Root-lesion nematodes (RLN; *Pratylenchus* species) are significant pests that feed on the roots of crop plants and cause yield loss.

**KEY POINTS**

- Root-lesion nematodes 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 *Pratylenchus neglectus*, *P. quasitereoides* (formerly known as *P. teres*), *P. thornei* and *P. penetrans*.
- The host range of RLN is broad and includes cereals, oilseeds, grain legumes and pastures, as well as many broadleaf and grass weeds.
- Nematode species present will influence the choice of suitable rotational options.

**Management of root-lesion nematodes in winter crops**

- Observation and monitoring of above and below ground symptoms of plant disease, followed by diagnosis of the cause(s) of any root disease, is the first step in implementing effective management. Although little can be done during the current cropping season to ameliorate nematode symptoms, the information will be crucial in planning effective rotations of crop species and varieties in following seasons.
- Well-managed rotations with resistant or non-host break-crops are vital. To limit RLN populations, avoid consecutive host crops (Table 1).
- Use a state department of agriculture [Crop Variety Guide](#) to choose varieties with high resistance ratings, which result in fewer nematodes remaining in the soil to infect subsequent crops.
- Reducing RLN can lead to higher yields in following cereal crops.
- Healthy soils and good nutrition can partly alleviate RLN damage through good crop establishment, and healthier plants may recover more readily from infestation under more suitable growing conditions.
- Observe crop roots to monitor development of symptoms.
- Weeds can host parasitic nematodes within and between cropping sequences, so choice of pasture species and control of host weed species and crop volunteers is important (Table 2).

**About the root-lesion nematode**

*Pratylenchus* are microscopic, worm-like organisms less than 1 mm in length and cannot be seen with the naked eye (Figure 1). They are migratory endoparasites, meaning that they enter roots to feed and lay eggs but may live for some time in soil, feeding on the exterior of the roots or travelling between roots and plants. All RLN species can survive dry periods in a dehydrated form or as eggs within roots or soil. Climatic and soil conditions are ideal for RLN reproduction during the broadacre cropping season in WA, and populations have the ability to increase rapidly during a cropping season in susceptible crops.

**Figure 1.** Mature root-lesion nematode, less than 1 mm long, as viewed under the microscope and cannot be seen. Notice the syringe-like stylet at the head end, which is used to penetrate plant roots and extract nutrients.
All growing regions in WA are affected by RLN (Figure 2) and at least 65% of cropping paddocks are infested with one or more of the *Pratylenchus* species. *Pratylenchus neglectus* is the dominant RLN species identified in infested paddocks in WA, followed by *P. quasitereoides* (formerly *P. teres*); *P. thornei* is much less common in WA than in other growing regions of Australia.

Mixed populations of the RLN species are also regularly identified (Figure 3). *Pratylenchus penetrans* is rare in broadacre crops but can cause severe damage to some crops. These estimates represent a compilation of more than 2,300 confirmed RLN reports gathered since 1997 by the Department of Agriculture and Food, Western Australia (DAFWA), including research trials, surveys and Agwest Plant Laboratory diagnostic samples.

Yield losses in broadacre cropping caused by *P. quasitereoides or P. penetrans* are a problem unique to WA. Research is under way to learn more about these species and the rotations that will limit their population below damaging levels in cropping soils.

More than one RLN species can be found in the roots of an individual crop, although one species usually dominates.

DAFWA has been conducting research for nearly 20 years into the distribution, host range among crop species, variety resistance within crop species, and yield impacts of RLN on crops. During this time, 486 varieties across a wide range of crops have been assessed for resistance to the four main RLN species. All species of RLN have a wide host range. Identification of nematode species is important to management decisions because varieties and crops species differ in their resistance or susceptibility to different members of the *Pratylenchus* genus (Table 1). For example, field peas, lupins and faba beans are resistant to *P. neglectus* but susceptible to *P. penetrans*; barley may be more susceptible to *P. quasitereoides* than to *P. neglectus*; and canola is more susceptible to *P. neglectus* than to *P. thornei*.

Although there is no truly resistant variety of wheat, barley or oats, sufficient variation exists for susceptibility that variety selection in rotations can be a useful tool in managing the impact of RLN. Refer to state department of agriculture [Crop Variety Guide](#) for information on more resistant varieties.

Pastures vary in their susceptibility to RLN, and under some pasture species, nematode levels could increase and become damaging to subsequent cereals. Pastures should therefore be monitored for RLN, and their place in the rotation should be considered for RLN management. In glasshouse trials, French and yellow serradella, lotus and sulla varieties were resistant to *P. neglectus*, whereas clovers and medics were more susceptible (Table 2).

Serradella has also been used successfully to reduce *P. quasitereoides* to manageable levels in a paddock with a history of high nematode densities.

Intensive cropping of susceptible crops, particularly wheat, will lead to an increase in nematode levels. Rotations are the key to limiting nematode multiplication and reducing future crop damage.

Several Australian studies have shown that the extent of yield loss attributed to *P. neglectus or P. thornei* is directly related to the population density at sowing.
### Table 1: Resistance of major crop broadacre species to Pratylenchus neglectus, *P. quasitertoides* and *P. penetrans*

<table>
<thead>
<tr>
<th>Susceptible</th>
<th>Moderately susceptible</th>
<th>Resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>Canola</td>
<td>Field peas</td>
</tr>
<tr>
<td>Barley</td>
<td>Oats</td>
<td>Lupins</td>
</tr>
<tr>
<td>Chickpeas</td>
<td>Durum wheat</td>
<td>Faba beans</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lentils</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Triticale</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rye</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Safflower</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Narbon beans</td>
</tr>
</tbody>
</table>

### Table 2: Resistance of pasture species to Pratylenchus neglectus

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Species</th>
<th>Resistance rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanjil lupin</td>
<td><em>Lupinus angustifolius</em></td>
<td>R</td>
</tr>
<tr>
<td>Charano yellow serradella</td>
<td><em>Ornithopus compressus</em></td>
<td>R</td>
</tr>
<tr>
<td>Flamenco sulla</td>
<td><em>Hedysarum coronarium</em></td>
<td>R</td>
</tr>
<tr>
<td>Yeibini yellow serradella</td>
<td><em>Ornithopus compressus</em></td>
<td>R</td>
</tr>
<tr>
<td>Margurita French serradella</td>
<td><em>Ornithopus sativus</em></td>
<td>R</td>
</tr>
<tr>
<td>Cadiz French serradella</td>
<td><em>Ornithopus sativus</em></td>
<td>MR</td>
</tr>
<tr>
<td>Santorini yellow serradella</td>
<td><em>Ornithopus compressus</em></td>
<td>MR</td>
</tr>
<tr>
<td>Erica French serradella</td>
<td><em>Ornithopus sativus</em></td>
<td>MR</td>
</tr>
<tr>
<td>Hykon rose clover</td>
<td><em>Trifolium hirtum</em></td>
<td>MS</td>
</tr>
<tr>
<td>Electra purple clover</td>
<td><em>Trifolium purpureum</em></td>
<td>MS</td>
</tr>
<tr>
<td>Sceptre lucerne</td>
<td><em>Medicago sativa</em></td>
<td>MS</td>
</tr>
<tr>
<td>Mauro biserrula</td>
<td><em>Biserrula pelecinus</em></td>
<td>S</td>
</tr>
<tr>
<td>Cashbah biserrula</td>
<td><em>Biserrula pelecinus</em></td>
<td>S</td>
</tr>
<tr>
<td>Caprera crimson clover</td>
<td><em>Trifolium incarnatum</em></td>
<td>S</td>
</tr>
<tr>
<td>Cefalu arrowleaf clover</td>
<td><em>Trifolium vesiculosum</em></td>
<td>S</td>
</tr>
<tr>
<td>Sothis eastern star clover</td>
<td><em>Trifolium dasyurum</em></td>
<td>S</td>
</tr>
<tr>
<td>CFD27 bladder clover</td>
<td><em>Trifolium spumosum</em></td>
<td>S</td>
</tr>
<tr>
<td>2002ESP4 biserrula</td>
<td><em>Biserrula pelecinus</em></td>
<td>S</td>
</tr>
<tr>
<td>Coolamon subterranean clover</td>
<td><em>Trifolium subterraneum</em></td>
<td>S</td>
</tr>
<tr>
<td>Machete wheat</td>
<td><em>Trifolium aestivum</em></td>
<td>S</td>
</tr>
<tr>
<td>Nitro Plus Persian clover</td>
<td><em>Triticum aestivum</em></td>
<td>S</td>
</tr>
<tr>
<td>Frontier balansa clover</td>
<td><em>Triticum michelianum</em></td>
<td>S</td>
</tr>
<tr>
<td>Dalkeith subterranean clover</td>
<td><em>Triticum subterraneum</em></td>
<td>S</td>
</tr>
<tr>
<td>Caliph barrel medic</td>
<td><em>Medicago truncatula</em></td>
<td>S</td>
</tr>
<tr>
<td>Urana subterranean clover</td>
<td><em>Medicago polymorpha</em></td>
<td>VS</td>
</tr>
<tr>
<td>Santiago burr medic</td>
<td><em>Medicago polymorpha</em></td>
<td>VS</td>
</tr>
<tr>
<td>Prima gland clover</td>
<td><em>Trifolium glanduliferum</em></td>
<td>VS</td>
</tr>
</tbody>
</table>

Legend: 
R - Resistant, MR - moderately resistant, MS - moderately susceptible, S - susceptible, VS - very susceptible

### MyCrop

MyCrop is an interactive tool that brings crop diagnostics to the paddock.
- Estimate whether you are reaching your wheat yield potential as determined by rainfall.
- Identify your soil type and provide information about key soil issues.
- Diagnose problems in your crop and provide possible remedies.

Department of Agriculture and Food, Western Australia (DAFWA) Development Officer Kelly Ryan discusses how the MyCrop app can be used in GRDC Ground Cover TV.
Root-Lesion Nematodes Western Region

The symptoms

Aboveground symptoms are often indistinct and difficult to identify. The first signs are poor establishment, stunting, poor tillering of cereals, and plants possibly wilting despite moist soil. Nematodes are usually distributed unevenly across a paddock, resulting in irregular crop growth (Figure 4). Sometimes symptoms are confused with nutrient deficiency and they can be exacerbated by a lack of nutrients.

When roots are damaged by RLN, the plants become less efficient at taking up water and nutrients, and less able to tolerate stresses such as drought or nutrient deficiencies. Depending on the extent of damage and the growing conditions, affected plants may partly recover if the rate of new root growth exceeds the rate at which nematodes damage the roots.

To gain the full picture, examination of what is going on under the ground is needed. Primary and secondary roots of cereals will show a general browning and discoloration and there will be fewer, shorter laterals branching from the main roots (Figure 5). Chickpea roots can show distinct dark-brown–orange lesions at early stages of infection and the lateral roots can be severely stunted and reduced in number. The root cortex (or outer root layer) is damaged and it may disintegrate.

Diagnosis is difficult and can be confirmed only with laboratory testing, particularly to identify the species because all RLN species cause identical symptoms. The PreDicta BTM™ soil test (SARDI Diagnostic Services) is a useful tool for several nematode species and is available through accredited agronomists.

Figure 4. Patchy, chlorotic growth caused by root-lesion nematode infestation in a cereal crop.

Figure 5. Barley roots with symptoms of Pratylenchus damage including stunting, lack of lateral roots, and browning lesions.

More information

To hear Dr Sarah Collins, DAFWA discuss root lesion nematodes at the GRDC Agribusiness Crop Updates in 2014, visit https://www.youtube.com/watch?v=XjtdPy7f0ks
The life cycle of RLN

Root-lesion nematodes are migratory plant parasitic nematodes, meaning that they migrate freely between roots and soil if the soil is moist. In the western region, the life cycle of RLN begins after the opening rains in autumn. Juvenile and adult nematodes rehydrate, become active and invade plant roots, where they feed and multiply as they move through the root (Figure 6).

Individual eggs are laid within the root, from which juvenile nematodes hatch and grow to adults, which in turn lay more eggs. They develop from egg to adult in 40–45 days (~6 weeks) depending on soil temperature and host (Figure 6). There may be 3–5 life cycles within the plant host each season. As plants and soil dry out in late spring, RLN enter a dehydrated state called anhydrobiosis and can survive high soil temperatures and desiccation over summer.

As the nematodes feed and multiply, lesions and/or sections of brown discoloration are formed on the plant root. Other symptoms include reduction in the number and size of lateral roots and root hairs.

Management of RLN

The most important management tool is the use of rotations that effectively reduce RLN populations. In heavily infested paddocks, resistant break-crops should be grown for 1 or 2 years to decrease the population. Resistant varieties should be selected for the following years using a current Crop Variety Guide.

Adequate nutrition (especially nitrogen, phosphorus (P) and zinc) help crops to compensate for the loss of root function caused by RLN, although this does not necessarily lead to lower nematode reproduction. In field trials in areas infested with P. neglectus, yield losses for intolerant wheat ranged from 12% to 33% when minimal levels of P were applied, but losses were reduced to only 5% with a high rate of P (50 kg/ha).

Weeds can play an important role in the increase or persistence of nematodes in cropping soils. Thus, poor control of susceptible weeds compromises the use of crop rotations for RLN management.

Wild oats, barley grass, brome grass and wild radish are susceptible to P. neglectus.

Several pasture species and varieties are suitable in rotations to reduce RLN when targeted to the species in your paddock (Table 2), but weeds must be managed because they can strongly influence nematode populations at the end of the pasture phase.

Manage volunteer susceptible crop plants, because they can harbour nematodes. Nematodes cannot move great distances unaided. However, they can be spread by surface water, and in soil adhering to vehicles and farm machinery. In uninfested areas, good hygiene should be practiced. They can also be spread in dust when they are in a dehydrated state over summer.
GRDC Radio (Western Update)

Each week GRDC brings you news and information that is timely and relevant to the Western cropping region of Australia.

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See more at http://www.grdc.com.au/Media-Centre/GRDC-Podcasts/Western-Weekly-Update

Are all nematodes harmful to crops?
Nematodes reveal soil health

Nematodes are emerging as the biological tool that will open the way to measure soil health; an on-going quandary for researchers and growers.

“Free living soil nematodes are abundant in all soils and play important roles in soil food webs,” said SARDI researcher Katherine Linsell. “Some free living nematodes feed only on bacteria, some feed only on fungi and others are omnivores and predators that feed on other nematodes.”

The cropping industry has historically focused on plant parasitic nematodes such as cereal cyst nematode and Pratylenchus because of the damage to crops.

“The abundance of a particular type of free living nematode reflects the number of soil microbes on which they feed,” Dr Linsell said. “The availability of these food sources determines the number and types of nematodes in the soil, so analysis of the nematode community provides information on the status of the soil food web.”

This well-defined response is overlaid on population differences due to basic soil conditions and rainfall regimes, Dr Linsell said.

“All soils have a base-line level of bacterial and fungifeeding nematodes present. Different nematodes are favoured by different soil types and annual rainfall, so different nematodes dominate in different regions.

“Nematode communities are also impacted by farming management practices such as tillage, fertiliser application and the adding or increasing of organic matter.

“if a soil becomes enriched by the addition of nutrients or some form of disturbance then bacterial-feeding nematodes increase rapidly. As a soil becomes better structured and more mature, larger predatory and omnivorous nematodes become more prevalent.

“Using this knowledge we have identified which types of nematodes are most common in different soil environments – till or no-till, high or low nutrition, high or low organic matter.”

Nematodes are easily extracted from the soil, readily identifiable and the various groups each have distinct and stable genetics, making it relatively easy to use DNA to identify the presence and prevalence, of particular nematode populations.

These attributes combined, make free-living nematode populations ideal candidates for the role of indicators of the biological status of soils – and are closely linked to ‘soil health’. Researchers working as part of the GRDC Soil Biology Initiative are developing DNA tests to measure the biological status of Australian cereal soils based on the presence and prevalence of the different types of nematodes.

The sensitive, quick and robust nematode DNA assays are currently available only to researchers, but will become available to growers through the PreDicta B™ soil diagnostic service once regional validation has been completed.

For more information: Katherine Linsell, 08 8303 9459, katherine.linsell@sa.gov.au

Getting to the root of the problem

A suite of new national GRDC programs has launched a fresh attack on root and crown diseases, which collectively cost Australian growers hundreds of millions of dollars in lost production and control costs each year. This Ground Cover Supplement reports on some of the activities from these national projects.

http://gc-supplement.realviewdigital.com/?iid=93946#folio=1
Testing

If RLN infestation is suspected, growers are advised to check the crop roots. Carefully digging up and washing the soil from the roots of an infected plant can reveal evidence of infestation in the roots, which warrants laboratory analysis.

Testing services are available at Agwest Plant Laboratory at the Department of Agriculture and Food, Western Australia (DAFWA), and the DNA-based soil testing service PreDicta BTM™, provided by the South Australian Research and Development Institute, can detect P. neglectus, P. thornei and P. quasitertioide. Growers are advised to contact their local DAFWA office for advice.

Frequently asked questions

Q. Can I use a chemical to control RLN?
Nematicides are not used commercially in broadacre cropping in Australia. They are not recommended because of their cost and mammalian toxicity, and because rotational crops are available for nematode management. If they were used commercially, their efficacy would likely be poor, particularly in situations where the nematode occurs at depth.

Currently, no nematicides are registered for use on broadacre crops in Australia.

Q. Does timing of sowing help?
There is limited information on the effect of time of sowing on yield loss in intolerant crops in the presence of RLN. Trials in the GRDC Northern Region have shown that later sown wheat crops can be more severely affected than those sown early. In Victoria, sowing in mid–July compared with late May resulted in 60% lower yield for an intolerant wheat variety and 10% lower yield for a tolerant variety where there was a high population of P. thornei.

Q. Are Pratylenchus quasitertioide and P. penetrans in other states?
Pratylenchus quasitertioide has been identified at a small number of sites in southern Australia but it only causes problems in crops in WA. Pratylenchus penetrans does occur in other states, where it is generally known as a horticultural pest.

Useful Resources

- Dr Sarah Collins, DAFWA, ph. (08) 9368 3612, email sarah.collins@agric.wa.gov.au
- Growing-season tests can be carried out on affected plants and the associated soil. Contact your state department of agriculture; for testing laboratories in WA, contact ph. (08) 9368 3721 or agwestplantlabs@agric.wa.gov.au.
- PreDicta BTM™: a soil analysis service delivered by accredited agronomists. PreDicta BTM™ can detect P. neglectus, P. thornei and cereal cyst nematode (CCN). While the test can detect P. quasitertioide and P. penetrans no risk ratings are available and results need to be interpreted with caution, particularly for WA. Contact your local agronomist, or to locate your nearest supplier, email your contact details and location to: predictab@saugov.sa.gov.au.
- DAFWA Bulletins: www.agric.wa.gov.au
- For variety ratings, see state Crop Variety Guide published annually at NVT Online Crop Guides.

Acknowledgements

Dr Sarah Collins, DAFWA; Dr Vivien Vanstone (formerly of DAFWA)
Check out eXtensionAUS pilot project at www.extensionaus.com.au

This pilot project is trialing whether the eXtension model developed in the United States has value for the Australian grains industry. It has commenced with two Grains Research and Development Corporation (GRDC) funded projects that have a specific and applied focus on the fields of crop nutrition and field crop diseases.

In the USA, eXtension is a national internet based educational network which compliments their community based Cooperative Extension System. It provides an interactive online learning environment that aims to deliver the best, most researched knowledge from the best knowledge sources to the consumers who need to use it, with 24/7/365 day availability.

The pilot is testing the potential of on-line systems to enable collaboration, facilitate the creation of virtual learning communities and promote knowledge exchange and technology adoption via closer and more immediate levels of engagement across the Australian grains sector.