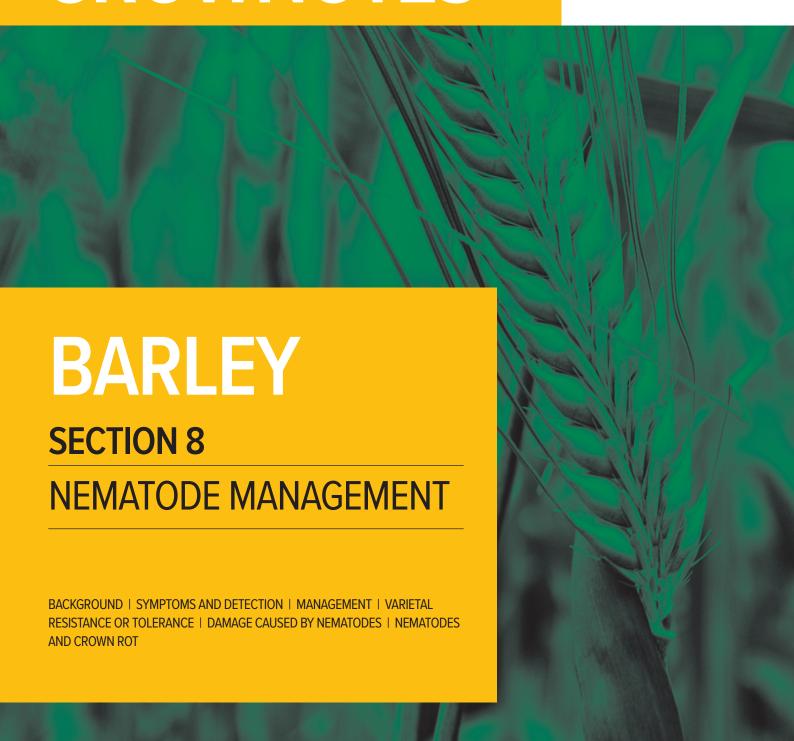


# **SERDC**GROWNOTES™







#### **SECTION 8**

# Nematode management



http://grdc.com. au/Research-and-Development/ GRDC-Update-Papers/2014/03/Hownematodes-reduce-yield

http://www.grdc. com.au/Researchand-Development/ GRDC-Update-Papers/2015/08/ Root-lesionnematodes-importanceimpact-andmanagement Root-lesion nematodes (RLN; *Pratylenchus* spp.) are microscopic, worm-like animals that extract nutrients from plants, causing yield loss. In the northern grains region, the predominant RLN, *P. thornei*, costs the wheat industry AU\$38 million¹ annually, and including the secondary species, *P. neglectus*, RLN are found in three-quarters of fields tested.

Intolerant crops such as wheat and chickpeas can lose 20–60%² in yield when nematode populations are high. Resistance and susceptibility of crops can differ for each RLN species; for example, sorghum is resistant to *P. thornei* but susceptible to *P. neglectus*. A tolerant crop yields well when large populations of RLN are present (the opposite is intolerance). A resistant crop does not allow RLN to reproduce and increase in number (the opposite is susceptibility).³

Successful management relies on:

- farm hygiene to keep fields free of RLN
- growing tolerant varieties when RLN are present, to maximise yields
- rotating with resistant crops to keep RLN at low levels<sup>4</sup>

Nematodes reduce yields in intolerant wheat cultivars and reduce the amount of water available for plant growth.

Nematodes also impose early stress that reduces yield potential despite the availability of water and nutrients.

Maintaining a low nematode population improves crop yields.5.

# 8.1 Background

Root-lesion nematodes use a syringe-like 'stylet' to extract nutrients from the roots of plants (Figure 1). Plant roots are damaged as RLN feed and reproduce inside plant roots. *Pratylenchus thornei* and *P. neglectus* are the most common RLN species in Australia. In the northern grains region, *P. thornei* is the predominant species but *P. neglectus* is also present. These nematodes can be found deep in the soil profile (to 90





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GM Murray, JP Brennan (2009) The current and potential costs from diseases of wheat in Australia. Grains Research and Development Corporation Report. <a href="https://www.grdc.com.au/~/media/B4063ED6F63C4A968B3D7601E9E3FA38.pdf">https://www.grdc.com.au/~/media/B4063ED6F63C4A968B3D7601E9E3FA38.pdf</a>

<sup>&</sup>lt;sup>2</sup> KJ Owen, T Clewett, J Thompson (2013) Summer crop decisions and root-lesion nematodes: crop rotations to manage nematodes – key decision points for the latter half of the year, Bellata. GRDC Grains Research Update, July 2013.

<sup>&</sup>lt;sup>3</sup> KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet. <a href="http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland">http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland</a>

R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013. <a href="https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice">https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice</a>

GRDC (2014), How nematodes reduce yield. <a href="http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/How-nematodes-reduce-yield">http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/How-nematodes-reduce-yield</a>

**Fact sheets** 

Soil Quality Pty Ltd nematode survey results GRDC Parasitic Plant Nematodes (Northern Region Fact Sheet) http://www.daff.qld. gov.au/ data/assets/ pdf\_file/0010/58870/ Root-Lesion-Nematode-

Brochure.pdf



February 2016

cm depth) and are found in a broad range of soil types, from heavy clays to sandy soils. Wheat is susceptible to both *P. thornei and P. neglectus*.<sup>6</sup>

New CSIRO research funded by the Grains Research and Development Corporation (GRDC) is examining how nematodes inflict damage by penetrating the outer layer of wheat roots and restricting their ability to transport water.



Figure 1: Microscope image of a root-lesion nematode. Notice the syringe-like 'stylet' at the head end, which is used for extracting nutrients from the plant root. This nematode is less than 1 mm long. (Photo: Sean Kelly, Department of Agriculture and Food, Western Australia)

## 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 have soil tested in a laboratory. Fee-for-service testing of soil offered by the PreDicta B root disease testing service of the South Australian Research and Development Institute (SARDI) can determine levels of *P. thornei* and *P. neglectus* present.<sup>7</sup>

Similar results can be obtained by soil testing either by manual counting (under microscopes) or by DNA analysis (PreDicta B), with commercial sampling generally at depths of 0-15 or 0-30 cm.<sup>8</sup>

Vertical distribution of *P. thornei* in soil is variable. Some paddocks have relatively uniform populations down to 30 cm or even 60 cm, some will have highest *P. thornei* counts at 0–15 cm depth, whereas other paddocks will have *P. thornei* populations increasing at greater depths, e.g. 30–60 cm. Although detailed knowledge of the distribution may be helpful, the majority of on-farm management decisions will be based on presence or absence of *P. thornei* confirmed by sampling at 0–15 or 0–30 cm depth.

Signs of nematode infection in roots include dark lesions or poor root structure. The damaged roots are inefficient at taking up water and nutrients—particularly nitrogen

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KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet. <a href="http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland">http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland</a>

KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet. <a href="http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland">http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland</a>

R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013. <a href="https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice">https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice</a>

**Testing** 

http://www.sardi.sa.gov. au/products and services/entomology/

diagnostic\_services/

predicta b



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(N), phosphorus (P) and zinc (Zn)—causing symptoms of nutrient deficiency and wilting in the plant shoots. Intolerant wheat varieties may appear stunted, with yellowing of lower leaves and poor tillering (Figure 2). These symptoms may not be present in other susceptible crops such as barley and chickpea.<sup>9</sup>



Figure 2: Symptoms of root-lesion nematode infection of an intolerant wheat variety include yellowing of lower leaves, decreased tillers and wilting. There are no obvious symptoms in the susceptible chickpea and faba bean plots on either side of the wheat. (Photo: Kirsty Owen, DAFF)

#### 8.2.1 What is seen in the paddock?

Although symptoms of RLN damage in wheat can be dramatic, they can easily be confused with nutritional deficiencies and/or moisture stress.

Damage from RLN is in the form of brown root lesions but these can be difficult to see or can also be caused by other organisms. Root systems are often compromised, with reduced branching, reduced quantities of root hairs and an inability to penetrate deeply into the soil profile. The RLN create an inefficient root system that reduces the ability of the plant to access nutrition and soil water.

Visual damage above ground from RLN is non-specific. Yellowing of lower leaves is often observed, together with reduced tillering and a reduction in crop biomass. Symptoms are more likely to be observed later in the season, particularly when the crop is reliant on moisture stored in the subsoil.

In the early stages of RLN infection, localised patches of poorly performing wheat may be observed. Soil testing of these patches may help to confirm or eliminate RLN as a possible issue. In paddocks where previous wheat production has been more uniform, a random soil-coring approach may be more suitable. Another useful indicator of RLN presence is low yield performance of RLN-intolerant wheat varieties.<sup>10</sup>

# More information

http://grdc.com. au/Research-and-Development/ GRDC-Update-Papers/2014/03/ Latest-nematodesummer-and-wintercrop-rotation-results

## 8.3 Management

There are four key strategies for the management of RLN (Figure 3):

- 1. Test soil for nematodes in a laboratory.
- 2. Protect paddocks that are free of nematodes by controlling soil and water run-off and cleaning machinery; plant nematode-free paddocks first.
- Choose tolerant wheat varieties to maximise yields (<u>www.nvtonline.com.au</u>).
   Tolerant varieties grow and yield well when RLN are present.



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<sup>&</sup>lt;sup>9</sup> KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet. http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland

R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013. <a href="https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice">https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice</a>



4. Rotate with resistant crops to prevent increases in RLN (Table 1,Figure 4). When large populations of RLN are detected, you may need to grow at least two resistant crops consecutively to decrease populations. In addition, ensure that fertiliser is applied at the recommended rate so that the yield potential of tolerant varieties is achieved.<sup>11</sup>

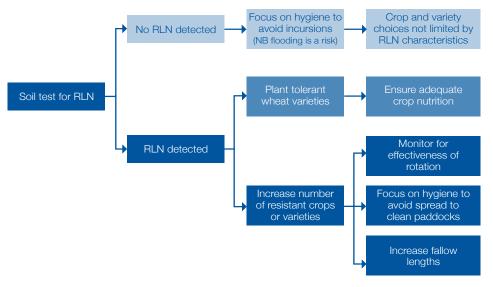


Figure 3: Root-lesion nematode management flow-chart

Other considerations include:

- Nematicides. There are no registered nematicides for RLN in broadacre cropping in Australia. Screening of potential candidates is conducted, 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 our most effective
  management tools for RLN. However the focus is on two different characteristics:
  tolerance, i.e. ability of the variety to yield under RLN pressure; and resistance, i.e.
  impact of the variety on RLN build-up. Note that varieties and crops often have
  varied tolerance and resistance levels to *P. thornei* and *P. neglectus*.
- Fallow. Populations of RLN will decrease during a 'clean' fallow, but the process is slow and expensive in lost 'potential' income. Additionally, long fallows may decrease arbuscular mycorrhiza (AM) levels and create more cropping problems than they solve.<sup>12</sup>

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KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet. <a href="http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland">http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland</a>

R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013. <a href="https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice">https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice</a>

Table 1: Susceptibility and resistance of various crops to root-lesion nematodes<sup>13</sup>

| RLN species  | Susceptible  | Intermediate  | Resistant   |
|--------------|--|---|---|
| P. thornei   | Wheat, chickpea, faba bean,<br>barley, mungbean, navy bean,<br>soybean, cowpea | Canola, mustard, triticale, durum wheat, maize, sunflower | Canary seed, lablab, linseed, oats, sorghum, millet, cotton, pigeon pea |
| P. neglectus | Wheat, canola, chickpea,<br>mustard, sorghum (grain),<br>sorghum (forage)      | Barley, oat, canary seed, durum wheat, maize, navy bean   | Linseed, field pea, faba bean, triticale, mungbean, soybean             |

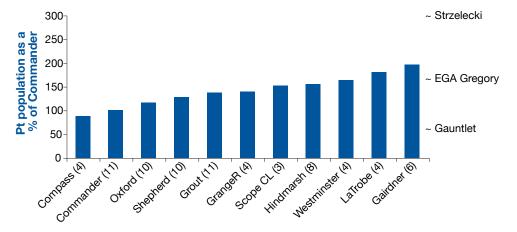


Figure 4: Resistance differences between commercial barley varieties (Source: http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2015/03/Impact-of-crop-varieties-on-RLN-multiplication)



Figure 5: Crop rotation to manage root-lesion nematodes depends on the nematode species present in your field. Mungbeans (left) are susceptible to P. thornei but resistant to P. neglectus. By contrast, sorghum (right) is resistant to P. thornei but susceptible to P. neglectus. (Photo: Kirsty Owen, DAFF)

Canola is now thought to have a 'biofumigation' potential to control nematodes, and a field experiment has compared canola with other winter crops or clean-fallow for reducing *P. thornei* population densities and improving growth of *P. thornei*-intolerant wheat (cv. Batavia) in the following year.

Immediately after harvest of the first-year crops, populations of P. thornei were lowest following various canola cultivars or clean-fallow and highest following susceptible wheat cultivars (1957–5200  $\nu$ . 31,033–41,294 P. thornei/kg dry soil). Unexpectedly, at planting of the second-year wheat crop, nematode populations were at more uniform,



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KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet. <a href="http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland">http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland</a>





https://www.grdc. com.au/Researchand-Development/ GRDC-Update-Papers/2013/07/ Summer-cropdecisions-and-rootlesion-nematodes

http://grdc.com. au/Media-Centre/ Ground-Cover/ Ground-Cover-Issue-109-Mar-Apr-2014/ Variety-choice-andcrop-rotation-key-tomanaging-root-lesionnematodes

http://www.nga. org.au/resultsand-publications/ download/325/ grdc-update-papersdiseases/rootlesion-nematodesin-winter-cereals/ grdc-grower-updatepaper-spring-ridgewarialda-burrenjunction-warracondamine-julaug-2014.pdf

lower levels (<5000/kg dry soil), regardless of the previous season's treatment, and remained that way during the growing season, which was quite dry.

Growth and grain yield of the second-year wheat crop were poorest on plots previously planted with canola or left fallow due to poor colonisation with AM fungi, with the exception of canola cv. Karoo, which had high AM fungal colonisation and low wheat yields. There were significant regressions between growth and yield parameters of the second-year wheat and levels of AM fungi following the pre-crop treatments.

Canola appears to be a good crop for reducing P. thornei populations, but the dependence of subsequent crops on AM fungi should be considered, particularly in the northern grains region.14

#### 8.3.1 **Crop Rotation**

P. neglectus was found in 32% of paddocks (often in combination with P. thornei) in the northern region in a survey of 800 paddocks (Thompson et al. 2010). Summer crops that are partially resistant or poor hosts of *P. neglectus* include sunflower, mungbean, soybean and cowpea. When these crops are grown, populations of *P. neglectus* do not increase because the crops do not allow the nematode to reproduce.

In a field experiment, populations of P. neglectus increased after growing grain sorghum (Figure 4). Populations increased from 3.1 times after MR32(1) (4,400 P. neglectus/kg soil) to 7.3 times after MRGoldrush(1) (10,400 P. neglectus/kg soil) compared to soil at planting (1,400 P. neglectus/kg soil).15

Summer crops have an important role in management of RLN. Research shows that when P. thornei is present in high numbers, two or more resistant crops in sequence are needed to reduce populations to low enough levels to avoid yield loss in the following intolerant, susceptible wheat crops.16

#### 8.3.2 Sowing time

Wheat variety choice can have a great impact on yield loss to P. thornei (up to 43% yield loss in intolerant bread wheat varieties in 2011), and yield losses from P. thornei can be exacerbated by delayed sowing and drier conditions.<sup>17</sup>

New South Wales Department of Primary Industries (NSW DPI) winter cereal time-ofsowing trials at Coonamble, Mungindi, Trangie, Come-by-Chance and Gurley, NSW, in 2011 showed the following:

- Winter crop type and variety choice have a large effect on the build-up of nematode populations in the soil due to differences in their resistance to *P. thornei*.
- This was most pronounced in bread wheat where the variety choice:
  - » increased the P. thornei population by 1.8–3.6 times (9737 up to 19,719 P. thornei/kg soil) at Coonamble, and
  - » decreased the P. thornei population by 64% between the most susceptible and most resistant varieties at Mungindi (25,448 v. 9050 P. thornei/kg soil).
- Pratylenchus thornei populations were six times larger in the most susceptible variety, Lincoln(1), than in the most resistant variety, Gauntlet(1), at Trangie.
- Earlier sowing generally increased the build-up of P. thornei populations Trangie, especially in the most susceptible variety.



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KJ Owen, TG Clewett, JP Thompson (2010) Pre-cropping with canola decreased Pratylenchus thornei populations, arbuscular mycorrhizal fungi, and yield of wheat. Crop & Pasture Science 61, 399-410. http:// www.publish.csiro.au/paper/CP09345.htm

Summer crop decisions and root lesion nematodes: <a href="http://www.grdc.com.au/Research-and-Development/">http://www.grdc.com.au/Research-and-Development/</a> GRDC-Update-Papers/2013/07/Summer-crop-decisions-and-root-lesion-nematodes

K Owen, T Clewett, J Thompson (2013) Summer crop decisions and root-lesion nematodes: crop rotations to manage nematodes - key decision points for the latter half of the year, Bellata. GRDC Grains Research Update, July 2013.

S Simpfendorfer, M Gardner, G McMullen (2012) Impact of sowing time and varietal tolerance on yield loss to the root-lesion nematode Pratylenchus thornei. GRDC Grains Research Update, Goondiwindi, March 2012. http://www.dpi.nsw.gov.au/\_\_data/assets/pdf\_file/0007/431287/Nematodes-and-sowing-date-2011.pdf

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Northern Grains Region

trial results autumn 2013



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- The build-up of *P. thornei* populations in the field trial is broadly in line with published resistance ratings, but discrepancies appear to exist, especially with LongReach Spitfire(), which appears better than its current rating of very susceptible.
- Both P. thornei and crown rot (caused by Fusarium pseudograminearum) cause significant yield loss in intolerant/susceptible varieties alone or in combination, as shown at Gurley.
- Pratylenchus thornei and crown rot did not reduce grain protein levels at the Gurley site.
- Some recently released varieties appear to combine improved tolerance to P.
   thornei with increased resistance to crown rot, which provided a yield advantage of up to 109% at the Gurley site in 2012.
- Reliable resistance ratings appear to be produced under both large and moderate starting populations of *P. thornei* at Mungindi. Hence, National Variety Trials (NVT) are a potentially useful source of reliable field-based assessments.<sup>18</sup> Visit <a href="www.nvtonline.com.au">www.nvtonline.com.au</a>

#### Delayed sowing

In two trials conducted in 2011, *P. thornei* was demonstrated to reduce yield by up to 43% under large starting populations with delayed sowing and drier growing conditions. Delayed sowing into late autumn/winter is likely to see crops initially develop under cooler soil temperatures, thus reducing the rate of root development. Conversely, earlier sown crops establish under warmer soil conditions and have more rapid, early root growth if adequate moisture is available.

Drier soil conditions during crop establishment and early growth, for example with the second sowing time (22 June) at Coonamble in 2011, are also likely to restrict early root development. In theory, any restriction to root development is likely to inhibit a crops ability to compensate for *P. thornei* feeding upon these root systems. Variety choice can have a large impact on yield and, hence, profitability when cropping in soils with large populations of *P. thornei*. To date, these trials have only examined the relative tolerance of varieties to *P. thornei*. It should be stressed that a variety's resistance to *P. thornei* (build-up of nematode populations within the soil) should also be an important consideration in variety choice.<sup>19</sup>

#### Interaction with crown rot

Crown rot remains a significant disease in the region, with losses dependent on soil moisture and temperature stress experienced during flowering and grain-fill. Crown rot caused yield losses of up to 37% in durum varieties at the Coonamble site in 2011, but cooler, wetter conditions limited the expression (yield loss) of this disease at Mungindi in 2011. Averaged across the different winter cereal types, crown rot reduced yield by 18% in barley, 27% in durum wheat and 22% in bread wheat at Coonamble in 2011. Research conducted by NSW DPI and the Northern Grower Alliance (NGA) across 11 sites in northern NSW in 2007 demonstrated that crown rot caused average yield losses of 20% in barley (up to 69% under drier conditions and hotter temperatures during grain-fill), 25% in bread wheat (up to 65%) and 58% in durum (up to 90%).

The Coonamble site trial demonstrates that the tolerance of wheat varieties to crown rot does not appear to be related to their level of tolerance to *P. thornei*. Yield losses to both diseases in intolerant varieties can be significant (up to 43% for *P. thornei* and up to 37% for crown rot at Coonamble in 2011) under high levels of inoculum. However, the benefit obtained from sowing a more tolerant bread wheat variety appears greater for *P. thornei* (up to 43%) than for crown rot (up to 21%). Another way of expressing this



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NSW DPI (2013) Northern Grains Region trial results autumn 2013. NSW Department of Primary Industries. http://www.dpi.nsw.gov.au/\_\_data/assets/pdf\_file/0004/468328/Northern-grains-region-trial-results-autumn-2013.pdf

NSW DPI (2013) Northern Grains Region trial results autumn 2013. NSW Department of Primary Industries. http://www.dpi.nsw.gov.au/\_\_data/assets/pdf\_file/0004/468328/Northern-grains-region-trial-results-autumn-2013.pdf





http://www.grdc. com.au/Researchand-Development/ GRDC-Update-Papers/2012/04/ Impact-of-sowing-timeand-varietal-toleranceon-yield-loss-to-therootlesion-nematodepratylenchus-thornei



www.nga.org.au/resultsand-publications/ download/49/surveys/ root-lesion-nematodesurvey.pdf



http://www.grdc. com.au/Researchand-Development/ GRDC-Update-Papers/2015/03/Impactof-crop-varieties-on-**RLN-multiplication** 

is that the difference in tolerance levels between wheat varieties appears larger for P. thornei than for crown rot.20

#### Selecting tolerant varieties

Selecting tolerant wheat varieties is one of the main options for maintaining profit in the presence of high populations of P. thornei. By contrast, even the most crown rot resistant/tolerant commercial wheat variety can still suffer up to 50% yield loss under high levels of inoculum when hot/dry conditions occur during grain-fill. Variety selection is not a primary strategy for managing crown rot. Hence, where soil populations of P. thornei are large, more emphasis should be placed on a wheat variety's tolerance to P. thornei than to crown rot. Rotation to non-host crops remains the primary management tool for crown rot and can also be a valuable strategy to reduce or maintain P. thornei populations below the threshold (<2,000 P. thornei/kg soil) for yield loss in intolerant wheat varieties.21

#### Current industry knowledge

In 2010, the NGA conducted a survey of current levels of knowledge about nematodes (particularly RLN) in northern broadacre farming systems and the management practices being employed. The results are being used to prioritise research and development activity.

#### 8.4 Varietal resistance or tolerance

A tolerant crop yields well when large populations of RLN are present (in contrast to an intolerant crop). A resistant crop does not allow RLN to reproduce and increase in number (in contrast to a susceptible crop) (Table 2).

Table 2: Combinations and examples of tolerance and resistance<sup>22</sup>

#### There are four possible combinations of resistance and tolerance:

Tolerant-resistant

e.g. sorghum cv. MR43 to P. thornei

and wheat breeding lines released for development

Intolerant-resistant

No commercial wheat lines in this category

Tolerant-susceptible

e.g. wheat cv. EGA Gregory to P. thornei

Intolerant-susceptible

e.g. wheat cv. Strzelecki to P. thornei

Tolerance and resistance of wheat varieties to RLN are published each year at www. nvtonline.com.au or in Wheat varieties for Queensland.

Current GRDC-funded research by the NGA and NSW DPI is examining the importance of crop and variety choice. The NGA has run large and complex trials and results are outlined in the GRDC Update Paper.

Growers are advised to recognise that there are consistent varietal differences in P. thornei and P. neglectus resistance within wheat and chickpea varieties; to avoid crops or varieties that allow the build-up of large populations of RLN in infected paddocks; and to monitor the impact of rotations.

The DAFF and NSW DPI wheat variety guides detail the level of variety tolerance to both species of RLN. Selection of wheat varieties based on these published RLN tolerance rankings is critical to avoid significant yield losses, particularly in paddocks with large populations of P. thornei.

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NSW DPI (2013) Northern Grains Region trial results autumn 2013. NSW Department of Primary Industries. http://www.dpi.nsw.gov.au/ data/assets/pdf file/0004/468328/Northern-grains-region-trial-resultsautumn-2013.pdf

S Simpfendorfer, M Gardner, G McMullen (2012) Impact of sowing time and varietal tolerance on yield loss to the root-lesion nematode *Pratylenchus thornei*. GRDC Grains Research Update, Goondiwindi, March 2012. http://www.dpi.nsw.gov.au/ data/assets/pdf file/0007/431287/Nematodes-and-sowing-date-2011.pdf

K Owen, T Clewett, J Thompson (2013) Summer crop decisions and root-lesion nematodes: crop rotations to manage nematodes - key decision points for the latter half of the year, Bellata. GRDC Grains Research



GRDC-funded researchers are currently incorporating *P. thornei* resistances found in a wheat line selected from the variety Gatcher<sup>()</sup> and some wheat landraces from West Asia and North Africa into pre-breeding efforts. Excellent resistance to *P. thornei* and *P. neglectus* has been found in synthetic hexaploid wheats.

Resistances are being incorporated into some of the most tolerant wheat varieties, including EGA Gregory() and EGA Wylie(), to produce parents that are adapted to the northern region.<sup>23</sup>

#### 8.4.1 Tolerance

Wheat breeding has provided a number of varieties with moderate or higher levels of tolerance to *P. thornei*, e.g. Sunvale(), Baxter(), EGA Wylie() and EGA Gregory(). These varieties will reduce the level of yield loss due to *P. thornei*.

At a trial site near Yallaroi in 2012, a range of crops and varieties was grown and performance evaluated under relatively 'low' and 'high' starting population densities of *P. thornei* (~2,000 and 19,000 nematodes/kg soil). Figure 6 shows the impact of *P. thornei* on yield of varieties with a range of tolerance levels.

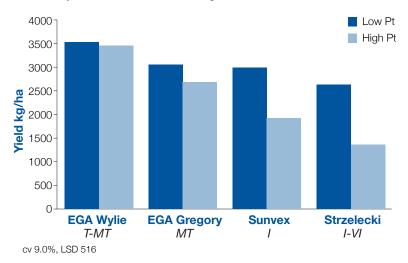


Figure 6: Comparison of wheat variety yields under 'low' and 'high' starting population densities of P. thornei (Pt) near Yallaroi 2012 (Trial RH1213)

\*Indicates significant yield difference within a variety between 'low' and 'high' P: thornei strips at P = 0.05. Codes below variety names are the DAFF published ratings of P: thornei tolerance: T, tolerant; MT, moderately tolerant; I, intolerant; VI, very intolerant.

NB: What was categorised as the 'low' starting population density of *P. thornei* was still equal to the current industry threshold. At this level, significant yield losses (up to 20%) may occur in intolerant wheat varieties. Consequently, the measured yield impact between 'low' and 'high' *P. thornei* in this trial is an underestimate of the full *P. thornei* affect.<sup>24</sup>

The varieties rated as *P. thornei* intolerant (Strzelecki( $^{()}$ ) and Sunvex( $^{()}$ ) suffered significant yield reductions of 35–48 % in this trial when grown in the 'high' *P. thornei* plots. Yield losses of ~1–1.25 t/ha were recorded, with economic losses >\$250/ha. The two varieties that were more tolerant (EGA Wylie( $^{()}$ ) and EGA Gregory( $^{()}$ ) did not suffer a significant yield reduction.

Choosing tolerant varieties will limit the yield and economic impact from *P. thornei*; however, some of these varieties still allow high levels of nematode build-up. The second issue to be considered is variety resistance/susceptibility.<sup>25</sup>



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J Thompson, J Sheedy, N Robinson, R Reen, T Clewett, J Lin (2012) Pre-breeding wheat for resistance to root-lesion nematodes. GRDC Grains Research Update, Goondiwindi, March 2012. <a href="https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Prebreeding-wheat-for-resistance-to-rootlesion-nematodes">https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Prebreeding-wheat-for-resistance-to-rootlesion-nematodes</a>

<sup>&</sup>lt;sup>24</sup> K Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet. http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland

R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013. <a href="https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice">https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice</a>



#### 8.4.2 Resistance

Resistance is the impact of the variety on RLN multiplication. Eradication of RLN from an individual paddock is highly unlikely, so effective long-term management is based on choosing options that limit RLN multiplication. This involves using crop or varieties that have useful levels of *P. thornei* resistance and avoiding varieties that will cause large 'blow-outs' in *P. thornei* numbers.

#### Resistance differences between crops

The primary method of managing RLN populations is to focus on increasing the number of resistant crops in the rotation. Knowledge of the species of RLN present is critical, as crops that are resistant to *P. thornei* may be susceptible to *P. neglectus*. Key crops that are generally considered resistant or moderately resistant to *P. thornei* are sorghum, sunflower, maize, canola, canary seed, cotton, field peas and linseed.

Wheat, chickpeas, faba beans, mungbeans and soybeans are generally susceptible, although the level of susceptibility may vary between varieties.<sup>26</sup>

Table 3: Disease and crop injury guide - barley (NSW DPI)

| Table 3: Disease and crop injury guide - barley (NSW DPI)     |  |  |   |  |  |  |  |
|---|--|--|---|--|--|--|--|
| Disease/cause   | Symptoms   | Occurrence   | Survival/Spread   | Control  |  |  |  |
| Foliar diseases   |  |  |   |  |  |  |  |
| Scald<br>Rhynchosporium<br>secalis                            | 'Scalded' patches with<br>dark brown margins on<br>leaf.   | More common and severe in south, favoured by wet weather.  | Rain-splashed spores<br>from barley and grass<br>residues and infected<br>leaves. | Resistant varieties; seed<br>and foliar fungicides;<br>avoid sowing into barley<br>and barley grass residues.                          |  |  |  |
| Net blotch – net<br>form<br>Pyrenophora teres<br>f. teres     | First, as small elliptical<br>dark brown spots which<br>elongate into fine, dark<br>brown streaks on the leaf<br>blades giving a netted<br>appearance. Severely<br>affected leaves wither. It<br>also infects heads. | Favoured by wet weather and early sowing.  | Air-borne spores from infected plants and stubble. Carried on seed.               | Resistant varieties;<br>rotation with other<br>crops. Stubble removal.<br>Clean seed. Treat<br>seed. Appropriate foliar<br>fungicides. |  |  |  |
| Net blotch – spot<br>form<br>Pyrenophora teres f.<br>maculata | Small, dark brown, round to oval spots or blotches up to 10 mm long becoming more straight-sided as they enlarge. Larger blotches are often surrounded by a yellow margin, particularly towards the leaf tip.        | Favoured by wet weather and early sowing.  | Air-borne spores from infected plants and stubble.                                | Resistant varieties;<br>rotation with other crops.<br>Stubble removal. Foliar<br>fungicides.   |  |  |  |
| Powdery mildew<br>Blumeria graminis<br>fsp. hordei            | White to grey cottony fungal growth on leaf and leaf sheath.   | More in north and south-west crops, more in winter and early spring.   | Air-borne spores from infected trash and infected plants.                         | Resistant varieties; Seed and foliar fungicides.   |  |  |  |
| Leaf rust<br>Puccinia hordei                                  | Very small pustules of<br>orange-brown powdery<br>spores on leaves and<br>leaf sheaths.  | Favoured by moist conditions and temperatures around 15°C.   | Air-borne spores from living plants.  | Resistant varieties; clean fallows; foliar fungicides to protect flag to flag-2 leaves. Monitor very susceptible varieties regularly.  |  |  |  |
| Stripe rust<br>Puccinia striiformis                           | Pustules and stripes of yellow powdery spores on leaves.   | Barley stripe rust is not present in Australia. However some varieties may develop small amounts of barley grass stripe rust and wheat stripe rust. Promoted by cool nights (10–15°C) with heavy dews. | Air-borne spores from living plants.  | Rarely required. Varieties<br>such as Skiff and<br>Tantangara may show<br>some infection. Resistant<br>varieties, foliar fungicides.   |  |  |  |

R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013. <a href="https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice">https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice</a>





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| Disease/cause   | Symptoms  | Occurrence   | Survival/Spread  | Control   |
|---|---|--|--|---|
| Stem rust<br>Puccinia graminis<br>spp.                                      | Elongated pustules of<br>dark brown spores on<br>stems, leaves and awns.                      | Favoured by warm (15–30°C) moist conditions. Only likely to be a problem in very late crops or where crops are in close proximity to other infected cereal crops.    | Air-borne spores from living plants.   | Clean fallows. Resistant<br>cereals (wheat, rye,<br>triticale); avoid sowing<br>very susceptible varieties;<br>foliar fungicides. |
| PLS<br>(Physiological leaf<br>spotting)                                     | Range from tiny white flecks to conspicuous dark brown to black spots and blotches on leaves. | Most prevalent under mild, moist growing conditions. Some genotypes are more susceptible. Grimmett often develops white flecking; Gairdner prone to brown blotching. | Not a pathogen. (Note<br>that some brown<br>flecking may be a<br>resistant reaction to<br>other diseases and in<br>some areas a reaction<br>to adverse soil nutrient<br>levels.) | Avoid susceptible varieties. Check cause to see whether any action is required.   |
| Sunblotch<br>(Physiological<br>reaction to nutrient<br>stress and sunlight) | Orange to dark brown<br>spots more common on<br>upper surface of leaf,<br>leaf death.         | Sporadic in occurrence.<br>Conditions causing it yet<br>to be defined.   | Not a pathogen.  | No control yet developed.   |
| Virus Diseases  |   |  |  |   |
| Barley yellow dwarf<br>Barley yellow dwarf<br>virus (BYDV)                  | Yellowing, dwarfing of infected plants, reduced seed set.                                     | Most common near perennial grass pastures and in early sown crops.   | Transmitted by aphids from infected grasses and cereals.   | Most varieties have some tolerance.   |
| Wheat streak<br>mosaic<br>Wheat streak mosaic<br>virus (WSMV)               | Light green leaf streaks<br>and blotches, stunting of<br>plants, reduced seed set.            | Not yet observed in<br>barley. Has occurred<br>in wheat in southern<br>irrigation areas and early<br>sown grazing wheat<br>crops on the tablelands<br>and slopes.    | Transmitted by the wheat curl mite.  | No control required.  |
| Root and Crown Ro   | ts  |  |  |   |
| Take-all<br>Gaeumannomyces<br>graminis var. tritici                         | Blackening of roots and crown, stunting, 'white heads', pinched grain.                        | More common in south,<br>favoured by wet winter<br>and early spring, then<br>dry. Less severe on<br>barley than on wheat.  | Soil-borne on grass and cereal residues.   | Crop rotation to provide one year free of grass hosts.  |
| Crown rot<br>Fusarium<br>pseudograminearum                                  | Browning of roots and<br>stem bases, stunting,<br>'white heads', pinched<br>grain.            | More common in north<br>and western areas,<br>favoured by cyclic wet/<br>dry soil during season.   | Soil-borne on grass and cereal residues.   | Crop rotation. Grass weed control. Balance inputs to available soil water.  |



http://www.dpi.nsw. gov.au/ data/assets/ pdf file/0003/431265/ Cereal-pathogen-survey. pdf

# 8.5 Damage caused by nematodes

Pratylenchus thornei is widespread in the northern grains region, with surveys conducted by DAFF and NSW DPI showing its presence in 50–70% of paddocks. It is frequently at concerning levels, being found at >2,000 individuals/kg soil in  $\sim$ 20–30% of paddocks.

Yield losses in wheat of up to 50% are not uncommon when *P. thornei*-intolerant wheat varieties are grown in paddocks infested with *P. thornei*. Yield losses in chickpeas of up

to 20% have also been measured in DAFF trials.27

### 8.6 Nematodes and crown rot

The NGA has been involved in 22 field trials since 2007, in collaboration NSW DPI, evaluating the impact of crown rot on a range of winter-cereal crop types and varieties. This work has greatly improved the understanding of crown rot impact and variety tolerance, but also indicates that we may be suffering significant yield losses from another 'disease' that often goes unnoticed.





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K Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet. http://soilquality.org.au/factsheets/root-lesion-nematode-in-queensland



More information

http://grdc.com. au/Research-and-Development/ GRDC-Update-Papers/2014/03/Crownrot-and-nematodes Although the trials were not designed to focus on nematodes, a convincing trend was apparent after 2008 that indicated *P. thornei* was having a frequent and large impact on wheat variety yield.

These trials were designed to evaluate the effect of crown rot on variety yield and quality. However, they strongly suggest that *P. thornei* is also having a significant impact on yield performance. The results do not compare the levels of yield loss due to the two diseases but do indicate that there is a greater range in variety of *P. thornei* tolerance than currently exists for crown rot tolerance.<sup>28</sup>

#### 8.6.1 Importance of variety choice

Variety choice appears a more valuable tool for use under *P. thornei* pressure than for crown rot management. It may be co-incidence, but four of the most widely adopted and successful wheat varieties in the northern grains region (EGA Wylie(D), EGA Gregory (D), Baxter(D) and Sunvale(D) are the varieties with the highest currently available level of *P. thornei* tolerance.

Root lesion nematodes are a 'disease' that has no obvious visual symptoms in the paddock. To improve management of this disease, growers must take more advantage of nematode testing. An increase in level of awareness of *P. thornei* status in individual paddocks and across properties will assist to:

- Develop sound hygiene practices to help limit further spread and reduce the risk of new infestations
- Provide a measure of the impact of varying management approaches designed to limit or reduce nematode build-up

This knowledge is also likely to provide direct economic gains from sound varietal and crop rotation choices. Soil testing for nematodes may also provide benefits in the identification of other plant parasitic species.<sup>29</sup>



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R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013. <a href="https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice">https://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Managing-root-lesion-nematodes-how-important-are-crop-and-variety-choice</a>

R Daniel, S Simpfendorfer, G McMullen, John Thompson (2010) Root lesion nematode and crown rot – double trouble! Australian Grain, September 2010. <a href="http://www.ausgrain.com.au/Back%20">http://www.ausgrain.com.au/Back%20</a> <a href="https://www.ausgrain.com.au/Back%20">lssues/203sogrn10/203sogrn10.pdf</a>