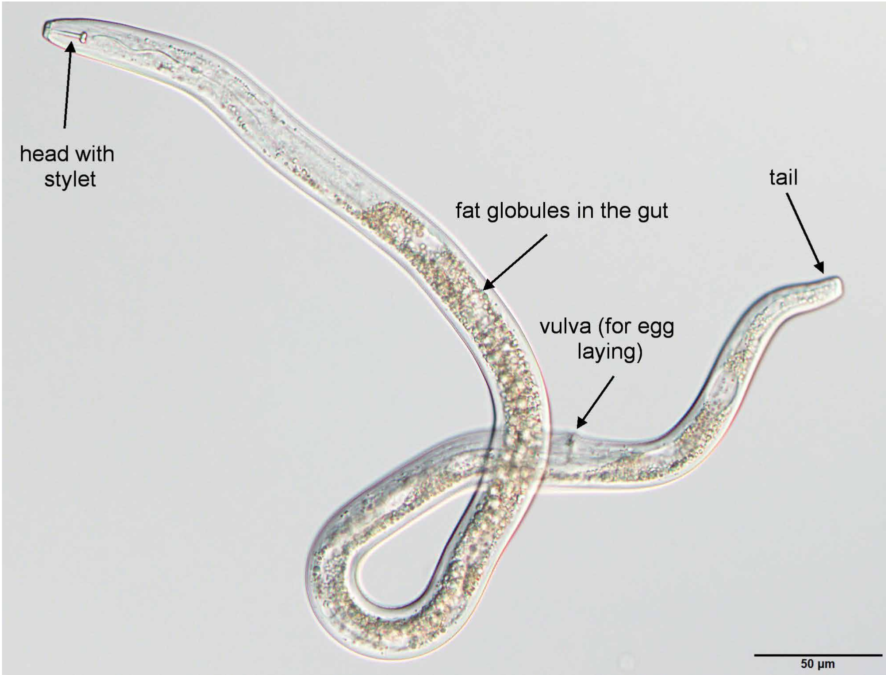


Figure 1: *A* Pratylenchus thornei *adult female viewed under the microscope. The nematode is approximately 0.65 mm long.*

Photo: GRDC Tips and tactics, Root-lesion nematodes. Northern region, https://grdc.com.au/Resources/Factsheets/2015/03/Root-Lesion-Nematodes

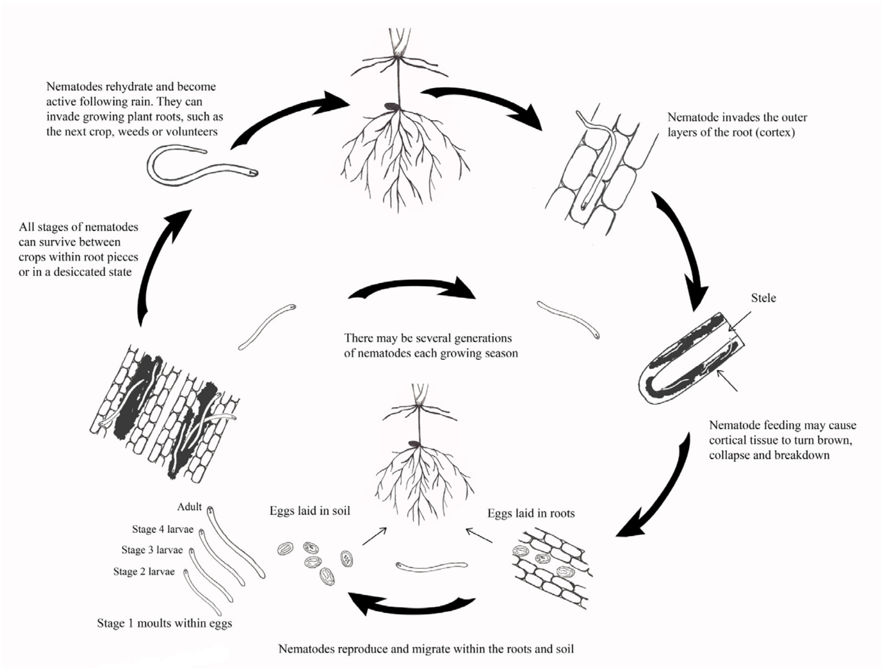


Figure 2: *Life cycle of root-lesion nematode.*

GRDC Tips and tactics, Root-lesion nematodes. Northern region, https://grdc.com.au/Resources/Factsheets/2015/03/Root-Lesion-Nematodes

MORE INFORMATION

Ground Cover Supplement: [Northern researchers dig deep to understand root lesion nematode life span]()

8.1.1 *Pratylenchus thornei*

In the northern grain region, RLN are found throughout northern New South Wales and Queensland. Pt is more widespread and generally occurs in higher populations than *P. neglectus* (see Figure 3).

MORE INFORMATION

GRDC Update Paper: Impact from Pratylenchus thornei, Macalister 2015

MORE INFORMATION

http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Summer-crop-decisions-and-root-lesion-nematodes#sthash.TECof4mR.pdf

https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice

Journal article: JP Thompson (2010) Occurrence of root-lesion nematodes (*Pratylenchus thornei* and *P. neglectus*) and stunt nematode (*Merlinius brevidens*) in the northern grain region of Australia. *Australasian Plant Pathology* (vol. 39, 254–264), http://link.springer.com/article/10.1071/AP09094

Results from 600 samples tested in 2010–13 showed that 50% of paddocks had populations above 2 nemotodes/g soil. A recent survey in Central Queensland found that 28% of paddocks had RLN, with 26% of those paddocks containing Pt. Populations were generally low, but in the Dawson–Callide region of Central Queensland, 5% of samples had populations above 2 nematodes/g soil. [2]

At planting, damaging populations of RLN can be found deep in the soil. In some soils, peak numbers are as deep as 60 cm. This happens because the hot, dry conditions of the surface soil can cause nematode death, and RLN can migrate down the soil profile where cooler, moist conditions favour survival. Therefore, be aware that RLN populations in surface soil may not give a full picture of the population density at depth threatening crops, particularly after a long fallow. However, if RLN are detected in the surface soil, start actively managing for RLN.

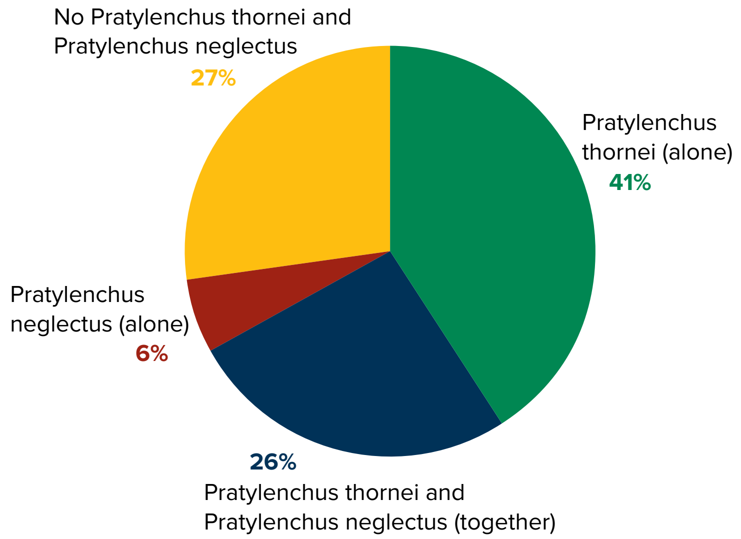


Figure 3: *Occurrence of* Pratylenchus thornei *and* P. neglectus *from 2010 to 2013 in the northern grain region (604 paddocks); 50% of samples had root-lesion nematode populations above the wheat damage threshold of 2,000 nematodes/kg soil (or 2/g soil).*

GRDC Tips and tactics, Root-lesion nematodes. Northern region, https://grdc.com.au/Resources/Factsheets/2015/03/Root-Lesion-Nematodes

8.1.2 Other nematodes in the northern grain region

The stunt nematode (*Merlinius brevidens*) is widely distributed in the northern region (found in about three-quarters of fields). It feeds on the outside of plant roots (an ectoparasite) and it is thought to be less damaging than RLN. In 2007, large populations were identified in winter cereals in northern NSW, and research is under way into the interaction of these nematodes with fungi in causing root disease.

In lighter textured soils, stubby-root nematode (*Paratrichodorus* sp.) and root-knot nematodes (*Meloidogyne* spp.) have been found on cereals and grain legumes. Other RLN species occurring away from traditional wheat areas are *Pratylenchus zeae* on maize and sugarcane, and *Pratylenchus brachyurus* on peanuts.

There have been isolated reports of cereal cyst nematode (*Heterodera avenae*) from near Tamworth and Dubbo in NSW, on lighter textured soils and friable clay soils. [3]

2 GRDC Tips and tactics, Root-lesion nematodes. Northern region, https://grdc.com.au/Resources/Factsheets/2015/03/Root-Lesion-Nematodes

3 J Thompson, K Owen, T Clewett, J Sheedy, R Reen (2009) Management of root-lesion nematodes in the northern grain region. Department of Agriculture, Forestry and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/crop-diseases/root-lesion-nematode

8.2 Symptoms and detection

Root-lesion nematodes are microscopic and cannot be seen with the naked eye in the soil or in plants. The most reliable way to confirm the presence of RLN is to test farm soil. Nematodes are extracted from the soil for identification and determination of their population size. Look out for tell-tale signs of nematode infection in the roots and symptoms in the plant shoots, and if seen, submit soil and root samples for nematode assessment.

Aboveground symptoms of RLN attack in wheat can include:

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

If crown rot is also present, then RLN attack can increase the expression of whiteheads. Many susceptible crops, other than wheat, do not show aboveground symptoms of RLN attack.

Figure 4: *Symptoms of severe root-lesion nematode damage in an intolerant wheat variety.*

Source: Management of root-lesion nematodes in the northern grain region: http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/crop-diseases/root-lesion-nematode

Symptoms can be confused with nutrient deficiency and may be exacerbated by a lack of nutrients. Infected plants may wilt prematurely in dry periods and at the end of the season.

When roots are damaged by RLN, the plants become less efficient at taking up water and nutrients and tolerating stresses such as drought or nutrient deficiencies. Affected plants may partly recover if the rate of new root growth exceeds the rate at which RLN damage the roots. However, recovery will depend on the extent of root damage, the growing conditions, and whether sufficient fertiliser is applied.

An examination of washed plant roots may provide some information, but symptoms can be difficult to see and roots may be difficult to remove from heavy clay soils. Primary and secondary roots may show a general browning and discoloration.

The root cortex (or outer root layer) is damaged and may disintegrate. Diagnosis is best confirmed with laboratory testing of soil and/or plants for the presence and population densities of the two species. [4]

4 GRDC (2009) Root lesion nematode dominates in the north. Northern Region. Plant Parasitic Nematodes Fact Sheet, GRDC, http://www.grdc.com.au/uploads/documents/GRDC_NematodesFS_North_4pp.pdf

MORE INFORMATION

GRDC Update Paper: Root lesion nematodes importance impact and management

MORE INFORMATION

Single test improves stubble-borne disease management

MORE INFORMATION

Predicta B an identity kit for soil borne pathogens

8.3 Management

No nematicides are currently registered for use in cereal crops in the northern grain region. Nematicides are expensive and offer only partial control of RLN in the northern grain region, because of poor penetration into the soil (RLN are often found deep in the soil profile). [5]

Rotations and variety choice are key to the successful reduction of RLN populations in the soil. Only non-host crops or resistant varieties will minimise the build-up of RLN. Tolerant crops will suffer less damage, but if these varieties are susceptible, RLN numbers can still increase.

As different species of RLN can be hosted on different crops, it is important to identify which species is/are present. Testing services are available around Australia and growers are advised to contact their local department of agriculture.

Regular testing has shown that there are crop varieties with tolerance to Pt. It is recommended that varieties be chosen to minimise crop loss. In cases of heavy infestation with Pt, non-affected crops such as sorghum (grain and forage), cotton, millets (but not white french millet), panicum, sunflowers, lablab, pigeon peas, canary seed, durum wheat and linseed can be grown in rotation.

For *P. neglectus*, faba beans, mungbeans, black gram, soybeans, cowpeas, lablab, triticale, and linseed can be grown.

Testing for RLN

1. *Test your farm.* A microscope-based identification and counting service for nematodes found on grain farms in the northern region provided by QDAF Qld. Contact QDAF Customer Service Centre on 13 25 23.
2. PreDicta B. A DNA-based soil analysis service that is delivered by accredited agronomists and can detect *P. neglectus*, *P. thornei* and cereal cyst nematode. Contact your local agronomist, or to locate your nearest supplier, email your contact details and location to predictab@saugov.sa.gov.au. Crown Analytical Services in Moree are the agents for the northern region (phone 0437 996 678 or email: crownanalytical@bigpond.com).

CASE STUDY

Impact of summer crops or a weed-free fallow on the yield of the next wheat crop and on Pratylenchus thornei populations in Queensland

The experiments were set up at a *P. thornei*-infested site, in adjacent fields with differing cropping histories: (i) a low *P. thornei* site with a cropping history of five successive, resistant crops (cotton, sunflowers and maize) where *P. thornei* populations were 0.15 nematodes/g soil at 0–90 cm soil depth; and (ii) a damaging *P. thornei* site with a cropping history of only one resistant sorghum crop (wheat, sorghum, wheat) where *P. thornei* populations were 2.5/g soil at 0–90 cm soil depth.

A weed-free fallow and several varieties each of sorghum, maize, sunflowers, mungbeans and soybeans were planted; then after a 13-month fallow, tolerant and intolerant wheat varieties were planted.

Low *P. thornei* site. This experiment showed no differences in *P. thornei* populations after growing the summer crops. Populations remained very low 0.25 nematodes/g soil at 0–90 cm soil depth. The following tolerant wheat (cv. EGA Wylie) yielded 3.7 t/ha and the intolerant wheat (cv. Strzelecki) 3.6 t/ha (see Figure 5).

5 J Thompson, K Owen, T Clewett, J Sheedy, R Reen (2009) Management of root-lesion nematodes in the northern grain region. Department of Agriculture, Forestry and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/crop-diseases/root-lesion-nematode

Damaging *P. thornei* site. Populations increased after growing most soybean and mungbean varieties. Mungbean cv. Emerald and soybean cv. Soya791⊕ were moderately resistant compared with the other varieties. After growing sorghum, maize and sunflowers, populations of

P. thornei were similar to those in the fallow and there were no significant differences between hybrids (see Figure 5). The following tolerant wheat (cv. EGA Wylie⊕) yielded 3.7 t/ha and the intolerant wheat (cv. Strzelecki) 1.9 t/ha (see Figure 5).

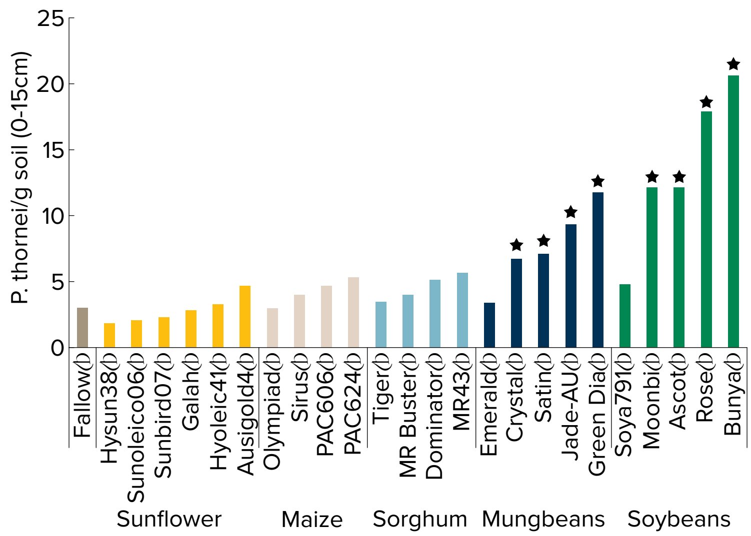


Figure 5: *Populations of* Pratylenchus thornei *per g soil (0–15 cm depth) at harvest of summer crops. The star indicates populations significantly (P < 0.05) higher than the fallow treatment.*

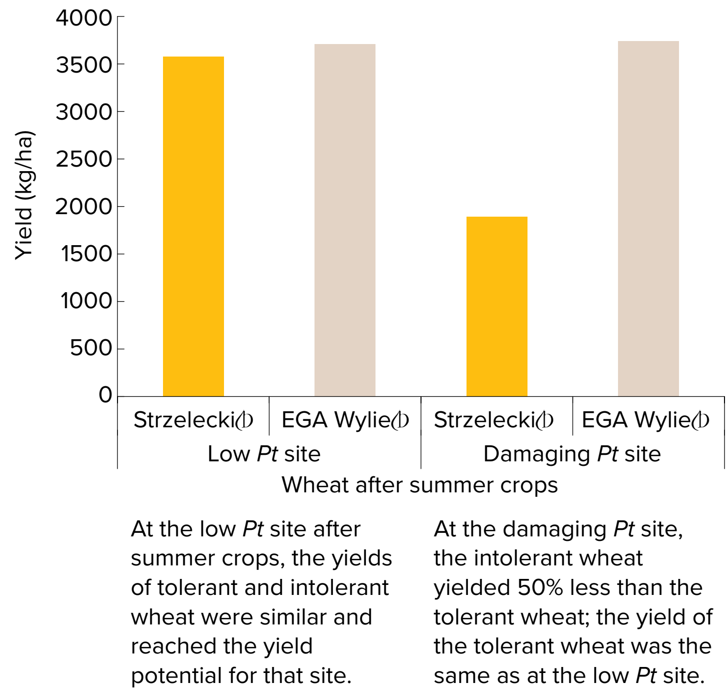


Figure 6: *Yields of tolerant wheat (cv. EGA Wylieⓓ), and intolerant wheat (cv. Strzelecki), at the sites that began with low or damaging populations of P. thornei (Pt). Wheat yields are averaged across the summer crops planted before the wheat.*

8.3.1 Resistance *versus* tolerance

Resistance: nematode multiplication

- Resistant crops do not allow RLN to reproduce and increase in number in their roots.
- Susceptible crops allow RLN to reproduce so that their numbers increase. Moderately susceptible crops allow increases in nematode populations but at a slower rate.

Tolerance: crop response

- Tolerant varieties or crops yield well when sown in fields containing large populations of nematodes.
- Intolerant varieties or crops yield poorly when sown in fields containing large populations of nematodes (Figure 7 and Table 1).

Variety ratings for nematodes

Varieties are rated according to their tolerance or intolerance and their susceptibility or resistance to nematodes. The mechanisms of resistance and tolerance are different and need to be treated as such.

Intolerance means the crop yields poorly when attacked.

Susceptibility means nematode numbers increase during the cropping season.

Tolerance and intolerance ratings indicate the effect nematodes will have on the yield of the current crop.

Resistance/susceptibility ratings indicate the effect the crop variety will have on reproduction of the nematodes, and hence the possible effect on the next crop via the nematode population remaining in the soil to infect the next crop.

Pictured are four combinations of ratings for nematodes. Tolerance/intolerance = the effect on the yield of the current crop, Resistance/susceptibility = the effect on building nematode numbers and the carryover to next year's crop.

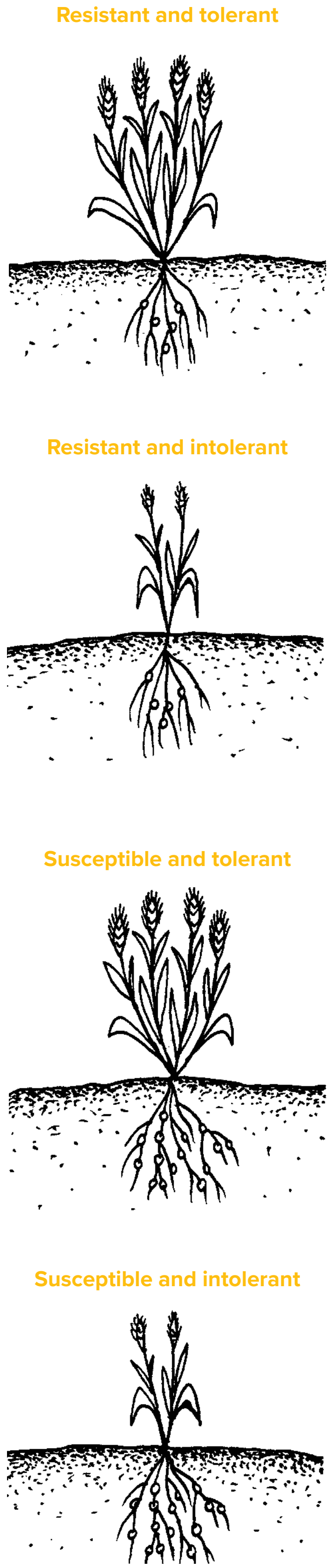


Figure 7: *Variety ratings for nematodes.*

Source: Southern and Western Plant Parasitic Nematodes Fact Sheet 2009, GRDC, http://www.grdc.com.au/uploads/documents/GRDC_NematodesFS_SthWst_6pp.pdf

Table 1: *Resistance and tolerance of pulses to* Pratylenchus *spp.*

	Pratylenchus neglectus		*Pratylenchus thornei*	
	Resistance	**Tolerance**	**Resistance**	**Tolerance**
Chickpeas	S–MR	MI–T	VS–R	MI–T
Faba beans	R	-	MR	MI
Field peas	R	-	R	T
Lentils	R	T	R	MT
Vetch:				
Blanchefleur	MR	T	S	I–MI
Languedoc	MR	T	MS	I–MI
Morava	MR	T	MS	I–MI

S, Susceptible; R, resistant; I, intolerant; T, tolerant; M, moderately; V, very. Chickpea varieties have a range of resistances and tolerances to Pratylenchus species

Paddock hygiene

A paddock that is free of parasitic nematodes is a valuable asset. RLN appears to be spread in soil moved by surface water, vehicles and farm machinery. Good hygiene, by removing adherent soil from farm machinery, should be adopted to avoid infesting clean paddocks. Avoid contamination of fields by ensuring that farm machinery entering this paddock is free of soil from other paddocks. It is essential to clean machinery with a pressure hose away from uninfested paddocks.

8.4 Damage caused by pest

Numbers of RLN build up steadily under susceptible crops (Figure 8), causing a decrease in yields over several years. Yield losses >50% can occur in some wheat varieties and up to 20% in some chickpea varieties. The amount of damage caused will depend on:

- the numbers of nematodes in the soil at sowing
- the tolerance of the variety of the crop being grown
- the environmental conditions

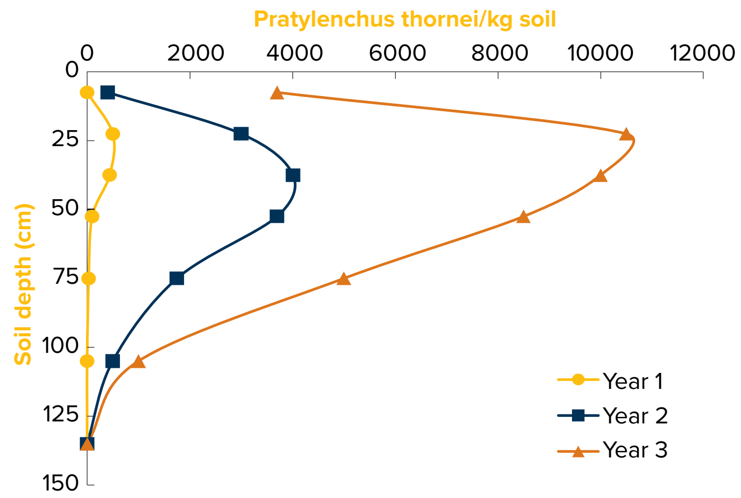


Figure 8: *Numbers of root-lesion nematode (*Pratylenchus thornei*) during 3 years of continuous wheat at Wellcamp, Queensland. Populations increased from low levels to levels that would reduce yields of intolerant crops. The graphs show numbers in the soil sampled before sowing wheat each year.*

Source: Management of root-lesion nematodes in the northern grain region: http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/crop-diseases/root-lesion-nematode

8.4.1 How do faba beans compare with other crops for build-up of *Pratylenchus thornei*?

The Northern Grower Alliance has conducted trials on the response of faba beans to Pt. Comparisons were made with other crops, and between varieties of faba beans.

Key findings:

- The faba bean varieties tested resulted in similar Pt build-up to the bread wheat and chickpea varieties. Canola (two sites), linseed and field peas left lower populations of Pt.
- The differences between faba bean varieties for Pt build-up appear smaller than for chickpea or wheat. PBA Warda⦇ tended to show lower Pt build-up than Doza⦇ and Cairo⦇.
- There is no evidence to date of yield losses to Pt in faba beans.

MORE INFORMATION

GRDC Update Paper: Impact from Pratylenchus thornei, Macalister 2015

Table 2: *Comparison of crops for Pt build-up risk and frequency of significant variety differences.*

Crop	Pt build-up risk	Variety differences
Sorghum	Low	None observed
Cotton	Low	None observed
Sunflower*	Low	None observed
Linseed*	Low	-
Canola*	Low** to Medium	None observed
Field peas*	Low to Medium	Low
Durum-wheat	Low to Medium	Moderate
Barley	Low to Medium**	Moderate
Bread-wheat	Low, Medium to High**	Large
Chickpea	Medium to High	Moderate to Large
Faba beans	Medium to High	Low
Mung beans*	Medium to High ?	Moderate to Large ?

Source: GRDC 2015

For crops with a range of build-up risk but a dominant category, the dominant category is in bold e.g. barley where the majority of varieties in the medium risk category but some low risk

* data only from 1–2 field trial locations for these crops; ** crops with a range of build-up risk but a dominant category, the dominant category is identified by (**), e.g. barley, where the majority of varieties are in the medium risk category but some low risk; bread-wheat, varieties in all categories but most varieties are in the medium to high risk categories.

Comparisons between species

Yallaroi 2012 (Figure 9)

Samples were taken on 2 January 2013.

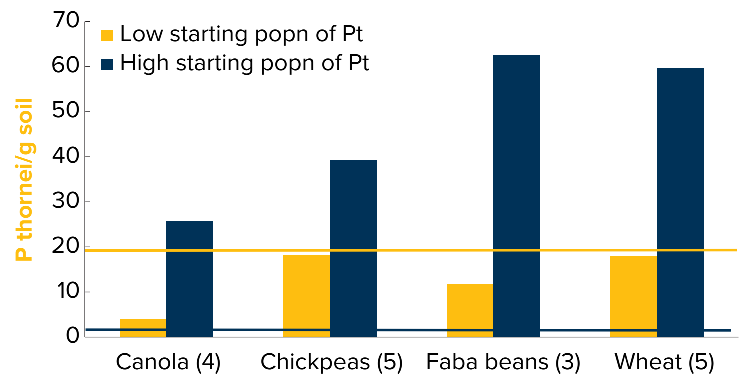


Figure 9: Pratylenchus thornei *populations remaining after a range of winter crop species at Yallaroi 2012 (numbers in parentheses are the number of varieties for each crop—for wheat, this is five common bread wheat varieties). The two horizontal lines indicate the starting population levels when sampled 24 February 2012.*

Weemelah 2011 (Figure 10)

Samples of all crops except faba beans and wheat were taken on 21 March 2012. Samples of faba beans and wheat were taken on 30 April 2012.

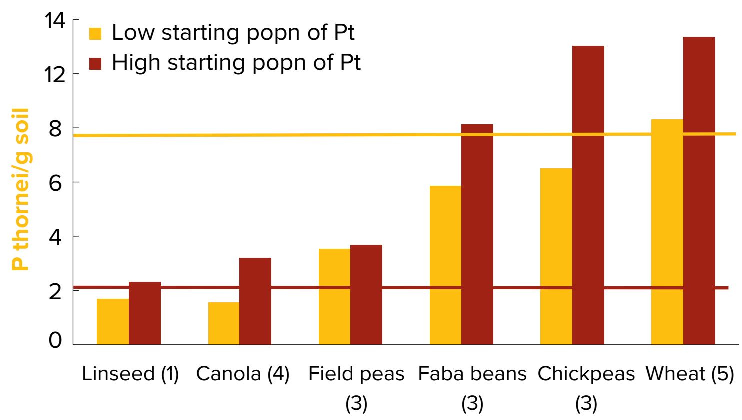


Figure 10: Pratylenchus thornei *populations remaining after a range of winter crop species at Weemelah 2011 (numbers in parentheses are the number of varieties for each crop—for wheat, this is five common bread wheat varieties). The two horizontal lines indicate the starting population levels when sampled 31 March 2011.*

Comparisons between faba bean varieties

Yallaroi 2012 (Figure 11)

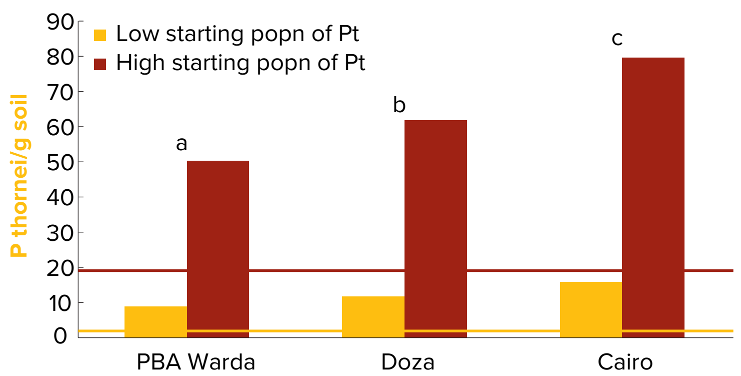


Figure 11: Pratylenchus thornei *populations remaining after growing faba bean varieties at Yallaroi 2012. The two horizontal lines indicate the starting population levels when sampled 24 February 2012. Varieties that do not share the same letter are significantly different at P = 0.05.*

Tulloona (NVT) 2012 (Figure 12)

Samples were taken on 19 February 2013.

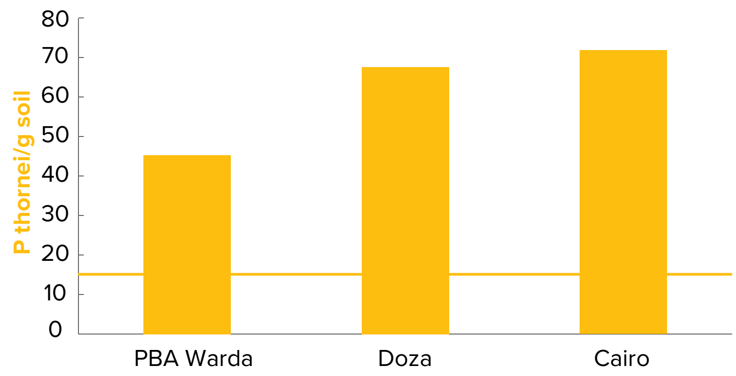


Figure 12: Pratylenchus thornei *populations remaining after a range of faba bean varieties at Tulloona 2012. Horizontal line indicates the starting population level at planting. There was no significant difference between varieties.*

Weemelah 2011 (Figure 13)

Samples were taken on 30 April 2012.

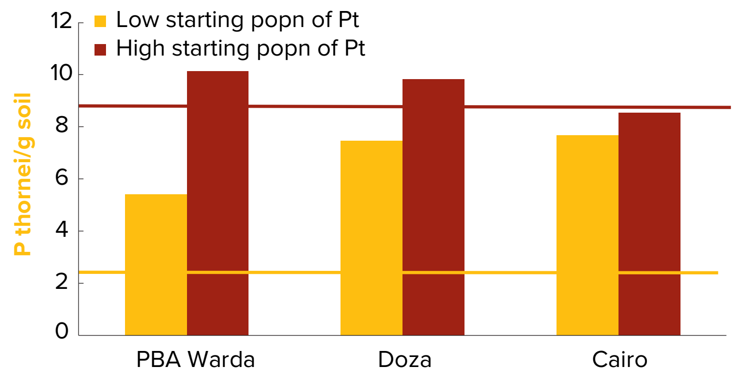


Figure 13: *Comparison of Pt populations remaining after a range of faba bean varieties at Weemelah 2011. The horizontal line indicates the starting population level when sampled 31 March 2011. There was no significant difference between varieties.*

For more information on nematodes in pulse crops, see GRDC GrowNotes—Chickpeas Section 8.

8.5 References

R Daniel (2013) Managing root lesion nematodes: how important are crop and variety choice? GRDC Update Papers 17 July 2013, https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice

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MORE INFORMATION

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JP Thompson (2010) Occurrence of root-lesion nematodes (*Pratylenchus thornei* and *P. neglectus*) and stunt nematode (*Merlinius brevidens*) in the northern grain region of Australia. *Australasian Plant Pathology* 39, 254–264; http://link.springer.com/article/10.1071/AP09094

J Thompson, K Owen, T Clewett, J Sheedy, R Reen (2009) Management of root-lesion nematodes in the northern grain region. Department of Agriculture, Forestry and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/crop-diseases/root-lesion-nematode