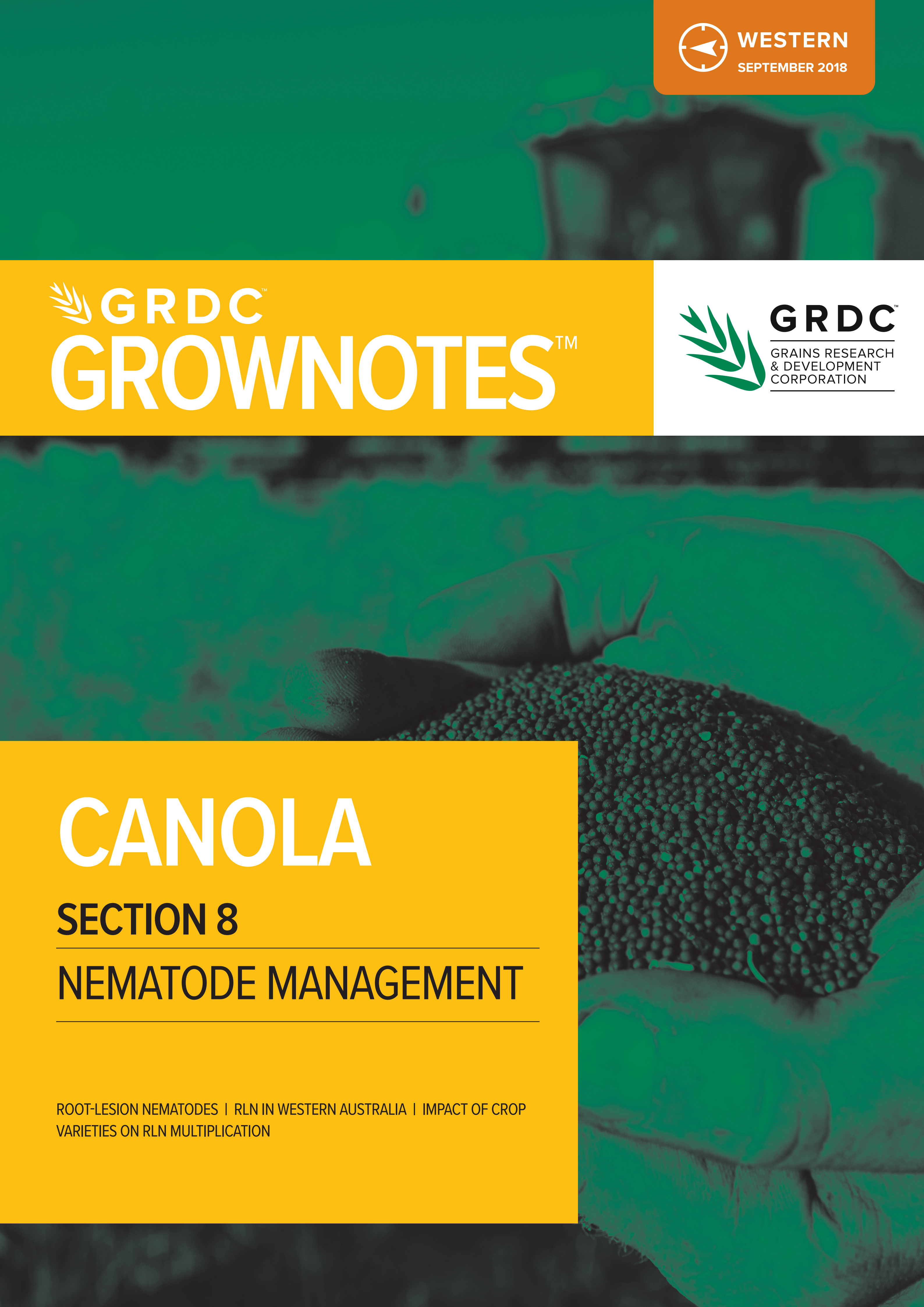

WESTERN
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CANOLA

SECTION 8

NEMATODE MANAGEMENT

ROOT-LESION NEMATODES | RLN IN WESTERN AUSTRALIA | IMPACT OF CROP VARIETIES ON RLN MULTIPLICATION

SECTION 8

Nematode management

More information

[Managing root lesion nematodes: how important are crop and variety choice?]

[Root lesion and burrowing nematodes: diagnosis and management]

[Plant parasitic nematodes Fact Sheet (Southern & Western Region)]

[eXtensionAUS: Root-lesion nematode]

[Root lesion nematode has a picnic in 2013]

8.1 Root-lesion nematodes

Root-lesion nematodes (RLN) can have an impact on canola growth (Figure 1). However, following harvest, levels of the RLN *Pratylenchus neglectus* have been found to decline rapidly, due to the release of isothiocyanates from decomposing root tissue. Sulfur-deficient or stressed crops are more likely to host increasing nematode numbers during the season and have less effect on their decline at the end of the season. [1]

Testing soil is the only reliable way to determine whether RLN are present in a paddock. Before planting, soil tests can be carried out by PreDicta B (SARDI Diagnostic Services) through accredited agronomists to establish whether crops are at risk and whether alternative crop types or varieties should be grown. Growing-season tests can be carried out on affected plants and associated soil; contact the Department of Agriculture and Food Western Australia (DAFWA) or PreDicta B.

Canola is considered moderately susceptible to *P. neglectus*, *P. quasitereoides* and *P. penetrans*. [2]

1 L Serafin, J Holland, R Bambach, D McCaffery (2005) Canola: northern NSW planting guide. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/148300/canola-northern-NSW-planting-guide.pdf

2 GRDC (2015) Root-lesion nematodes. GRDC Tips and Tactics, February 2015, http://www.grdc.com.au/TT-RootLesionNematodes

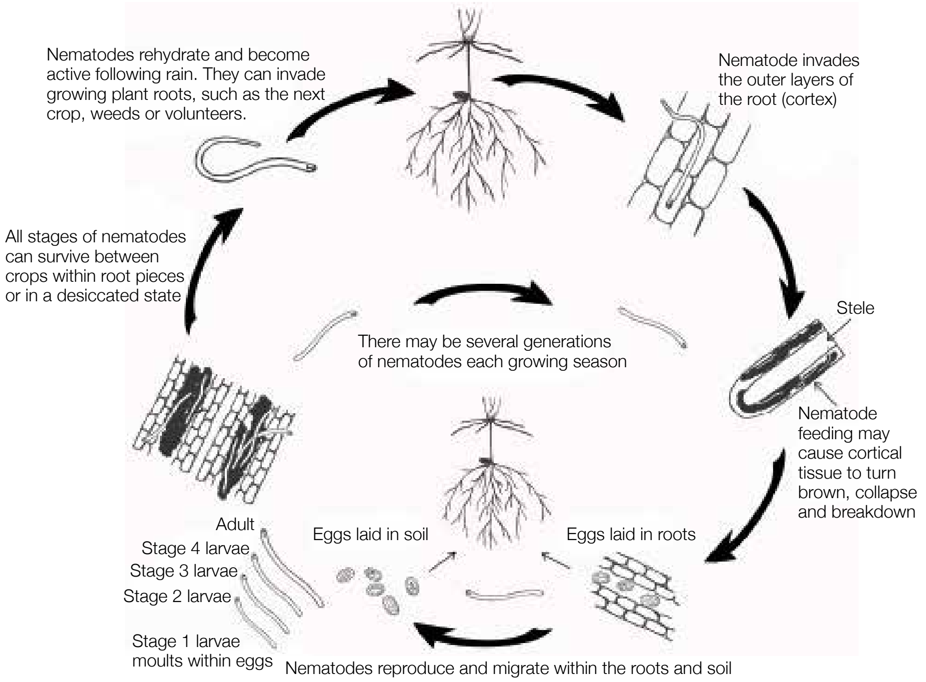

Figure 1: Disease cycle of root-lesion nematode. Adapted from: GN Agrios (1997) Plant pathology, 5th edn. (Illustration by Kylie Fowler) [3]

More information

[Root-lesion nematodes](#)

[RLN in WA](#)

[*Pratylenchus quasitereoides*—WA's home grown root lesion nematode](#)

8.2 RLN in Western Australia

- RLN are found over 5.74 million ha (or ~65%) of the cropping area of Western Australia (WA).
- Populations potentially limit yield in at least 40% of these infested paddocks.
- The main species found in broadacre cropping in WA are *P. neglectus*, *P. quasitereoides* (previously known as *P. teres*), *P. thornei* and *P. penetrans*.
- The host range of RLN is broad, and it includes cereals, oilseeds, grain legumes and pastures, as well as many broadleaf and grass weeds.

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8.2.1 *Pratylenchus quasitereoides*—WA's home-grown RLN and its unique impacts on broadacre crops

Key messages

- *Pratylenchus quasitereoides* is unique to WA, has a wide host range and is capable of causing significant yield damage.
- Crop rotation and selection of resistant cultivars are the keys to management of RLN. Growers need to know which species of RLN are present because cultivars resistant to one species may be susceptible to another, so suitable rotations will vary.

[3] GRDC (2015) Root-lesion nematodes. GRDC Tips and Tactics, February 2015, http://www.grdc.com.au/TT-RootLesionNematodes

- Ongoing DAFWA research is developing rotational recommendations through the characterisation of wheat cultivar resistance and tolerance levels.
- Become familiar with root and crop symptoms associated with nematode damage.
- Make use of available testing services to determine nematode species and levels, but be aware that PreDicta B cannot currently detect the presence of *P. quasitereoides* in crops.
- AGWEST Plant Laboratories can conduct in-season nematode diagnosis.
- Consider the influence of soil nematode levels not only on the current crop, but also on subsequent crops in the rotation.

Aims

Root-lesion nematodes are microscopic, migratory endoparasites. This means that RLN enter roots, feed on cell contents, and then either remain to continue feeding within the same root or exit and move to nearby root systems. This process damages the root system, making water and nutrient uptake less efficient. Plants are therefore less able to tolerate other stresses. RLN damage is estimated to cause crop losses of ~$190 million/year in southern and Western Australia. [4]

It is estimated that one or more species of RLN occur in at least 60% of WA cropping paddocks, that is, over at least 5.3 million ha of the WA cropping zone. Surveys also found that RLN is at yield-limiting levels in at least 40% of paddocks. Several types of RLN are responsible: *P*. *neglectus* is the most frequently identified in WA, occurring in at least 40% of paddocks; *P*. thornei occurs rarely (~8% of paddocks); and *P. quasitereoides* is found in ~15% of cropping paddocks in WA. Cereal yield losses due to RLN are ~10–30% but can be higher (25–75%) for individual crops, particularly where *P. quasitereoides* occurs.

Pratylenchus quasitereoides is unique to WA, can reach high population levels, and can cause more significant and widespread damage within a crop than *P. neglectus*. Information is required to enable growers to manage *P. quasitereoides* within their cropping rotations by using species that are poor hosts or non-hosts, or resistant cultivars of wheat and barley to limit the multiplication of this pest in the soil. Crops resistant to *P. neglectus* can be highly susceptible to *P. quasitereoides*, which means that a different suite of rotational crops and cultivars is needed for effective management. It is therefore imperative that the species of RLN is correctly identified in field diagnoses.

Nematodes cannot be controlled in broadacre Australian agriculture by chemical means; therefore, genetic and other solutions should be deployed to facilitate effective management in dryland cropping systems. This involves not only the development and use of cereals with resistance and/or tolerance, but also the appropriate use of non-cereal crops in rotational sequences to maintain low nematode populations. By screening and field-testing the resistance and tolerance of wheat and barley cultivars,

4 V Vanstone, G Holloway, G Stirling (2008) Managing nematode pests in the southern and western regions of the Australian cereal industry: continuing progress in a challenging environment. *Australasian Plant Pathology* 37, 220–234.

relevant information can be supplied to allow growers to incorporate cultivars into rotations that limit the populations of, and damage caused by, nematodes.

Methods

Field assessments

Trials conducted in 2009 at Katanning assessed resistance of a wide range of crops to *P. quasitereoides*, including 22 wheat, 21 barley and 12 canola cultivars. Resistance refers to the effect of the plant on the nematode; resistant plants inhibit nematode reproduction, resulting in declining nematode numbers. To determine resistance, nematode numbers were compared at planting and anthesis, with the level of multiplication of the nematodes over the growing season providing an estimate of the relative susceptibility or resistance of the cultivars assessed (multiplication by >1 indicates a susceptible cultivar). These assessments provided valuable information for development of current field and glasshouse trials.

Current trials are conducted over 2 years. In the first year, *P. quasitereoides*-resistant and -susceptible crops are bulk-sown to manipulate nematode levels to produce 'high' and 'low' populations at which to compare yields of 24–26 wheat cultivars in the following year. In this way, relative cultivar tolerances are determined based on the yield differences that occur between paddocks with the 'high' and 'low' nematode populations. Tolerance is a measure of the effect of the nematode on plant growth, so the larger the yield difference, the more intolerant the cultivar. For tolerant cultivars, there will be little difference in yield between the paddocks with 'high' and 'low' nematode populations. Resistance information was also collected for each variety.

Glasshouse trials

Crop-cultivar resistance data are required to recommend management and rotations. Glasshouse trials allow assessment of multiple cultivars in highly replicated trials. Cultivar testing of wheat, barley, canola, field peas and lupins was conducted. Because of the inherent variability in nematode experimentation, trials will be repeated up to five times to validate.

Results and discussion

Susceptibility to *P. quasitereoides* varies between cultivars and crops. For example, at the Katanning field trial, nematodes multiplied 3–16 times for wheat, 3.5–14 times for barley, and 3–11 times for canola cultivars. At Toodyay in 2012 and in glasshouse trials, although the average multiplication was lower (range 1–4.5 times), results also indicate that cultivar susceptibility ranges from very susceptible (VS) to moderately resistant–moderately susceptible (MR–MS) (Tables 1 and 2). Data collected from field and glasshouse trials between 2009 and 2012 are being used to build reliable information for *P. quasitereoides*.

Significant yield effects occurred for wheat varieties at Toodyay in 2012 when assessing yield against nematode numbers at anthesis (Table 2). Very high yield impacts were recorded for cvv. Carnamah and Emu Rock (24%), Machete (16%), and Arrino and Westonia (12%). Significant yield loss was also evident for Brookton and EGA Eagle Rock (15%) and Ruby (7%). Coupled with resistance data, these results indicate that Emu Rock may be only moderately susceptible but very intolerant to

P. quasitereoides, whereas the other varieties are intolerant but range in levels of susceptibility to the pest. Yield effects were negligible for most of the remaining varieties tested; of note, Yitpi and Yenda appeared tolerant of *P. quasitereoides*.

Table 1: Most resistant and most susceptible cultivars of various crops as determined in studies of resistance/susceptibility to P. quasitereoides

Results are provisional; number of trials indicated in parentheses

Crop	Most resistant cultivars tested	Most susceptible cultivars tested
Lupin	Tanjil (1)	Coromup (1)
Field pea	Kaspa (1)	PBA Gunyah (1)
Barley	Yagan (1), Wimmera (1), Mundah (2)	Stirling (2), Hamelin (2), Vlamingh (2), Bass (1)
Canola	Stubby (1), Tanami (2)	Rottnest (1), Thunder (2)
Wheat	Mace (≥3), Yitpi (≥3), Stiletto (≥3)	Calingiri (≥3), Carnamah (≥3), Catalina (≥3)

Table 2: Yield impacts for wheat cultivars in the field trial at Toodyay, 2012

Provisional resistance ratings developed from results for P. quasitereoides glasshouse and field trials, with comparison to P. neglectus resistance ratings. S, susceptible; R, resistant; V, very; M, moderately

Cultivar	Yield loss (%)	Provisional resistance rating for *P. quasitereoides*	Resistance rating for *P. neglectus*
Arrino	12	S	S
Carnamah	24	VS	S
Emu Rock	24	MS–S	S
Mace	0	MS	MS
Magenta	0	MS	MS–S
Westonia	12	S	S
Wyalkatchem	0	MS–S	MR–MS
Yitpi	0	MS–S	MS–S

Data collected to date indicate that *P. quasitereoides* has a broad host range (Table 3). Wheat, canola, lupins, barley and field pea cultivars assessed between 2009 and 2012 appear susceptible to this pest (Table 1 and 2). Importantly, levels of susceptibility varied for both host species and cultivar. Smaller increases in nematode numbers when growing a more resistant cultivar or crop may produce smaller impacts on both the current crop and in subsequent seasons. This impact could be mitigated by appropriate cultivar and crop selection.

Table 3: Reaction of major crop and pasture species to Pratylenchus neglectus, P. quasitereoide and P. penetrans. [5]

Hosting ability	*P. neglectus*	*P. quasitereoide*	*P. penetrans*
Susceptible	Wheat Barley Chickpea	Wheat Canola Barley Oat	Field peas Lupins Chickpeas Oats Durum wheat Wheat Triticale Faba beans Wild oats Wild radish
Moderately susceptible	Canola Durum wheat Oat	Narrow-leafed lupin	Barley Canola
Resistant	Field pea Narrow-leafed lupin Faba bean Triticale Lentil Safflower Narbon beans		

Nematodes are characterised by patchy infestations and variable impacts on plants, depending on environmental conditions. RLN lifecycle and impact in a crop is influenced by seasonal variations, soil type and management practices for any given year. For example, seasonal influence of rainfall may have affected the multiplication of RLN in the field trials assessed in 2009 and 2012. Katanning in 2009 experienced rainfall of 356 mm between May and October, and *P. quasitereoides* multiplication ranged from 3 to 16 times across the wheat, barley and canola cultivars tested. Toodyay in 2012 had 260 mm, and *P. quasitereoides* multiplication of 1–4 times was measured.

Across trials, some cultivars have shown inconsistent results to date that may be related to environmental influences. For example, cv. Endure behaved as a highly susceptible crop at Katanning in 2009, with *P. quasitereoides* multiplication of 16 times, but in the subsequent glasshouse and 2012 field trial, it has been much more moderately susceptible. Wyalkatchem and Arrino have also ranged from susceptible to moderately resistant between trials. These inconsistencies highlight the importance of repeated trials in a range of circumstances.

Conclusions

The most commonly found RLN, *P. neglectus*, affects broadacre cropping across Australia. The volume and reliability of information available for this pest reflects local and national research initiatives over >20 years. *Pratylenchus quasitereoides,* on the other hand, is unique to WA and research into this nematode has been much more

5 GRDC (2015) Root-lesion nematodes. GRDC Tips and Tactics, February 2015, http://www.grdc.com.au/TT-RootLesionNematodes

limited. Current DAFWA research initiatives will continue to develop tolerance and resistance information for selection of rotations and suitable cultivars. More data are required for this RLN species; however, both glasshouse and field trial assessments to date indicate that crop reaction may vary from that for other *Pratylenchus* species. It is therefore important to ascertain the species of nematode affecting the crop to determine the appropriate management. This is particularly important with respect to *P. quasitereoides*, because it appears that crops may be more affected by this species than by the more common *P. neglectus*.

Research in WA focuses on management, principally through rotational recommendations for cereal cultivars and other host crops. Results for *P. quasitereoides* are preliminary, and although some provisional recommendations are appropriate, development of rotational advice requires further field and glasshouse assessment of the commercial cultivars grown within the farming system against this RLN species encountered in the WA broadacre growing areas. This information will be widely extended to growers and consultants to facilitate the management of RLN and minimise losses incurred by grain growers. [6]

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8.3 Impact of crop varieties on RLN multiplication

8.3.1 Take-home messages

- Know your enemy—test soil to determine whether RLN are a problem, and which species are present.
- Select wheat varieties with high tolerance ratings to minimise yield losses in RLN infected paddocks.
- To manage RLN populations, it is important to increase the frequency of RLN-resistant crops in the rotation.
- Multiple resistant crops in a rotation will be necessary for long-term management of RLN populations.
- Avoid crops or varieties that allow the build-up of large populations of RLN in infected paddocks.
- Monitor the impact of your rotation. [7]

Figure 2 is a simplified chart highlighting that the critical first step in the management of RLN is to test the soil and determine whether there is a problem to manage. Where

6 S Collins, S Kelly, H Hunter *et al.* (2013) *Pratylenchus quasitereoides*—WA's home grown Root Lesion Nematode (RLN) and its unique impacts on broadacre crops. GRDC Update Papers, 12 March 2013, http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/03/Pratylenchus-quasitereoides-WAs-home-grown-Root-Lesion-Nematode

7 B Burton (2105) Impact of crop varieties on RLN multiplication. GRDC Update Papers, 1 March 2015, http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/03/Impact-of-crop-varieties-on-RLN-multiplication

RLN are present, growers should focus on planting tolerant wheat varieties and on increasing the number of resistant crops or varieties in the rotation. [8]

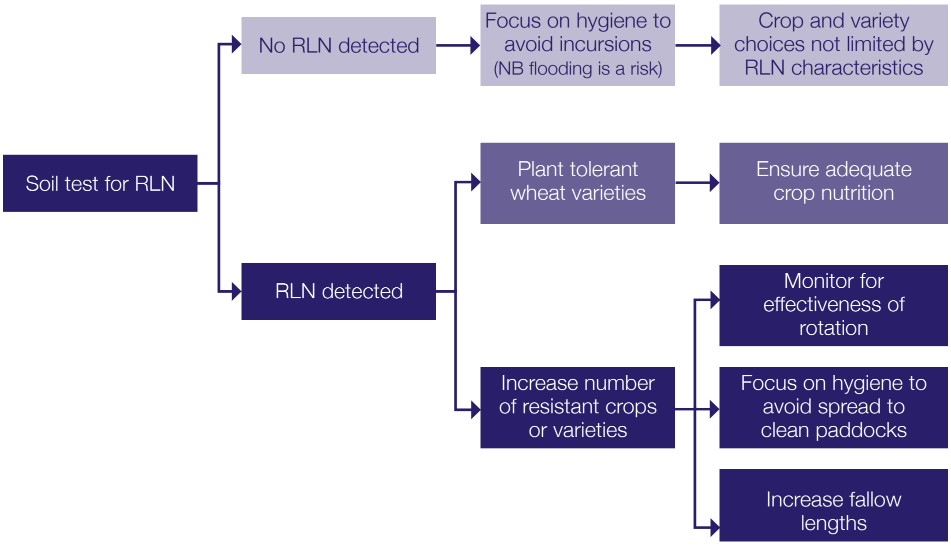

Figure 2: Management flow chart for root-lesion nematode.

More information

[Variety choice and crop rotation key to managing root lesion nematodes](#)

[Impact of crop varieties on RLN multiplication](#)

8.3.2 Soil testing

The first step in the management of RLN is to test the soil and determine whether the problem is present. Testing of soil samples is most commonly conducted via DNA analysis (commercially available as the PreDicta B test from SARDI) with sampling to depths of 0–15 or 0–30 cm.

To organise testing and sending of soil samples, visit the PreDicta B website.

8.3.3 Management of RLN

- Nematicides. There are no registered nematicides for RLN in broadacre cropping in Australia. Screening of candidates continues, but RLN are a very difficult target with populations frequently deep in the soil profile.
- Nutrition. Damage from RLN reduces the ability of cereal roots to access nutrients and soil moisture and can induce nutrient deficiencies. Under-fertilising is likely to exacerbate RLN yield impacts; however, over-fertilising is unlikely to compensate for a poor variety choice.
- Variety choice and crop rotation. These are currently the most effective management tools for RLN. Note that the focus is on two different characteristics: *tolerance*, which is the ability of the variety to yield under RLN pressure; and *resistance*, which is the impact of the variety on the buildup of RLN populations. Varieties and crops often have different tolerance and resistance levels to different RLN species.
- Fallow. RLN populations will generally decrease during a 'clean' fallow, but the process is slow and expensive in lost 'potential' income. Additionally, long fallows

[8] B Burton (2105) Impact of crop varieties on RLN multiplication. GRDC Update Papers, 1 March 2015, http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/03/Impact-of-crop-varieties-on-RLN-multiplication

may decrease levels of arbuscular mycorrhizal fungi (AMF) and create more cropping problems than they solve. [9]

Resistance differences between winter crops

The primary method of managing RLN populations is to increase the number of resistant crops in the rotation. Knowledge of the species of RLN present is critical, because resistance to different species of RLN varies between crops. For example, canola is generally considered resistant or moderately resistant to *P. thornei*, along with sorghum, sunflowers, maize, canary seed, cotton and linseed. Wheat, barley, chickpeas, faba beans, mungbeans and soybeans are generally susceptible, although the level of susceptibility may vary between varieties. Field peas have been considered resistant; however, many newer varieties appear more susceptible. Figure 3 shows the mean *P. thornei* population remaining after a range of winter crops were grown near Weemelah, New South Wales, in 2011. Crops were sown in individual trials to enable weed and pest control, and so data cannot be directly compared; however, the data broadly indicate the magnitude of differences in *P. thornei* resistance between these crops. Assessment of the risk of buildup of *P. thornei* in different crops (i.e. susceptibility) and of whether variety differences exist shows that canola has low to moderate risk of buildup, but no varietal differences have yet been detected (Table 4). [10]

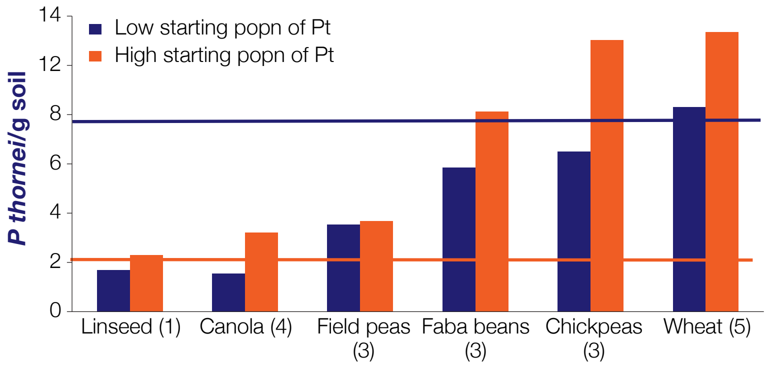

Figure 3: Comparison of P. thornei populations remaining in March–April 2012 following different winter crop species near Weemelah, NSW, 2011. Numbers of varieties within crops are in parentheses. The two horizontal lines indicate the respective 'low' and 'high' starting levels of P. thornei in March 2011. Soil sampling depth was 0–30 cm.

[9] B Burton (2105) Impact of crop varieties on RLN multiplication. GRDC Update Papers, 1 March 2015, http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/03/Impact-of-crop-varieties-on-RLN-multiplication

[10] B Burton (2105) Impact of crop varieties on RLN multiplication. GRDC Update Papers, 1 March 2015, http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/03/Impact-of-crop-varieties-on-RLN-multiplication

Table 4: Comparison of crops for risk of P. thornei buildup and the frequency of significant variety differences [11]

Crop	*Pt* buildup risk	Variety differences
Sorghum	Low	None observed
Cotton	Low	None observed
Sunflowers[A]	Low	None observed
Linseed[A]	Low	–
Canola[A]	Low to medium	None observed
Field peas[A]	Low to medium	Low
Durum wheat	Low to medium	Moderate
Barley	Low to medium	Moderate
Bread wheat	Low, medium to high	Large
Chickpeas	Medium to high	Moderate to large
Faba beans	Medium to high	Low
Mungbeans[A]	Medium to high?	Moderate to large?

[A]Data from only one or two field trial locations for these crops.

[11] B Burton (2105) Impact of crop varieties on RLN multiplication. GRDC Update Papers, 1 March 2015, http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/03/Impact-of-crop-varieties-on-RLN-multiplication