CHOOSING ROTATION CROPS FACT SHEET

GRDC
Grains Research & Development Corporation

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NORTHERN REGION

Short-term profits, long-term payback

Crop rotations, particularly those that include nitrogen-fixing pulses, are forging a permanent place in northern region farming systems. A break from winter cereals can provide for the long-term insect, weed and disease management benefits and short-term potential profits.

KEY POINTS

- Crop sequencing is a key part of a long-term farming systems approach to tackling weed, disease and moisture challenges in the northern grains region.
- Nitrogen-fixing summer and winter pulses are gaining increasing popularity as cereal breaks.
- Using winter cereal/summer crop and winter pulse/summer crop rotations are key strategies for reducing crown rot pressure and the incidence of root lesion nematodes (RLN) in the northern region.
- GRDC-supported research aims to increase the profitability of minor rotation crops such as faba beans by improving pest and disease resistance.
- Development of new varieties is boosting potential rotation crop yields and disease resistance.
- The potential fit of sorghum as part of the rotation in western areas is the subject of further research.

PHOTO: ROB LONG

Research into production-limiting factors including crown rot (pictured), stripe rust, root lesion nematode and declining soil fertility points to crop sequencing as crucial to the long-term sustainability of cropping in the northern region.

Overview

Northern region grain growers have embraced crop rotations for the benefits they offer for producers operating within an increasingly challenging cropping environment.

More and more growers are understanding there are no quick fixes for many of the region's grain growing challenges and are turning to a farming system approach hinging on crop sequencing, herbicide rotations, integrated weed and pest management (IWM and IPM) and practices such as minimum tillage that promote soil health.

Growing a diversity of crops, particularly where machinery can be readily adapted, also allows growers to spread marketing risks and capitalise on market-driven crop prospects. Growers can design a farming system that effectively uses available soil moisture and takes advantage of seasonal opportunities.

Over the last decade adoption of crop sequencing, particularly including chickpeas and long fallow combined with sorghum production, has substantially increased in the northern region. Growers and advisers are recognising the short and long-term benefits on offer, particularly from nitrogen-fixing pulse rotation crops.

Pulses, including chickpeas and faba beans, are proving to be effective rotation crops, particularly for combating soil and stubble-borne

PHOTO: PULSE AUSTRALIA

Research conducted near St George, Queensland, showed chickpeas followed by wheat is the most profitable rotation.

fungal diseases such as crown rot. A mix of broadleaf and cereal or grass crops also enables growers to rotate herbicide groups as a means of reducing the risk of herbicide resistance.

In 2006, it was estimated that the then low adoption rate of chickpeas was costing northern region growers at least $7.8 million per year. Since then, the rising incidence of crown rot and root lesion nematodes (RLN) in the northern region and the fluctuating price of nitrogen fertiliser have put rotation crops in the spotlight as a vital component of the region's farming system.

In 2010, 433,000 hectares of chickpeas and beans were sown in the northern region, including 100,000ha of the new desi chickpea variety, PBA HatTrick⁽ᴰ⁾. Despite a difficult production year marked by extreme disease pressure and flooding in some parts of the region, it is expected rotation crops, particularly chickpeas, will cement a place in northern operations.

In the grains belt of northern New South Wales and southern Queensland, wheat, barley and sorghum are the principal crops and all have a substantial demand for nitrogen. For example, a three-tonne-per-hectare wheat crop at eight per cent protein needs 65 kilograms of nitrogen per hectare. At 10 per cent protein, it is 86kg N/ha and at 12 per cent, 125kg N/ha. Increasingly, growers are looking to the winter pulses, chickpeas and faba beans, to provide at least some of the required nitrogen (Table 1).

TABLE 1 Summary of a decade of experimental results from the northern grains belt showing the rotational benefits of chickpeas on yield and grain protein levels of the following wheat crop

Sites/rotations	Nil fertiliser nitrogen (N)		+ fertiliser N (75-150kg N/ha)	
	Yield (t/ha)	Per cent protein	Yield (t/ha)	Per cent protein
NEW SOUTH WALES				
Chickpeas	1.9			
Wheat after wheat	2.1	11.2	2.7	13.2
Wheat after chickpeas	2.8	12.2	2.9	13.8
QUEENSLAND				
Chickpeas	1.5			
Wheat after wheat	2.2	10.3	2.8	13.8
Wheat after chickpeas	2.8	11.7	3.1	13.8

SOURCE: Lucy et al. 2005

Having summer crop as well as winter crop spreads risk and the workload, which reduces demand for labour and machinery. Diversified farms can operate with smaller machinery. For example, a 2000ha farm might need more than one planter and harvester if it grows only winter crop, whereas one machine may suffice if a significant area of summer crop is planted each year.

When designing rotations, growers are drawing together many aspects of the farming system and must consider issues such as crop profitability, climate, soil type, plant available soil water, soil cover levels, rainfall outlook, insect, weed and disease pressure and the presence of root lesion nematode (RLN).

Leading soil scientists are promoting pulses within grain rotations as the key to reducing carbon emissions related to grain growing. The inclusion of pulses in a farming system reduces carbon emissions produced by the manufacture and transport of nitrogen fertiliser.

Much of the latest GRDC-supported research into production-limiting factors including crown rot, stripe rust, RLN and declining soil fertility points to crop sequencing as crucial to the long-term sustainability of cropping in the northern region.

Profitable rotations

Leading growers and advisers advocate sustainable rotations as a valuable strategy for northern farming systems.

In a survey of leading growers it was reported that those adopting farming systems based on best management practices allocated about 25 per cent of their winter cropping area to chickpeas or other broadleaf crops.

Their major motivation for introducing a non-cereal was to break the crown rot cycle and consequently improve profitability. The growers reported in the survey that subsequent wheat crops, following a rotation crop, averaged up to one tonne per hectare extra yield as well as an additional one per cent grain protein. In addition, the growers reported savings in nitrogen and weed control inputs.

Many growers are sacrificing cereal yield and protein by not adopting current research findings on the use of rotations.

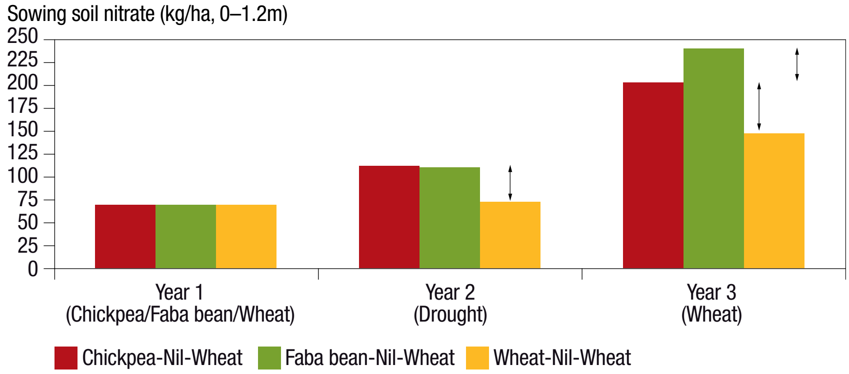
A decade of research in northern NSW and southern Queensland on rotations and crop sequences has produced some major findings. These include:

- wheat following chickpeas outyielded wheat after wheat by an average of 0.7t/ha in the NSW trials and by 0.6t/ha in the Queensland trials. Proteins were increased by an average of 1 per cent (NSW) and 1.4 per cent (Qld) (Table 1);
- where water was not limiting, the yield benefit from a break of chickpeas to the following wheat crop was more than 1.5t/ha;
- the major factor in the increased wheat yields was nitrate supply. In NSW, there was, on average, an additional 35kg nitrate-N/ha in the 1.2m profile after chickpeas than in the continuous wheat; and
- chickpea yields were, on average, about 85 per cent of the unfertilised wheat and about 70 per cent of the N-fertilised wheat.

The substantial rotational benefit of pulses on wheat yields tends to last for one season only (Figures 1 and 2). Results from six sites in northern NSW showed that chickpeas provided an average soil nitrate benefit equivalent to 42kg nitrate-N/ha and an average grain yield benefit equivalent to 1.0t/ha for the following wheat crop (Figures 1 and 2). Residual benefits of chickpeas for a second wheat crop were small and inconsistent.

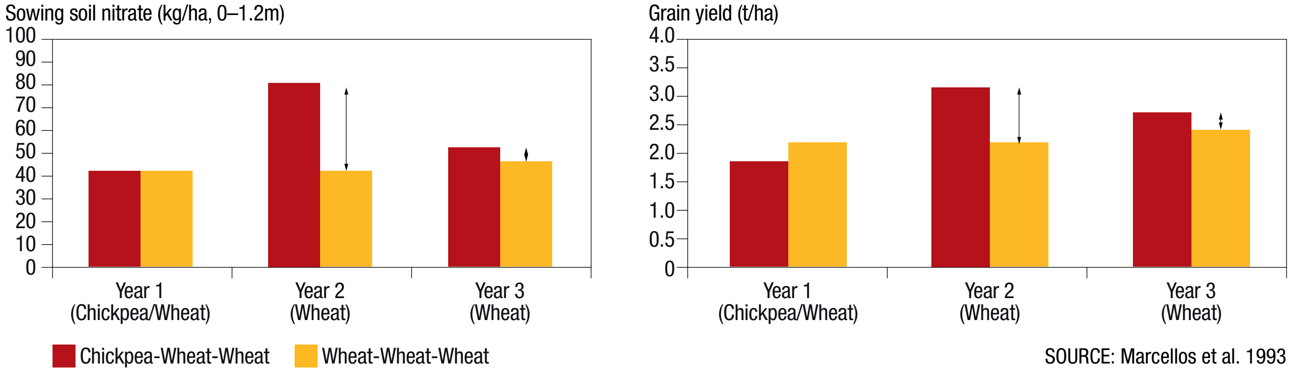
Most of the data on rotational benefits of pulses in the northern grains belt relates to chickpeas. One of the

FIGURE 3 Benefits of chickpeas and faba beans, relative to wheat, on soil nitrate levels. The Year 2 crops were not sown because of drought and the land lay fallow for 12 months. Nitrate levels for Year 2 are after a six-month summer fallow and for Year 3 are after an 18-month summer-winter-summer fallow



SOURCE: Unpublished data of W. Felton, H. Marcellos, D. Herridge, G. Schwenke and M. Peoples

FIGURES 1 & 2 The rotational benefits of pulses on wheat yields tend to last for one season only so long-term crop sequencing is important for sustained profitability



SOURCE: Marcellos et al. 1993

objectives of the long-term no-tillage experiments of NSW I&I was to compare chickpeas and faba beans in terms of nitrate nitrogen fixation and rotational benefits.

Nitrate nitrogen fixation was, to some extent, achieved while rotational benefits were compromised by a combination of drought (1994), frost (1995) and a very wet season causing disease (1998). The limited data available shows:

- no difference between chickpeas and faba beans in terms of soil nitrate benefits when pulses are sown into low nitrate soils (Figure 3);
- possible longer term nitrate benefits of faba bean (see Year 2 data in Figure 2); and
- slight superiority of faba bean in higher nitrate soils in terms of soil nitrate and grain yield benefits (data not shown).

Similar results were reported from rotation trials conducted near St George. In these trials, the advantages of using rotations were made up of a nitrogen-fixation benefit and a biological benefit. The latter largely related to the break effect of the pulse on soil and stubble-borne diseases of cereals. In these trials, the disease-break effect could be worth 0.2 to 0.5t/ha in the following cereal crop; canola, chickpeas and faba beans were found to be profitable crops when compared to wheat and barley.

Which rotation crop?

For northern region growers and researchers the key to successful crop sequencing has been to understand the principles behind the effectiveness of rotation crops. Increasing levels of crown rot and RLN have been found to be a substantial limitation in intensive cereal rotations.

Crops with a dense canopy and early canopy closure such as mustard, canola or faba beans are effective at breaking down plant residues infected with crown rot, reducing inoculum levels. Crown rot is a fungal disease hosted by all winter cereals and many grassy weeds, so warm, damp conditions under the canopy will result in the fastest decomposition of stubble and plant residue.

Another key finding in relation to crown rot is that a rotation crop is only as good as the season in which it was grown, in terms of rainfall. During low in-crop rainfall years, even if it is a summer rotation crop such as sorghum, if there is not sufficient moisture to break the stubble down, high levels of crown rot inoculum can carry through that rotation crop period.

Crop rotation is the main method of reducing the impact of RLN, however crops and varieties can vary in their ability to prevent nematode reproduction. There are two major RLNs impacting on cereal production in the northern region, *Pratylenchus thornei* and *Pratylenchus neglectus*. While wheat and chickpeas are susceptible to both species of nematodes, other crops, such as sunflower, have resistance to both minimising the build-up of either species (Table 2).

Chickpeas

Chickpeas are the preferred broadleaf rotation crop in the predominantly cereal farming systems of the northern region.

The crop brings many benefits to the farming system and is currently the most adapted of all the rotation crops to the climate, soils and the no-till farming systems of the north. Careful management must be undertaken to combat diseases such as ascochyta blight. Chickpeas are susceptible to both species of RLN.

Key benefits are:

- expanded weed control options;
- a break for diseases such as crown rot in wheat;
- improved nitrogen supply for cereal crops; and
- improvement in soil health.

TABLE 2 Resistance/susceptibility of summer crops to *Pratylenchus thornei* and *Pratylenchus neglectus*

Summer Crops	*P. thornei*	*P. neglectus*
Barley	Moderately resistant	Moderately resistant
Blackgram	Susceptible	Resistant
Chickpeas	Susceptible	Susceptible
Cotton	Resistant	Not tested
Cowpeas	Moderately resistant	Resistant
Durum wheat	Moderately resistant	Moderately susceptible
Faba beans	Susceptible	Resistant
Lablab	Resistant	Resistant
Linseed	Resistant	Resistant
Maize	Moderately resistant	Moderately resistant
Millet - Japanese - Pearl - Siberian - White French	 Resistant Moderately resistant Resistant Moderately resistant	 Resistant Resistant Resistant Moderately resistant
Mungbeans	Susceptible	Resistant
Navybeans	Moderately resistant	Moderately resistant
Panicum - Foxtail - Panorama - Pearl	 Resistant Resistant Resistant	 Not tested Not tested Not tested
Pigeon peas	Resistant	Not tested
Oats	Moderately resistant	Moderately resistant
Sorghum - grain	Resistant	Susceptible
Sorghum - forage	Resistant	Susceptible
Soybeans	Susceptible	Resistant
Sunflower	Resistant	Resistant
Wheat	Susceptible	Susceptible

SOURCE: J Thompson, 2009

Faba beans have great potential as a roation crop for crown rot in the northern region.

Chickpeas also provide flexibility, offering benefits such as:

- a profitable crop in its own right;
- the ability to sow the crop in wide rows (up to 100 centimetres) using a no-till system, which offsets small yield loss potential;
- band spraying wide rows reduces the amount of pesticide in the environment; and
- the ability to deep sow providing the opportunity to plant on time most years.

Faba beans

Faba beans have great potential as a break crop for crown rot in the northern region due to the crop's dense and early canopy closure. This creates the suitably humid conditions for stubble breakdown. Faba beans are only resistant to *P.neglectus*.

Profitability has been an issue but research aims to increase disease-resistance and lower inputs.

Researchers aim to make the crop attractive enough for growers so that a viable and profitable faba bean industry can be established. This will allow growers to diversify farming systems and rotations.

Faba beans can contribute large amounts of nitrogen to the soil (up to 100kg N/ha over an extended period), while helping to control crown rot and improving overall soil health.

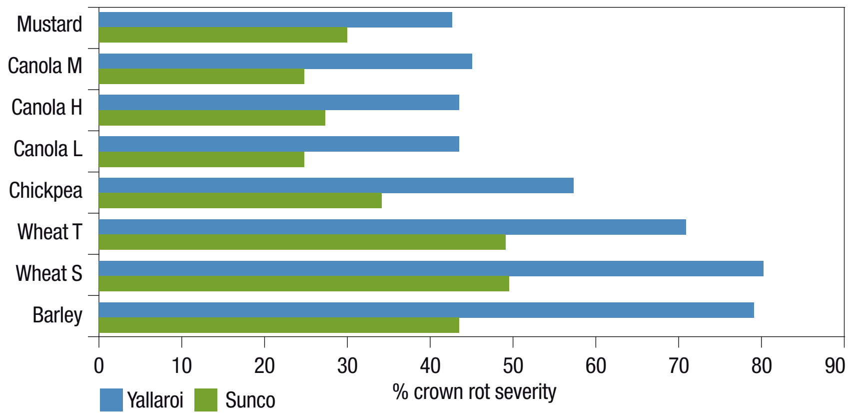
Returns are relatively low compared to chickpeas but are earning their place in mixed grazing/farming enterprises due to their stockfeed value.

Field peas

Field pea varieties developed for the northern region now provide a viable pulse alternative for grain growers. Advanced lines under evaluation indicate significant yield advantages over existing varieties.

For grain growers in the region the

FIGURE 4 Brassicas such as mustard and canola have been found to be effective at reducing the severity of crown rot in highly susceptible durum wheat varieties



With canola, the following letter refers to glucosinolate levels in the root system. M = medium, H = high and L = low. With wheat the following letter refers to variety reaction to crown rot. T = tolerant and S = susceptible. Source: Kirkegaard JA, Simpfendorfer S, Holland J, Bambach R, Moore KJ, Rebetzke GJ (2004). Effect of previous crops on crown rot and yield of durum and bread wheat in northern NSW. Australian Journal of Agricultural Research 55: 321-334.

establishment of field peas as a crop has been slow, with delays caused by a combination of poor seasons and the soaring prices of pulses already established in the region, particularly chickpeas.

From a grain grower's viewpoint it appears that gross margins for field peas would need to be equivalent to chickpeas (in those areas where chickpeas are established), before field peas could be a substantial part of these grower's rotations.

Grain growers should consider trying field peas as a pulse in their rotations based on gross margins comparisons between alternate pulse (or other) rotational crops.

Soybeans and mungbeans

Soybeans are a summer pulse that play an increasingly important role in rotations on the east coast of Australia in a variety of cropping systems stretching from Victoria to Queensland.

Soybeans are gaining a foothold in the sugarcane monoculture and proving their worth as an alternative source of nitrogen, valuable in reducing fertiliser requirements and run-off.

Mungbeans are a short-season, indeterminate and small-seeded tropical pulse crop originating from the north-east India/Burma region of Asia. They are closely related to black gram (*Vigna mungo*) and adzukis (*Vigna angularis*). Mungbeans are a high protein food crop for human consumption. Seed appearance and quality are of paramount importance.

Mungbeans are a potentially good summer crop alternative to provide diversification in the cropping mix as a means of providing risk management in terms of agronomy, environment and marketing. Being such a quick crop they often slot in between other summer crops allowing for better utilisation of farm labour and machinery.

Canola and mustard

Trials in northern NSW have shown that brassicas – canola and mustard – can be effective rotation crops for reducing crown rot in following wheat crops.

The effect of previous crop species (oilseed, pulse and cereal) on the incidence and severity of crown rot and wheat yields was investigated in two three-year, no-till field experiments at Tamworth, NSW.

The experiments compared the effectiveness of the brassica rotation crops, canola and mustard, with chickpeas. It found that all rotation crops (brassicas and chickpeas) significantly reduced the severity of crown rot in both a highly susceptible and partially resistant wheat crop, compared to a wheat on wheat or wheat on barley rotation.

Brassica crops were generally more effective than chickpeas in reducing the severity of crown rot in the highly susceptible durum wheat Yallaroi (23 to 26 per cent reduction in severity) but the advantage was less evident with Sunco which has partial resistance to crown rot (Figure 4).

Crown rot management

Crown rot is caused by the fungus *Fusarium pseudograminearum* and is a major constraint to winter cereal production across Australia. Although more common in the northern cropping belt, it can occur throughout all mainland cereal-growing areas and costs the Australian grains industry an estimated $56 million every year.

The fungus survives in cereal and grass weed residues and has three distinct stages. The first is 'survival' of the crown rot fungus in residue.

The second is 'infection', though while present may not lead to major yield loss. The main influence growers can have at this stage is the selection of partially resistant wheat varieties.

The third stage is the formation of whiteheads and basal browning, when moisture stress occurs around flowering and beyond. This is the stage that leads to significant yield loss.

In the third stage, the fungus is believed to prevent water movement from the soil to the heads – leading to whitehead formation in infected tillers.

Although the degree of water stress is largely at the mercy of the season, there are management practices growers can follow to reduce moisture stress around flowering. These include effective fallow management, grass weed control, adequate zinc nutrition and matching nitrogen inputs to available water.

However, strategic crop rotation is the key management strategy for crown rot in the northern region. Crown rot is a stubble-borne pathogen and stubble must decompose to displace the fungus to below damaging levels. The use of rotation crops with bulky canopies can help accelerate stubble decomposition.

A recent Northern Grower Alliance (NGA) survey shows 40 per cent of respondents believe their level of crown rot risk has decreased over the last five to 10 years. Advisers and growers attribute the drop to effective use of rotations, backing up GRDC-funded research recommendations.

Many early adopters of minimum till realised that despite the soil moisture and other benefits of stubble retention, crown rot became a bigger threat. They responded by designing rotations to capture the benefits of stubble retention but minimise the disease impact.

The survey showed that where risk had decreased, a smaller cropping area was impacted and yield losses were both less frequent and at a lower level (Table 3).

TABLE 3 Suggested rotations under varying crown rot conditions

LEVEL OF CROWN ROT INFECTION	HIGH (25% DISEASED PLANTS)	MEDIUM (11–24%)	LOW (10%)
ROTATIONS	LF – sorghum – DC chickpeas – wheat	Pre plant burn – chickpeas – Wheat	No limitation to crop choice. However, regular inclusion of break crops will prevent crown rot levels from rising
	Chickpea – LF – sorghum – LF – wheat	chickpea – pre plant burn – wheat	
	DC mungbean – LF – sorghum – DC chickpea – wheat	LF – sorghum – wheat	
	LF sorghum – LF – wheat – chickpeas	DC Summer Crop – LF – wheat	
	3 years lucerne provided it is kept grass free		

SOURCE: Northern Grower Alliance LF = long fallow; DC = double crop

NOTE: In the examples above, faba beans, field peas and canola/mustard can substitute for chickpeas and other summer crops for sorghum. Barley can be substituted for wheat.

Growing brassicas allows the use of weed control techniques and herbicide groups that cannot be used in cereals and possibly pulses. For example, windrowing can help control late germinating in-crop grass weeds such as wild oats or annual ryegrass.

The effectiveness of brassicas in reducing crown rot appears related to the level of microbial activity under the canopy and its effect on increasing the rate of residue breakdown.

Rotation crops with a denser canopy, such as brassicas and faba beans, are likely to provide conditions more conducive to the breakdown of cereal residues than crops such as chickpeas. Chickpeas generally have thinner canopies and do not close over until later in the season.

Brassicas also appear to influence the soil and residue biology with increased levels of *Trichoderma spp.*, a beneficial fungus.

Sorghum

Rotation benefits can be substantial from a period of sorghum in a wheat cropping system; these include:

1. a disease break for wheat diseases, such as crown rot, and for RLN from grain sorghum;
2. improved control of difficult weeds, such as wild oats, sow thistle and fleabane; and
3. reducing risk of herbicide resistance.

The GRDC is currently funding new research into sorghum reliability in the crown rot-effected areas of north-west NSW.

The research hinges on new sorghum varieties and optimum row configuration in order to find a compromise between yield stability and the rotation crop effect.

Every rotation crop gives some decomposition of winter cereal stubble but sorghum is expected to be a good rotation crop for controlling both crown rot and weeds in order to minimise herbicide resistance.

Dryland cotton

Dryland cotton offers substantial crown rot break benefits. Currently, benefits related to soil quality are being researched within crop rotation experiments at Narrabri. Several crop rotations are being compared that include or exclude a pulse phase. Following cotton harvest at the end of the previous cycle, rotation crops are sown (winter cereal, faba beans (grain) or vetch (green manured)). Cotton is sown in the following October across all systems. The cropping systems also include continuous (annual) cotton in one experiment, with or without green-manured vetch each winter and a cereal-vetch treatment is included in each experiment.

The soil water factor

Farming systems have changed significantly over the past 10 to 15 years with more summer crops, a greater diversity of available crops, widespread use of zero-tillage and the emergence of controlled traffic and specialised planting machinery such as disc-openers with moisture-seeking abilities.

In addition, local climate is changing. Summer rains are now coming later in some parts of the region, while frosts also start later and finish earlier.

These changes have altered growers' planting opportunities and also their risks.

The majority of growers do consider stored soil water levels in their planting decisions but the decision of whether to plant or not is moderated by a range of other factors, such as the need to maintain a return on their investment, a requirement for cash flow and a desire to maintain the structure of their farming system.

The sequence of crops and fallows impacts on the water use efficiency

Root lesion nematode (RLN) management

Pratylenchus thornei and *Pratylenchus neglectus*) feed on roots, leading to declines of up to 70 per cent in wheat and 20 per cent in chickpeas.

In the northern region, RLN is found in northern NSW and Queensland. Reducing RLN populations can lead to higher yields in the following susceptible crop.

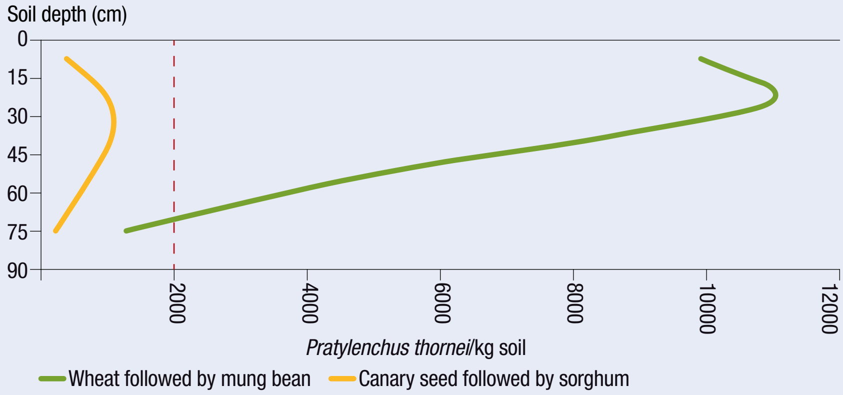
Varieties are rated according to their tolerance, intolerance, susceptibility and resistance to RLN. Intolerance means the crop yields poorly when attacked and susceptibility means nematode numbers increase. Some varieties are rated tolerant but susceptible.

Crops can differ in their susceptibility and tolerance of each species of nematode (Table 2, see page 4). Research on the nematode, *Pratylenchus thornei*, shows growing two resistant crops (canary seed followed by sorghum) reduced nematode populations 10-fold compared to growing two susceptible crops (wheat followed by mungbeans) (Figure 5).

Testing to identify which nematodes are present is essential if the most appropriate crop choices are to be made.

Crop selection is the main management tool for managing nematodes in the soil. Planning forward rotations and using soil tests to determine which species of nematodes are present, can have a big impact on future crop yield and profit.

FIGURE 5 *Pratylenchus thornei* levels were reduced when two resistant crops (canary seed followed by sorghum) were grown compared to two susceptible crops (wheat followed by mungbean).



The red, broken vertical line is a threshold of nematode density for causing economic yield loss in wheat.

of the whole cropping system. Conservative cropping systems, where crops are only planted when soil moisture levels are high, will result in high individual crop yields but relatively fewer crops and long, inefficient fallow periods.

More aggressive cropping systems that include double cropping will result in a greater number of lower-yielding crops and generally more efficient use of available rainfall.

The appropriate balance between aggressive and conservative systems will depend on a whole range of factors, including a grower's attitude to risk, and is the subject of ongoing research. Table 4 (showing a representative situation in central Queensland) illustrates some of the trade-offs that occur.

TABLE 4 Effect of soil water threshold for planting systems on water use efficiency and other system performance parameters*

System		Conservative	Moderate	Aggressive
Planting threshold	mm	150	100	50
Number of crops		35	45	72
Crops/year		0.69	0.88	1.41
Total grain produced	t/ha	141	172	197
Average yield	t/ha	4.04	3.82	2.73
Average cover		40%	49%	55%
Soil water use efficiency	kg/ha/mm	4.55	5.53	6.32
% rainfall ending up as:				
Transpiration		21%	26%	32%
Evaporation		56%	55%	55%
Run-off		18%	16%	11%
Drainage		5%	3%	2%

* This table presents the results of a simulation modelling analysis for a cropping system at Emerald from 1955 to 2006. SOURCE: R Routley, 2009

Useful resources:

- **Richard Daniel, NGA** — 07 4639 5344 Email richard.daniel@nga.org.au
- **Steven Simpfendorfer, NSW I&I** — 02 6763 1261 Email steven.simpfendorfer@industry.nsw.gov.au
- **Gordon Cumming, Pulse Australia** — 0408 923 474 Email pulse.gordon@bigpond.com
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- **Richard Routley, DEEDI** — 07 4688 1174 Email richard.routley@deedi.qld.gov.au
- **GRDC website** — www.grdc.com.au/pestlinks and www.grdc.com.au/diseaselinks
- **GRDC Fact sheets: Water Use Efficiency – Northern region, Crown Rot in Cereals – Northern Region, Parasitic nematodes – Northern region, Northern weeds** — Ground Cover Direct, freephone 1800 11 00 44, www.grdc.com.au/bookshop
- **GRDC Updates papers** — www.grdc.com.au/director/events/researchupdates
- **Summer crop production guided – NSW Industry and Investment** — www.dpi.nsw.gov.au/agriculture/field
- **Department of Employment, Economic Development and Innovation** — www.dpi.qld.gov.au/26_3394.htm
- **Pulse Australia** — www.pulseaus.com.au
- **Australian Oilseeds Federation** — www.australianoilseeds.com
- **Cotton CRC** — www.cottoncrc.org.au
- **Northern Grower Alliance** — www.nga.org.au
- **National Variety Trials** — www.nvtonline.com.au

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