



NORTHERN FOCUS

COVERING NORTHERN NSW AND QUEENSLAND

THE RESEARCH VIEW

RLN - another good reason to rotate

By Dr John Thompson¹

Root-lesion nematodes, *Pratylenchus thornei* and *Pratylenchus neglectus*, have been detected at potentially damaging levels in nearly 30 per cent of fields in the northern grain region.

Intolerant wheat varieties can lose more than 50 per cent in yield and some chick-pea varieties up to 20 per cent yield when nematode populations are high.

The best way to find out if there are nematodes in your fields and if they are at damaging levels is to have soil samples tested in a laboratory.

Successful management relies on:

- Growing tolerant crop varieties to maximise yields when RLN are present;
- Rotating with resistant crops to keep RLN at low levels; and,

- Cleaning soil from farm machinery to keep fields/farms free of RLN.

What are nematodes?

Nematodes are minute (mostly less than one millimetre long) eel-like worms that live in many environments including the soil. They are the most numerous multicellular animal life-forms on earth.

Many nematodes feed on soil microorganisms and contribute beneficially to the cycling of nutrients. But some species feed on the roots of plants.

These plant-parasitic nematodes are equipped with mouthparts that form a retractable, hollow, spear-like structure ('stylet') which they use to break the walls

of root cells and withdraw the contents for their nutrition.

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Consultants' Corner



Consultants' Corner is an initiative by *Australian Grain* highlighting current GRDC-funded research with a particular focus on the commercial implications of adopting cutting-edge research.



TEST YOUR FARM FOR NEMATODES

It is important to have paddocks diagnosed for plant parasitic nematodes so that optimal management strategies can be implemented.

Testing your farm will tell you:

- If nematodes are present in your fields and at what density; and,
- What species are present.

It is important to know what species are present because some of the crop management options are species specific.

If a particular species is present in high numbers it is important to make immediate decisions to avoid losses in the next crop to be grown.

With low numbers it is important to take decisions to safeguard future crops.

Learning that a paddock is free of these nematodes is valuable information because it may be possible to take steps and avoid future contamination of that field.

Both testing soil samples taken before a crop is sown or while the crop is in the ground, provides valuable information.

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Endoparasitic nematode species enter into the root tissues by using their stylet and head to physically break root cell walls and by excreting enzymes that dissolve cell walls.

Ectoparasitic nematodes remain outside the roots and use their stylet to feed on root hairs and surface cells of the root.

What are root-lesion nematodes?

There are two important species of root-lesion nematode in the northern grain region, *Pratylenchus thornei* (the most commonly found species) and *Pratylenchus neglectus*.

Root-lesion nematodes feed and reproduce inside plant roots (endoparasitic nematodes). The damage to the plant roots leads to yield loss in crops such as wheat and chickpea. These nematodes can also build-up numbers under many other crops.

Root-lesion nematodes in the northern grain region can be found deep in the soil profile and in some cases peak populations occur 30–60 cm deep in the soil.

Symptoms of RLN

Root-lesion nematodes are microscopic and cannot be seen with the naked eye in the soil or in plants. The most reliable way to confirm the presence of RLN is to test



Root-lesion nematodes and egg viewed under a microscope. The stylet in the nematode's mouth is used to break plant cell walls and for feeding.

your farm soil.

Look out for tell-tale signs of nematode infection in the roots and symptoms in the plant tops and if seen, submit soil and root samples for nematode assessment.

HOW NO-TILL IMPACTS ON RLN

Studies have been conducted in several long-term tillage experiments where RLN have been found to be a significant factor affecting the grain crop.

After 11 years of continual cropping in a factorial experiment involving tillage (mechanical or zero), stubble management (burnt or retained) and nitrogen fertiliser on a self-mulching vertosol near Warwick (south Queensland), numbers of *P. thornei* in the top soil were highest in the zero tillage, high N fertiliser treatments.

Nematodes were considered to be one of the factors resulting in nitrogen deficiency in the wheat growing on the zero-till, stubble-retained treatments.

When the plots were split for wheat or barley, *P. thornei* was found to limit the response of wheat – but not barley – to the extra stored moisture resulting from zero tillage, particularly when this practice was combined with stubble retention. *P. thornei* can be an important factor limiting water use efficiency in wheat.

In an experiment on a similar soil type near Toowoomba, southern Queensland, *P. thornei* populations in the soil profile increased more with stubble retention and zero or reduced tillage than with stubble burning and frequent tillage.

Both stubble burning and frequent tillage tended to result in poorer storage of soil water and lower wheat yields than stubble retention and zero or reduced tillage treatments.

In a third experiment on a chromosol at a site north of Goondiwindi (south Queensland), eight years of stubble retention generally increased both numbers of *P. neglectus* and the amount of water stored in the soil profile.

When stubble was burnt, frequent tillage had the same effect, largely because, in this particular soil, it reduced the impact on raindrop pounding and surface sealing on water penetration.

These results suggest that tillage and stubble practices that improve the supply of water in the soil profile will also increase numbers of *P. thornei* and *P. neglectus*, probably by increasing root biomass.

Root damage

Root-lesion nematodes invade the root tissue resulting in light browning of the roots or localised deep brown lesions. But these lesions can be difficult to see on roots. The damage to the roots and the appearance of the lesions can be made worse by fungi and bacteria also entering the wounded roots.

Roots infected by RLN are poorly branched, lack root hairs and do not grow deeply into the soil profile. Such root systems are inefficient in taking up soil nutrients (particularly nitrogen, phosphorus and zinc under northern region conditions) and soil water.

Plant tops

When RLN are present in very high numbers the lower leaves of the wheat plants are yellow and the plants are stunted with reduced tillering. There is poor canopy closure so that the wheat rows appear more open.

The tops of the plants may exhibit symptoms of nutrient deficiency (nitrogen, phosphorus and zinc) when the roots are damaged by RLN.

Infected crops can wilt prematurely, particularly when conditions become dry later in the season because the damaged root systems are inefficient at taking-up stored soil moisture. With good seasonal rainfall, wilting is less evident and plants may appear nitrogen deficient.

Deteriorating wheat yields over several years, called 'wheat sickness', may also indicate a nematode problem.

Life cycle

The adult RLN are nearly all self-fertile females. They lay eggs inside the roots and pass through a complete life cycle in about six weeks under favourable conditions (warm, moist soil) and so pass through several generations in the life of one host crop.

The newly hatched nematodes can remain in the plant roots, or leave the plant to seek another root system to attack. The nematodes survive through fallow periods, particularly in the subsoil where they escape the hot, drying conditions of the surface soil. In drought, the nematodes can dehydrate (anhydrobiosis) to further aid their survival until favourable conditions return.

What is resistance and tolerance?

Resistance: Nematode multiplication

Resistant crops do not allow RLN to re-

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produce and increase in number in their roots.

Susceptible crops allow RLN to reproduce so that their numbers increase. Moderately susceptible crops allow increases in nematode populations but at a slower rate.

Tolerance: Crop response

Tolerant varieties/crops yield well when sown in fields containing high populations of nematodes.

Intolerant varieties/crops yield poorly when sown in fields containing high populations of nematodes.

Crop damage and potential losses

Root-lesion nematode numbers build up steadily under susceptible crops and cause decreasing yields over several years. Yield losses of more than 50 per cent can occur in some wheat varieties and up to 20 per cent yield loss in some chickpea varieties.

The amount of damage caused will depend on:

- The numbers of nematodes in the soil at sowing;
- The tolerance of the variety of the crop being grown; and,
- The environmental conditions.

Generally, a population density of 2000 RLN per kilogram of soil anywhere in the soil profile has the potential to reduce the grain yield of intolerant wheat varieties.

RLN distribution

Pratylenchus thornei is the most common root-lesion nematode and is present in about two-thirds of fields in the northern grain region. *Pratylenchus neglectus*



Recent DEEDI trials showed that wheat yields were doubled when grown after resistant crops (right-hand side) compared with those following susceptible crops (left-hand side).

is found in about one-third of fields and both species occur together in just over one-quarter of fields. About one-quarter of fields have no RLN.

The spread of RLN

Pratylenchus thornei was probably introduced into the northern grain region. Root-lesion nematode populations increase as the period of cultivation of wheat increases.

Samples taken from a farm at Pirriuan on the Darling Downs, Queensland had no *Pratylenchus thornei* present in vir-

gin grassland, or in a field that had been cropped for only three years. But they were present in large numbers in a field that had been cropped for 20 years and had grown 12 wheat crops. The effect on wheat yields was dramatic.

The farm at Pirriuan provided an ideal site for research and paired trials of wheat varieties were grown on the nematode-free and nematode-infected sites. Some varieties were treated with a nematicide.

Where fertiliser was applied, the major difference in yield of intolerant varieties between the old and new cultivation was the presence of *P. thornei*. Nematicide gave substantial yield response but controlled the nematodes in the topsoil only.

What soil types do RLN prefer?

There are no hard and fast rules for the type of soil that RLN prefer. Root-lesion nematodes are found throughout the northern grain region across the range of soil types.

Tolerant wheat varieties

Valuable information has been obtained on the tolerance of northern wheat varieties to *Pratylenchus thornei* and breeding programs have actively selected for this trait (Table 1).

Up-to-date information is produced by DEEDI every year in the *Wheat Varieties for Queensland Guide* and is also available at the GRDC-funded National Variety Trial website (www.nvtonline.com.au).

The ratings, ranging from tolerant to



In a four-year crop rotation experiment on the Darling Downs the best yields of the final Strzelecki wheat crop were obtained on plots previously planted with resistant crops such as sorghum, millet and panicum. This effect was more striking if the resistant canary seed had been planted three years before.

very intolerant, are based on a variety's yield as a percentage of the average of all varieties sown in the trials. The variety EGA Wylie has proved to be the most tolerant of the varieties tested so far.

The yield of each variety as a percentage of EGA Wylie's yield on *Pratylenchus thornei* infested sites is also given in Table 1. It represents the yield loss if a particular variety had been sown on a highly infested

TABLE 1: Tolerance/intolerance of some wheat varieties to *Pratylenchus thornei*

Grain yield in fields heavily infested with *P. thornei*

Wheat variety	Yield (as a % of EGA Wylie)	Tolerance ranking
EGA Wylie	100	T
QAL2000	91	MT
EGA Gregory	90	MT
Baxter	90	MT
Sunvale	89	MT-MI
Yallaroi (durum)	86	MT-MI
Rees	85	MT-MI
GBA Ruby	85	MT-MI
Sunstate	84	MT-MI
GBA Hunter	84	MT-MI
EGA Burke	83	MT-MI
Leichhardt	83	MT-MI
Ventura	82	MT-MI
Kennedy	80	MT-MI
Livingston	79	MI
Hartog	79	MI
Giles	76	MI
EGA Bellaroi (durum)	76	MI
EGA Wills	75	MI
Jandaroi (durum)	74	MI
EGA Kidman	72	MI
Wollaroi (durum)	71	MI
EGA Wentworth	66	MI-I
Lang	63	MI-I
QALBis	63	MI-I
GBA Sapphire	61	MI-I
Strzelecki	60	MI-I
Sunco	59	I
EGA Stampede	59	I
Petrie	57	I
Sunlin	57	I
EGA Hume	55	I
Ellison	53	I
Sunsoft98	37	VI

T= tolerant; MT= moderately tolerant; MT-MI= moderately tolerant, moderately intolerant; MI = moderately intolerant; MI-I = Moderately intolerant, intolerant; I = Intolerant; VI = Very intolerant.

site instead of EGA Wylie – that is: per cent yield loss of a variety = 100 per cent minus yield of that variety as a per cent EGA Wylie's yield.

Clearly, sowing an intolerant variety in a paddock with high numbers of *Pratylenchus thornei* equates to a considerable economic loss for a wheat grower.

Only preliminary information on the tolerance of northern wheat varieties to *Pratylenchus neglectus* is available.

Data that is available indicates that tolerance information for *Pratylenchus thornei* is not applicable to *Pratylenchus neglectus*, reinforcing the need for accurate species identification in soil samples.

Resistant wheat varieties

There are currently no bread wheat varieties with a high level of resistance to RLN. This means that root-lesion nematode populations will increase when wheat is grown. But some wheat varieties are less susceptible than others (see the *Wheat Varieties for Queensland 2009 Guide* for a complete list). Durum wheats generally have good resistance to *P. thornei* but growers need to be careful where crown rot is present. Choosing the least susceptible variety can limit the build-up of RLN and aid management.

RLN MANAGEMENT

Chemical control measures

There are no nematicides currently registered for use in cereal crops in the northern grain region. Nematicides are expensive and offer only partial control of RLN in the northern grain region due to poor penetration into the soil (RLN are often found deep in the soil profile).

Preventing spread to clean fields

A paddock that is free of parasitic nematodes is a valuable asset. Avoid contamination of fields by making sure farm machinery that enters this paddock is free of soil from other paddocks. It is essential to clean machinery with a pressure hose away from uninfested paddocks.

Nematodes may also be spread in run-off water. Therefore, all measures that control run-off and soil erosion can lessen the likelihood of nematodes spreading in this way.

Fertiliser

Increasing fertiliser rates to luxury levels beyond normally recommended commercial rates can give some reduction in plant symptoms and improve grain yield, but this is not a recommended method for managing RLN.

Resistant crops

Growing resistant crops is the main tool for managing nematodes. In the case of crops such as wheat or chickpea, choose the most tolerant variety available and rotate with resistant crops to keep nematode numbers at low levels.

It is worth noting that *Pratylenchus thornei* and *Pratylenchus neglectus* may prefer different crops. Additionally there are often useful levels of resistance within many crop varieties.

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TABLE 2: Choose resistant crops to keep RLN numbers at low levels, avoid or limit the use of susceptible crops and choose tolerant varieties to maximise yields

Crop	<i>P. thornei</i>	<i>P. neglectus</i>
Winter Crops		
Barley	MS	MS
Canaryseed	R	MS
Chickpea	S	S
Durum wheat	R	MS
Faba bean	S	R
Linseed	R	R
Oats	MR	MR
Triticale	MR	R
Wheat	S	S
Summer Crops		
Blackgram	S	R
Cotton	R	—
Cowpea	S	R
Lablab	R	R
Maize	MR	MR
Millet		
– Japanese	R	
– Pearl	MR	—
– Siberian	R	
– White french	MR	
Mung bean	S	R
Navybean	S	MR
Panicum		
– Foxtail	R	
– Panorama	R	—
– Pearl	R	
Pigeon pea	R	—
Sorghum – grain	R	S
Sorghum – forage	R	S
Soybean	S	R
Sunflower	R	R

S = susceptible; MS = moderately susceptible; R = resistant; — = not tested

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Crop rotation – research results

We have shown that wheat yields can be doubled if grown in rotation with resistant crops.

We carried out a four-year crop rotation experiment at Formartin on the Darling Downs, and followed the nematode numbers throughout the trial.

In the first year of the trial a susceptible wheat crop or a resistant canaryseed crop

was grown to establish plots with high or low *Pratylenchus thornei* populations.

After a further 11 months of clean fallow, summer crops were grown. These included several varieties each of mung bean, soybean, maize, sunflower, millet, panicum and sorghum.

After the summer crops were harvested all plots had a 13-month clean fallow. Strzelecki wheat was planted over the entire site.

The best yields of the final Strzelecki

wheat crop were obtained on plots previously planted with resistant crops such as sorghum, millet and panicum. This effect was more striking if the resistant canaryseed had been planted three years before.

Dr Kirsty Owen and Tim Clewett from DEEDI will present current results from GRDC-supported research at the GRDC Update at Mungindi, NSW on March 2. For more information visit www.grdc.com.au.

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CROP DOCTOR
With Peter Reading

NORTH

BLACK LAYER BEST SORGHUM INDICATOR

Grains Research and Development Corporation (GRDC) research shows assessing the 'black layer' in sorghum grain is the most practical tool for scheduling timing of sorghum spray out.

GRDC-supported research by the Northern Grower Alliance (NGA) has responded to local grower requests for investigations into the timing of sorghum spray-out.

Richard Daniel, NGA chief executive officer says it is well known that sorghum grain or head colour is a poor indicator of actual maturity as it varies widely by both hybrid and environmental conditions.

Richard says in many areas of northern NSW, sorghum spray-out timing has often been regarded as overly conservative.

As a result growers and advisers were interested in better understanding the 'best triggers' for timing and quantifying the risks and benefits to allow better on-farm decision making.

There were two key areas where growers believed an advantage might be gained:

- To avoid being overly conservative and consequently bring harvest dates forward and limiting exposure to adverse weather issues.
- To maximise the chance of double cropping to chickpeas by stopping sorghum soil moisture use as early as economically practical.

Richard says the rule of thumb used by seed companies such as Pacific Seeds and Pioneer is to start looking in-field from about 35 days after flowering.

He said this was a good starting point but would always need to be refined in individual paddocks.

Richard says growers should consider all the implications of sorghum spray-out, including:

- Dramatic negative impact of early spray-out timing on yield and grain quality.



Researchers say the black layer on this sorghum seed is 'close to ideal' for spray-out.

- Little or no advantage from delaying past grain physiological maturity.
- Soil moisture benefits from early timing were erratic and not consistent enough to budget on.
- Approximately 35 days after flowering is a good time to commence checking for crop maturity.
- Identify the latest heads/tillers that you consider important to take to harvest.
- Assess 'black layer' or physiological maturity on grain in heads of that maturity and schedule timing accordingly.

He says aggressively spraying before physiological maturity is far too costly in terms of sorghum returns and is not warranted by the soil moisture conserved.

However being overly conservative is also a production constraint to avoid. This was in fact seen at one trial site in 2007–08 where the commercial spray-out timing could have been considered two to three weeks earlier.

Hybrids with staygreen attributes may take longer to mature but also individual paddock timing will be heavily influenced by row configuration and particularly by the number of late tillers which can be taken successfully to yield.

Although sorghum spray-out can be a very useful management tool, it is unlikely to be appropriate in all cases.

In situations with highly moisture stressed crops or with high stalk rot levels, sorghum spray-out may actually result in yield losses due to crop lodging. New research in this area is planned for 2009–10.

Certainly this project has confirmed the use of 'black layer' as the most practical tool for scheduling timing and reinforced the need to judge 'black layer' development on heads of the maturity desired to take to harvest.

Although soil moisture benefits were recorded in some trials, the key approach should be to desiccate the sorghum as soon as practical after 'black layer' and treat any soil moisture benefit as a bonus.

This project was run in close collaboration with Industry & Investment NSW (I&I NSW). In 2007–08 two trials were conducted on NSW's Liverpool Plains with an additional eight trials conducted in 2008–09 from southern Queensland to the Liverpool Plains. (See *Australian Grain*, Northern Focus Nov–Dec 2009.)

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