



**NORTHERN**

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# **GRDC™** **GROWNOTES™**



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GRAINS RESEARCH  
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CORPORATION

# **DURUM**

## **SECTION 8**

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## **NEMATODE MANAGEMENT**

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DURUM AND PRATYLENCHUS THORNEI (P. THORNEI) | BACKGROUND |  
SYMPTOMS AND DETECTION | MANAGEMENT | VARIETAL RESISTANCE  
OR TOLERANCE | DAMAGE CAUSED BY NEMATODES | NEMATODES AND  
CROWN ROT

SECTION 8

# Nematode management



Research trial results

## 8.1 Durum and *Pratylenchus thornei* (*P. thornei*)

### 8.1.1 Resistance (impact of durum varieties on *P. thornei* build-up)

Figure 1 shows a multi-year analysis of variety impact on *P. thornei* build-up.

Figure 2 shows data from a single trial in 2015 where a wider range of durum varieties were evaluated including DBA Lillaroi<sup>®</sup>.

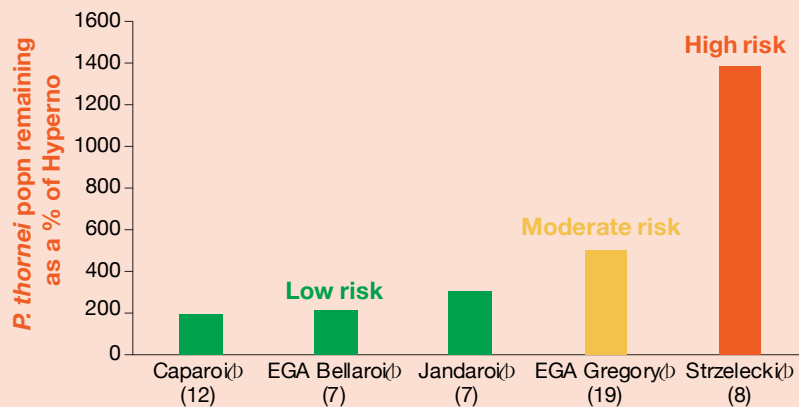


Figure 1: Relative *P. thornei* build-up following durum and bread wheat varieties, expressed as a percentage of Hyperno. Number in brackets is the actual number of trials for each variety.

NB: Hyperno, Caparoi<sup>®</sup> and EGA Bellaroi<sup>®</sup> resulted in significantly lower final populations of *P. thornei* than EGA Gregory<sup>®</sup>. Strzelecki<sup>®</sup> resulted in significantly larger populations of *P. thornei* than all other varieties graphed.

Data courtesy NGA and NSW DPI field trials 2009-14 with MET analysis conducted by QDAF.

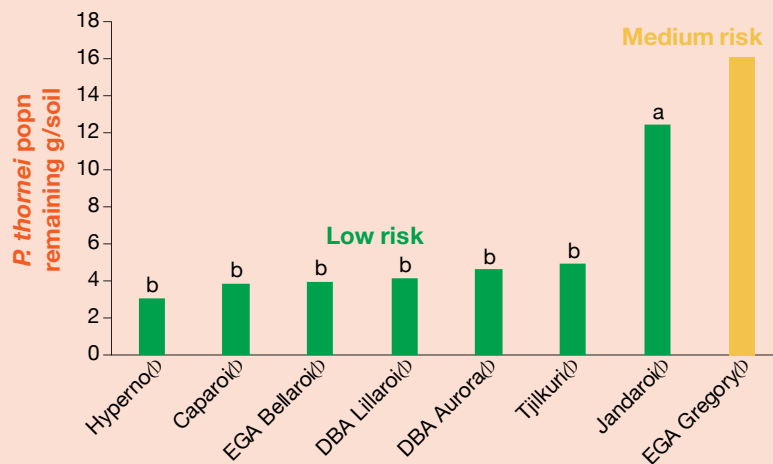


Figure 2: *P. thornei* populations sampled on 7 Mar 2016 at Macalister, Qld. Starting population of 2.7 *P. thornei*/g soil on 18 Feb 2015.

NB: EGA Gregory<sup>®</sup> result is from an adjacent bread wheat trial and is indicative only.

**Research trial results**

**Key Points**

*Resistance (impact of durum varieties on P. thornei build-up)*

Durum varieties consistently show higher levels of resistance to the root-lesion nematode *P. thornei* than bread wheat and barley varieties.

The average *P. thornei* population remaining after a single durum crop is ~40-80% less than after EGA Gregory(♾) and 80-90% less than after a single season of Strzelecki(♾).

Early indications are that DBA Lillaro(♾) DBA Aurora(♾) and Tjilkuri(♾) have similar levels of *P. thornei* resistance as Caparo(♾) and EGA Bellaro(♾).

Jandaroi(♾) is generally the least *P. thornei* resistant durum but is still similar to the most resistant commercial bread wheat options.

**8.1.2 Tolerance (yield impact from P. thornei)**

Figure 3 shows yield impact due to *P. thornei* from a trial near Yallaro, NSW, in 2012.

Figure 4 shows yield impact due to *P. thornei* from a trial near Macalister, Qld, in 2015.

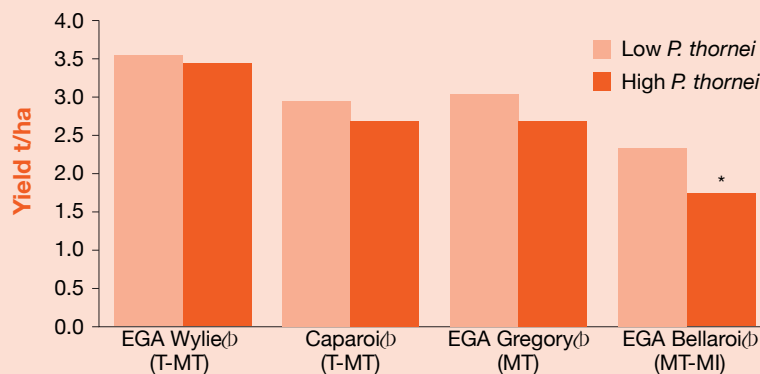


Figure 3: Yield impact from *P. thornei* near Yallaro in 2012 with varieties ranked from left to right in decreasing *P. thornei* tolerance ranking. Letters in brackets are the tolerance ranking (2016 Qld Variety Guide).

Dark columns show variety yield with a starting population of 1.9 *P. thornei*/g soil. Lighter columns show yield when starting population was 19 *P. thornei*/g soil.

\*= significant yield loss in variety under increased *P. thornei* population, e.g. EGA Bellaro.

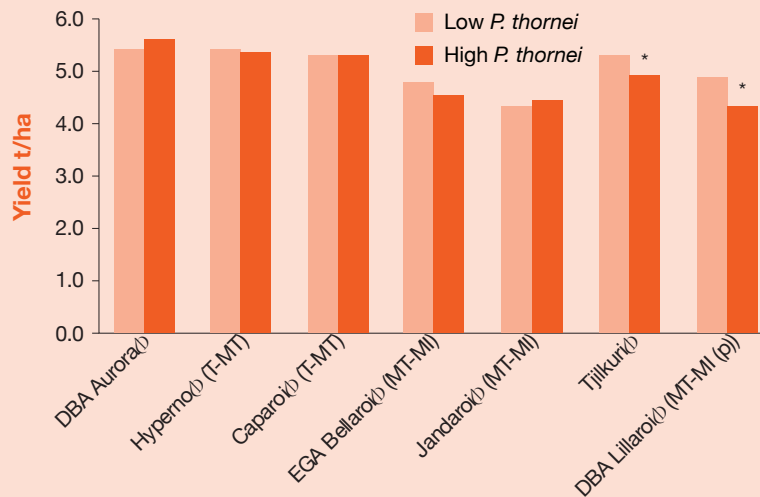


Figure 4: Yield impact from *P. thornei* near Macalister in 2015 with varieties ranked from left to right in decreasing *P. thornei* tolerance ranking. Letters in brackets are the tolerance ranking (2016 Qld Variety Guide).

NB: No available tolerance ranking for DBA Aurora(♾) and Tjilkuri(♾). Dark columns show variety yield with a starting population of 2.7 *P. thornei*/g soil. Lighter columns show yield when starting population was 29 *P. thornei*/g soil.

\*= significant yield loss in variety under increased *P. thornei* population, e.g. Tjilkuri(♾) and DBA Lillaro(♾).



### Key Points

#### Tolerance (yield impact from *P. thornei*)

Durum varieties differ in tolerance to *P. thornei*. Significant levels of yield impact were seen in EGA Bellaroi<sup>(b)</sup> in 2012 (-0.6t/ha) and DBA Lillaro<sup>(b)</sup> (-0.6t/ha), and in Tjilkuri<sup>(b)</sup> (-0.4t/ha) in 2015.

Caparoi<sup>(b)</sup> (and potentially Hyperno<sup>(b)</sup> and DBA Aurora<sup>(b)</sup>) may be better options for durum production in paddocks with concerning levels of *P. thornei*.

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 million<sup>1</sup> 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%<sup>2</sup> 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).<sup>3</sup>

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.<sup>5</sup>

## 8.2 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 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>

<sup>1</sup> GM Murray, JP Brennan (2009) The current and potential costs from diseases of wheat in Australia. Grains Research and Development Corporation Report. <https://www.grdc.com.au/~media/B4063ED6F63C4A968B3D7601E9E3FA38.pdf>

<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>3</sup> KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet.

<sup>4</sup> R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013.

<sup>5</sup> GRDC (2014), How nematodes reduce yield. <http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/How-nematodes-reduce-yield>

<sup>6</sup> KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet.

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. (Image: Sean Kelly, Department of Agriculture and Food, Western Australia)

## 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](http://www.daff.qld.gov.au/_data/assets/pdf_file/0010/58870/Root-Lesion-Nematode-Brochure.pdf)

## 8.3 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 (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

<sup>7</sup> KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet.

<sup>8</sup> R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013.

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. (Image: Kirsty Owen, DAFF)

### Testing service

[http://pir.sa.gov.au/research/services/molecular\\_diagnostics/predicta\\_b](http://pir.sa.gov.au/research/services/molecular_diagnostics/predicta_b)

#### 8.3.1 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>

## 8.4 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.
3. Choose tolerant wheat varieties to maximise yields ([www.nvtonline.com.au](http://www.nvtonline.com.au)). Tolerant varieties grow and yield well when RLN are present.

<sup>9</sup> KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet.

<sup>10</sup> R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013.

**i More information**

<http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Latest-nematode-summer-and-winter-crop-rotation-results>

[B Burton \(2015\). Impact of crop varieties on RLN multiplication.](#)

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>

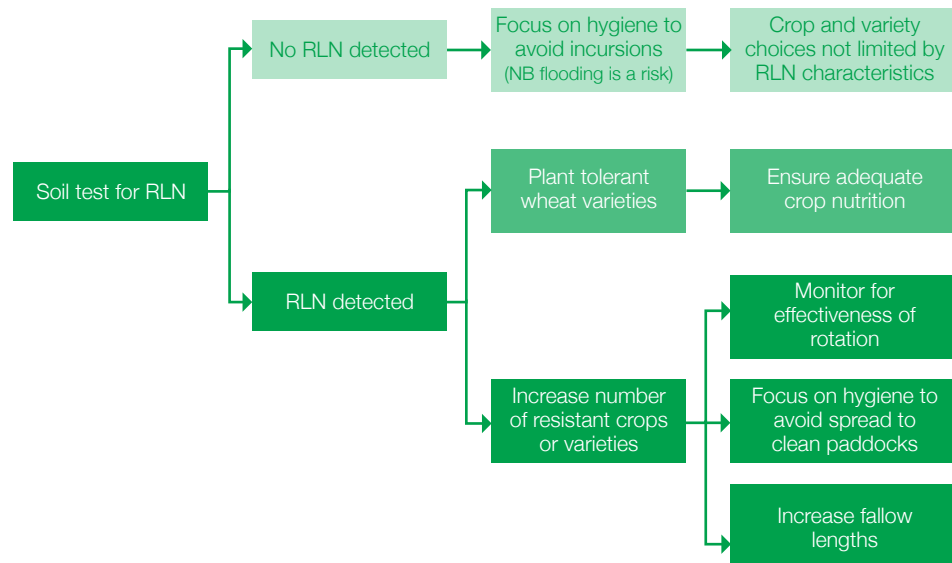


Figure 3: Root-lesion nematode management flow-chart.

<sup>11</sup> KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet.

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>

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

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



Figure 4: 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*. (Image: Kirsty Owen, DAFF)

<sup>12</sup> R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013.

<sup>13</sup> KJ Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet.



## More information

[J Whish, J Thompson \(2016\), How long does it take to reduce \*Pratylenchus thornei\* \(Root lesion nematode\) population in the soil?](#)

[B Burton, L Bailey, K Adhikari \(2016\), Impact from \*Pratylenchus thornei\*, Macalister 2015.](#)

[N Seymour, G Stirling, J Li \(2016\), Biological suppression of root lesion nematodes in northern grain growing soils.](#)

[B Burton, L Bailey, K Adhikari \(2015\), Impact from \*Pratylenchus thornei\*, Macalister 2015.](#)

## More information

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

<http://grdc.com.au/Media-Centre/Ground-Cover/Ground-Cover-Issue-109-Mar-Apr-2014/Variety-choice-and-crop-rotation-key-to-managing-root-lesion-nematodes>

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 v. 31,033–41,294 *P. thornei*/kg dry soil). Unexpectedly, at planting of the second-year wheat crop, nematode populations were at more uniform, 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.<sup>14</sup>

### 8.4.1 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<sup>(1)</sup> (4,400 *P. neglectus*/kg soil) to 7.3 times after MRGoldrush<sup>(1)</sup> (10,400 *P. neglectus*/kg soil) compared to soil at planting (1,400 *P. neglectus*/kg soil).<sup>15</sup>

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.<sup>16</sup>

*P. thornei* populations greater than 40,000 per kilogram at harvest will require a double break of around 40 months free of a host to reduce the population below the accepted threshold of 2000 *Pt*/kg. *P. thornei* populations greater than 10,000/kg at harvest will require a single break of around 30 months free of a host to reduce the population below the accepted threshold of 2000 *Pt*/kg.<sup>17</sup>

### 8.4.2 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>18</sup>

<sup>14</sup> 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.

<sup>15</sup> <http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/07/Summer-crop-decisions-and-root-lesion-nematodes>

<sup>16</sup> 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.

<sup>17</sup> J Whish, J Thompson (2016), How long does it take to reduce *Pratylenchus thornei* (Root lesion nematode) population in the soil? <https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2016/02/How-long-does-it-take-to-reduce-Pratylenchus-thornei-populations-in-the-soil>

<sup>18</sup> 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.

New South Wales Department of Primary Industries (NSW DPI) winter cereal time-of-sowing 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<sup>(1)</sup>, than in the most resistant variety, Gauntlet<sup>(1)</sup>, at Trangie.
- Earlier sowing generally increased the build-up of *P. thornei* populations Trangie, especially in the most susceptible variety.
- 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<sup>(1)</sup>, 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>19</sup> Visit [www.nvtonline.com.au](http://www.nvtonline.com.au)

## Download

[Northern grains region trial results Autumn 2015.](#)

### 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>20</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

<sup>19</sup> NSW DPI (2013) Northern Grains Region trial results autumn 2013. NSW Department of Primary Industries.

<sup>20</sup> NSW DPI (2013) Northern Grains Region trial results autumn 2013. NSW Department of Primary Industries.


**GRDC Update Paper**

<http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2012/04/Impact-of-sowing-time-and-varietal-tolerance-on-yield-loss-to-the-root-lesion-nematode-pratylenchus-thornei>


**Survey results**

[www.nga.org.au/results-and-publications/download/49/surveys/root-lesion-nematode-survey.pdf](http://www.nga.org.au/results-and-publications/download/49/surveys/root-lesion-nematode-survey.pdf)

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 is that the difference in tolerance levels between wheat varieties appears larger for *P. thornei* than for crown rot.<sup>21</sup>

#### 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.<sup>22</sup>

#### 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.

## 8.5 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) (Figure 5.)

### 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

#### Tolerant-susceptible

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

#### Intolerant-resistant

No commercial wheat lines in this category

#### Intolerant-susceptible

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

Figure 5: Combinations and examples of tolerance and resistance.<sup>23</sup>

Tolerance and resistance of wheat varieties to RLN are published each year at [www.nvtonline.com.au](http://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](#).

<sup>21</sup> NSW DPI (2013) Northern Grains Region trial results autumn 2013. NSW Department of Primary Industries.

<sup>22</sup> 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.

<sup>23</sup> 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.

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*.

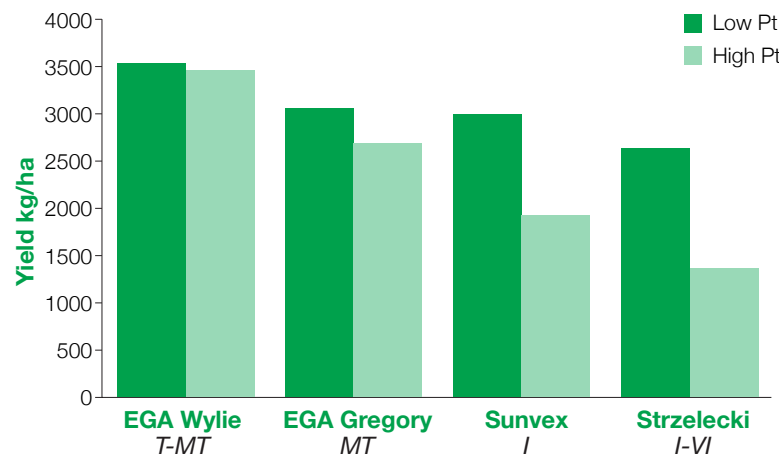
GRDC-funded researchers are currently incorporating *P. thornei* resistances found in a wheat line selected from the variety Gatcher<sup>(b)</sup> and some wheat landraces from West Asia and North Africa into pre-breeding efforts. Excellent resistance to *P. thornei* and *P. neglectus* has been found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

Resistances are being incorporated into some of the most tolerant wheat varieties, including EGA Gregory<sup>(b)</sup> and EGA Wylie<sup>(b)</sup>, to produce parents that are adapted to the northern region.<sup>24</sup>

### 8.5.1 Tolerance

Wheat breeding has provided a number of varieties with moderate or higher levels of tolerance to *P. thornei*, e.g. Sunvale<sup>(b)</sup>, Baxter<sup>(b)</sup>, EGA Wylie<sup>(b)</sup> and EGA Gregory<sup>(b)</sup>. 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.



cv 9.0%, LSD 516

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>25</sup>

The varieties rated as *P. thornei* intolerant (Strzelecki<sup>(b)</sup> and Sunvex<sup>(b)</sup>) 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

<sup>24</sup> 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.

<sup>25</sup> K Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet.

varieties that were more tolerant (EGA Wylie<sup>(1)</sup> and EGA Gregory<sup>(1)</sup>) 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>26</sup>

### 8.5.2 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.

#### Resistance differences between commercial wheat varieties

Resistance ratings for wheat varieties to RLN have been available for many years; however, the development of high-throughput DNA analysis has enabled an increased amount of testing to compare RLN build-up between varieties under field conditions. These data appear to be a very useful addition to our current knowledge on varietal resistance, with relative variety performance fairly consistent across sites. Figure 7 shows the relative performance of a range of varieties as a percentage of EGA Gregory<sup>(1)</sup> in a wide range of trials during 2009–2012.

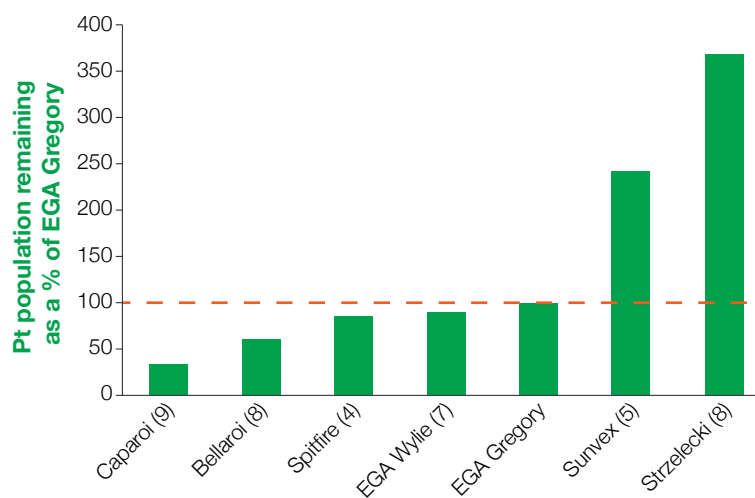


Figure 7: Comparison of *P. thornei* (Pt) population remaining as a percentage of EGA Gregory<sup>(1)</sup>, 2009–2012. Values in parentheses are the number of trials in which the variety was compared with EGA Gregory<sup>(1)</sup>. The red broken line indicates the Pt level remaining after EGA Gregory<sup>(1)</sup>.

Bread wheats are generally susceptible to *P. thornei* but there are large differences between varieties in the level of susceptibility. Growers with *P. thornei* infestations must avoid 'sucker' varieties that result in very high levels of *P. thornei* multiplication.

<sup>26</sup> R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013.

Although durum wheats generally restrict *P. thornei* multiplication compared with bread wheats, they are very susceptible to crown rot.<sup>27</sup>

## **i** More information

[http://www.dpi.nsw.gov.au/data/assets/pdf\\_file/0003/431265/Cereal-pathogen-survey.pdf](http://www.dpi.nsw.gov.au/data/assets/pdf_file/0003/431265/Cereal-pathogen-survey.pdf)

## 8.6 Damage caused by nematodes

*Pratylenchus thornei* is widespread in the northern grains region, with surveys conducted by QDAF 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 ~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 QDAF trials.<sup>28</sup>

## 8.7 Nematodes and crown rot

The NGA has been involved in 22 field trials since 2007, in collaboration with 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.

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>29</sup>

### 8.7.1 Importance of variety choice

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>30</sup>

Two durum and 10 bread wheat varieties were evaluated by NSW DPI in the presence of added or no added crown inoculum across 11 field sites in 2013.<sup>31</sup>

## **i** More information

<http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Crown-rot-and-nematodes>

<sup>27</sup> R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013.

<sup>28</sup> K Owen, J Sheedy, N Seymour (2013) Root lesion nematode in Queensland. Soil Quality Pty Ltd Fact Sheet.

<sup>29</sup> R Daniel (2013) Managing root-lesion nematodes: how important are crop and variety choice? Northern Grower Alliance/GRDC Update Paper, 16/07/2013,

<sup>30</sup> R Daniel, S Simpfendorfer, G McMullen, John Thompson (2010) Root lesion nematode and crown rot – double trouble! Australian Grain, September 2010. <http://www.ausgrain.com.au/Back%20Issues/203sognr10/203sognr10.pdf>

<sup>31</sup> GRDC (2014), Crown rot and nematodes. Are you growing the right variety? <http://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2014/03/Crown-rot-and-nematodes>