GRDC
Grains Research & Development Corporation

Impact from *Pratylenchus thornei*

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Key words

Pratylenchus thornei, yield, wheat, rotation crops

GRDC code

NGA00003: GRDC Grower Solutions for Northern NSW and Southern Qld

Take home messages

1. **Multi-crop and variety trials were conducted over strips of 'low' and 'high' *Pratylenchus thornei* (*Pt*) pressure**
2. **Excellent growing conditions experienced with exceptionally high yields produced:**
3. **No impact from *Pt* on crop establishment**
4. **'High' *Pt* strips significantly reduced NDVI readings in field peas, chickpeas and in some wheat trials**
5. **'High' *Pt* strips significantly reduced yield in field peas by 8% (~280kg/ha)**
6. **However negligible yield impact from *Pt* apparent even in intolerant wheat varieties under these conditions**

Background

Previous NGA trial work has highlighted that the root-lesion nematode, *Pratylenchus thornei (Pt),* appears to be one of the key 'diseases' for winter cereal production in the northern region. *Pt* is a major constraint due to: the large impact on yield and economics when intolerant varieties are grown, broad geographic distribution with *Pt* populations frequently at above threshold levels and the susceptibility (*Pt* hosting) of key rotation crops such as chickpeas.

Successful *Pt* management will involve a range of practices including on-farm hygiene and soil testing to identify problem paddocks. However crop and variety choice are likely to be the major tools used for management. Wheat varieties are well characterised in terms of *Tolerance* (yield impact suffered during the year of crop production) and *Resistance* (impact from variety on the multiplication or build-up of *Pt*). Both characteristics are important for long term management.

This paper reports on trial work conducted in 2010 and 2011 at a site between Weemelah and Garah. The activity was designed to improve our understanding of the differences in tolerance between a range of winter crops and varieties followed by an assessment of the impact of these options on subsequent *Pt* densities. An approach was used to create alternating strips of 'low' and 'high' *Pt* population where the impact of increased *Pt* numbers on each variety could be evaluated.

Primary Aims

1. Evaluate the impact from *Pratylenchus thornei* (*Pt)* on the **yield and economic returns** from a range of winter crops and varieties
2. Examine the impact from different winter crops and varieties on the **multiplication of *Pt***

Trial activity 2010

Soil testing was conducted from a paddock in the Weemelah/Garah area where *Pt* had previously been found at above threshold levels (>2000 *Pt*/kg soil). Initial samples were analysed by the DNA method (PreDicta B test) with subsequent deeper soil cores (for site characterisation) assayed using manual counts at DEEDI in Toowoomba.

Table 1: *Pt* populations/kg soil (Autumn 2010)

Test	Soil sample depth				
	0-15cm	15-30cm	0-30cm	30-60cm	60-90cm
DNA	1629	3071			
Manual			2637	2483	2279

Despite the different sampling times, depths and assay methodology, both tests indicated a *Pt* population close to the 2000/kg soil threshold widely used in the industry. The site also appeared suitable due to negligible levels of other common plant-parasitic nematodes (*Merlinius brevidens* were only found at ~ 500/kg soil and *Pratylenchus neglectus* were not detected in any soil sample).

The aim in 2010 was to create 'strips' of alternating *Pt* population to allow multi-crop evaluation in 2011. Commercial scale strips of Strzelecki(D) wheat or canary were planted in early June 2010 with each strip ~ 300m long x 18.3m wide. Strzelecki(D) was used to maximise the increase in *Pt* population and canary was selected as the winter cereal most likely to reduce the multiplication. Strzelecki(D) is rated as S-VS (susceptible to very susceptible) and canary is rated as R-MR (resistant to moderately resistant) for *Pt* resistance or multiplication.

To reduce the potential for weed problems or differences in moisture extraction due to maturity differences, all strips were sprayed out with glyphosate prior to canary seed set. No grain was produced from these cereal strips in 2010 and the 'summer fallow' was commenced ~2 months earlier than in the surrounding commercial wheat.

Impact on *Pt* populations

Figure 1 shows the manual counts of *Pt* in March 2011 in the strips where Strzelecki(D) and canary had been grown in 2010 and the initial soil test result. Strips sown to Strzelecki(D) had significantly higher *Pt* populations than where canary had been sown, with the majority of difference in the 0-30cm zone. Strzelecki(D) soil samples had ~3 times as many *Pt* as found in the canary soil samples with populations in all canary soil samples below the 2000/kg threshold. *Pt* populations appeared to have decreased in all strips at 30-90cm.

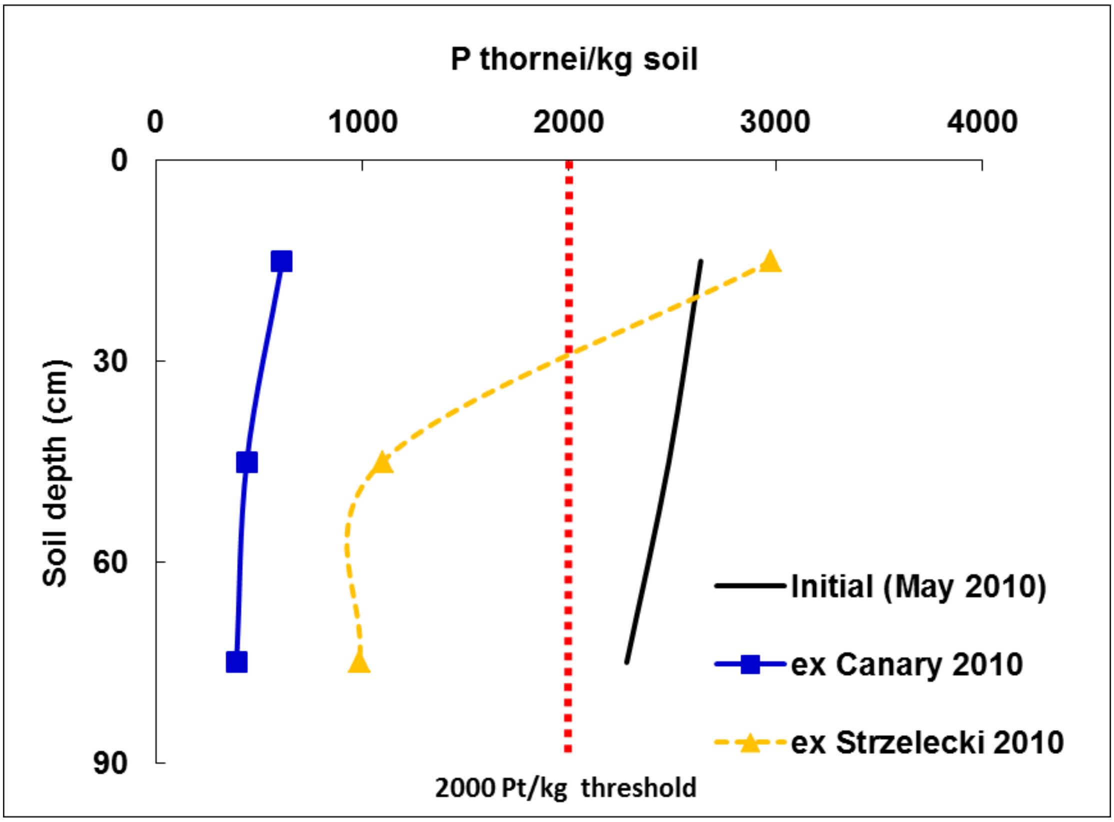

Figure 1: Back transformed means of manual counts of *Pt* populations (March 2011)

Figure 2 shows the DNA result from detailed transects sampled at 0-15cm in early April 2011. Four transects were sampled across all strips at roughly 50m intervals to examine *Pt* uniformity over the entire site. The *Pt* magnitude was higher than in the manual counts but confirmed the Strzelecki strips had significantly higher *Pt* populations than found in the canary strips and that the populations were relatively uniform across the site.

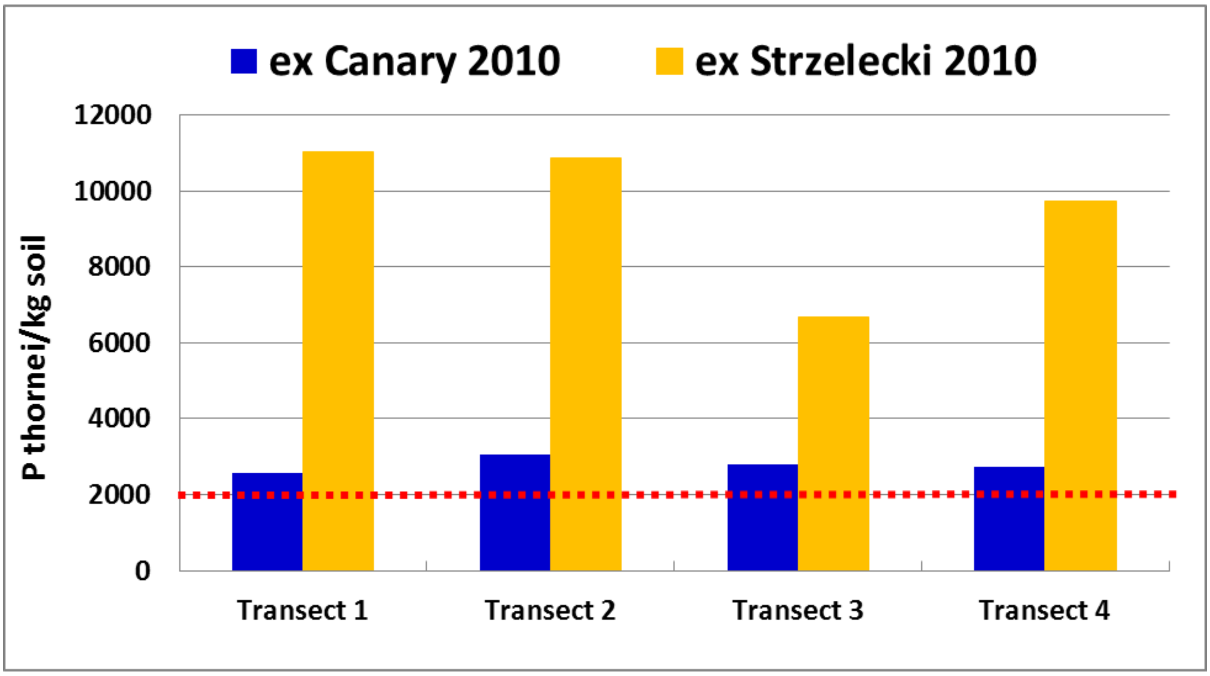

Figure 2: Back transformed means of DNA assay of *Pt* populations (April 2011)

Both analysis methods showed the Strzelecki strips had *Pt* populations ~3-3.5 times larger than found after canary production. The *Pt* population in the canary strips varied between the two assays from either just exceeding threshold (DNA) to below threshold (manual counts).

Trial activity 2011

A total of 45 different varieties of the major winter cereal and broadleaf cropping options were evaluated in nine individual split plot trials. Seed size and % germination were assessed for all seed lots with sowing rates adjusted to plant an equivalent number of viable seeds for each crop. Urea was spread over the entire site on the 28/4/11 at 100kg/ha and incorporated by planting. All crops received DAP + Zinc at 80kg/ha at planting. Commercial crop protection products (and chipping) were used to manage weeds, foliar diseases and insect pressure.

There were three replicates in all trials with additional treatment 'duplicates' in faba beans, field peas and linseed due to the low number of treatments. Plots were sown at ~18m length x 5 rows on 32cm row spacings. Strips sown to Strzelecki in 2010 were described as having 'high' *Pt* pressure and the strips sown to canary were described as having 'low' *Pt* pressure. **NB even the 'low' *Pt* pressure strips had consistent populations of *Pt* but at ~1/3 of the population present in the 'high' *Pt* strips.**

Individual trial details are shown in Table 2. Trials RH1101-1103 and RH1106-09 were conducted as standard split plot trials comparing variety performance in the 'low' and 'high' Pt strips. Trials RH1104 & RH1105 had additional factor(s) included. **In both trials all varieties were evaluated with and without additional crown rot inoculum (2g/m row) at sowing in an attempt to partition the impact from *Pt* and crown rot.** In trial RH1104 a single fungicide application was also investigated.

Table 2: Key details of individual trials conducted in 2011

Trial #	**Planting date**	**Crop**	**Number of varieties**	**Additional factors**	**Target plant stand/m^2**
RH1101	2/05/2011	Faba bean	3	-	20
RH1102		Canola x 3, mustard x 1	4	-	30
RH1103		Wheat – early varieties	5	-	80
RH1104	18/05/2011	Wheat	2	+/- CR inoculum, +/- fungicide	
RH1105		Wheat	7	+/- CR inoculum	
RH1106		Mixed cereal	20	-	
RH1107		Field pea	3	-	40
RH1108		Chickpea	5	-	25
RH1109		Linseed	1	-	120

RH1106 consisted of 11 bread wheats, 2 durums and 7 barley varieties

2011 season

2011 was an exceptionally high yielding winter crop season in the Weemelah/Garah area. The rainfall total in August through October was 188mm, more than double the long term average and the 5th highest received during that period since records commenced in 1938. Interestingly 2010 had the 2nd highest registration in that period with 207mm (only 1983 was higher with 221mm).

Trial assessments

Key in-crop assessments were establishment, 'greenness' (measured by NDVI), yield for all crops and grain quality for all cereals and brassicas. Soil coring to determine residual *Pt* population is to be conducted in February 2012.

Crop establishment

Uniform plant establishment resulted from both planting dates with nearly all varieties within ~10% of their target plant stand. The only variety with a poor plant stand was the mustard (Xceed Oasis CL) with a mean establishment of only ~15 plants/m^2. **There was no significant difference in establishment in any trial between the 'low' and 'high' *Pt* strips.**

NDVI assessment

NDVI (Normalised Difference Vegetation Index) readings were taken on July 27 using a handheld GreenSeeker by Bruce Haigh, NSW DPI. NDVI is an assessment of the reflectance of the crop or variety. **Higher NDVI scores within the same variety usually indicate increased green leaf area which may also relate to biomass differences**. The NDVI readings were taken when the cereals were in early stem elongation with ~ 4.5t/ha of dry matter present. Table 3 summarises the significant differences found in NDVI.

The column labelled Pt 'low' v 'high' indicates where there was a significant REDUCTION in NDVI score from the 'low' to the 'high' *Pt* strips. The column labelled Variety shows where there were significant differences identified between varieties. As expected this was found in all crops. The final column shows that in one of the two trials a REDUCTION in NDVI was measured when crown rot inoculum was added at planting. The % impact from the addition of crown rot inoculum was less than that due to *Pt.*

Table 3: Patterns of significant differences in crop reflectance (NDVI, July 2011)

		Significant differences due to:		
Trial #	**Crop**	***Pt*** **'low' v 'high'**	**Variety**	**Crown rot 'nil' v 'added'**
RH1101	Faba bean	No	***Yes***	-
RH1102	Canola x 3, mustard x 1	No	***Yes***	-
RH1103	Wheat – early varieties	No	***Yes***	-
RH1104	Wheat	***Yes***	***Yes***	**Yes**
RH1105	Wheat	***Yes***	***Yes***	No
RH1106	Mixed cereal	No	***Yes***	-
RH1107	Field pea	***Yes***	***Yes***	-
RH1108	Chickpea	***Yes***	***Yes***	-
RH1109	Linseed	No	-	-

Significant NDVI reductions in 'high' *Pt* strips:

- Average 6% reduction in field peas
- Average 4% reduction in chickpeas
- Average 4% reduction in RH1104
- Average 5% reduction in RH1105

Significant NDVI reduction in 'added' CR plots:

- Average 1% reduction in RH1104

Yield

Table 4 shows the pattern of significant differences in yield. The only crop where yield was significantly reduced in the 'high' *Pt* strips was field peas, although a non-significant trend was apparent in chickpeas.

Significant yield differences between varieties were found in all crops. There was no significant impact on yield from the addition of crown rot inoculum.

Table 4: Patterns of significant differences in yield 2011

Trial #	Crop	Harvested	**Significant differences due to:** *Pt* 'low' v 'high'	Variety	Crown rot 'nil' v 'added'
RH1101	Faba bean	14/11/2011*	No	***Yes***	-
RH1102	Canola x 3, mustard x 1	20/10/2011	No	***Yes***	-
RH1103	Wheat – early varieties	1/11/2011	No	***Yes***	-
RH1104	Wheat		No	***Yes***	No
RH1105	Wheat		No	***Yes***	No
RH1106	Mixed cereal		No	***Yes***	-
RH1107	Field pea	20/10/2011	***Yes***	***Yes***	-
RH1108	Chickpea	14/11/2011	No	***Yes***	-
RH1109	Linseed		No	-	-

*Faba bean harvest was later than expected due to a severe undiagnosed disease/ frost impact in July 2011 delaying maturity in all varieties and reducing height and yield potential

Significant yield reduction in 'high' *Pt* strips:

- Average 8% reduction (~280kg/ha) in field peas

Significant yield differences based on varietal yields:

Figures 3-12 show the variety yields in each individual trial. **NB Yield differences between varieties would be due to a very wide range of factors that include *Pt* tolerance/ intolerance.**

In each figure, the main column is the variety yield in the 'high' *Pt* strips. An additional 'stacked' column is present ONLY where the variety recorded a higher yield in the 'low' *Pt* strips. In all cases the letters of significance and LSD refer to the mean variety yield.

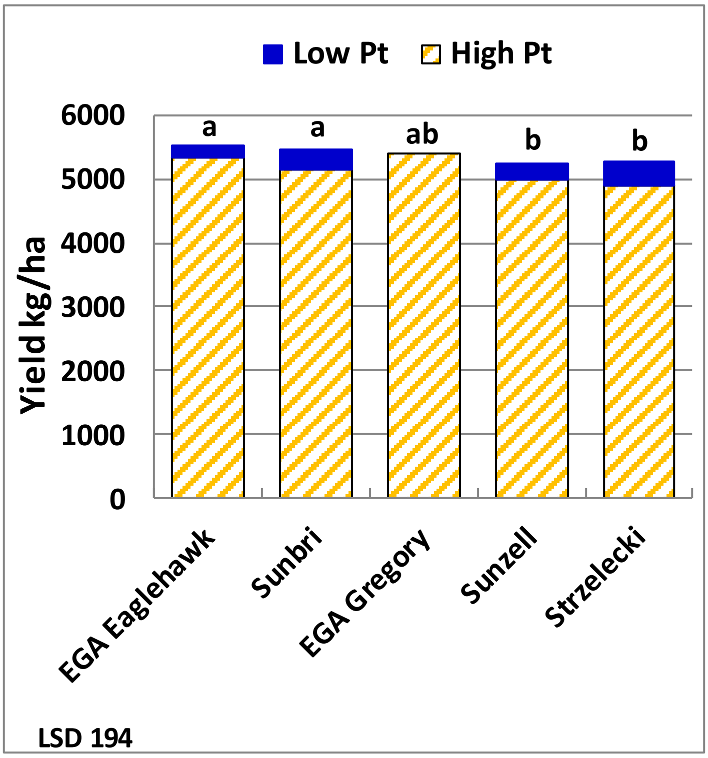

Figure 3: RH1103 – wheat yield early varieties

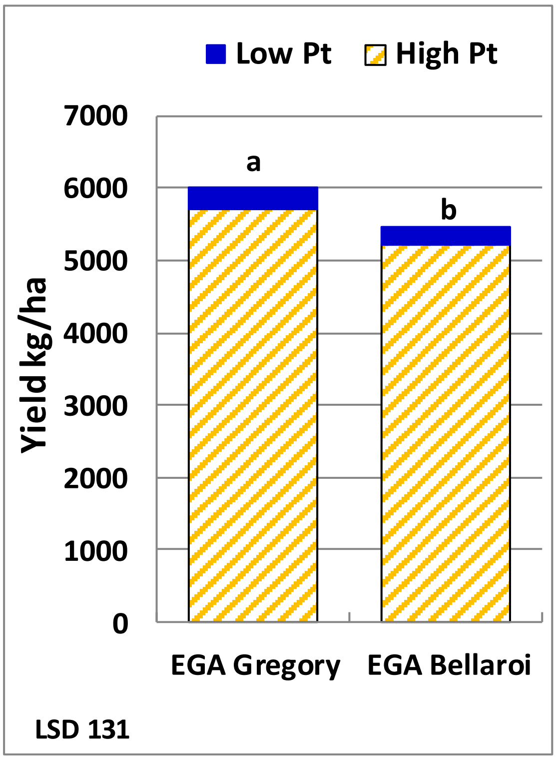

Figure 4: RH1104 - wheat yield

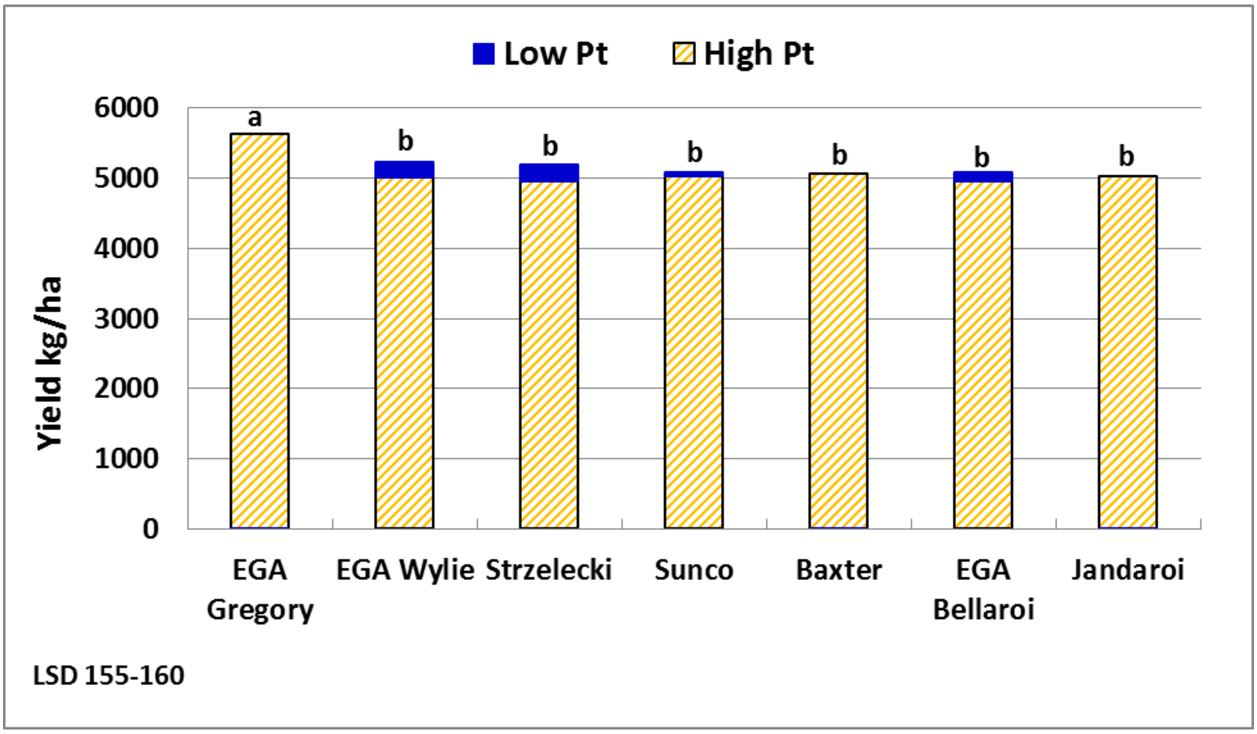

Figure 5: RH1105 - wheat yield

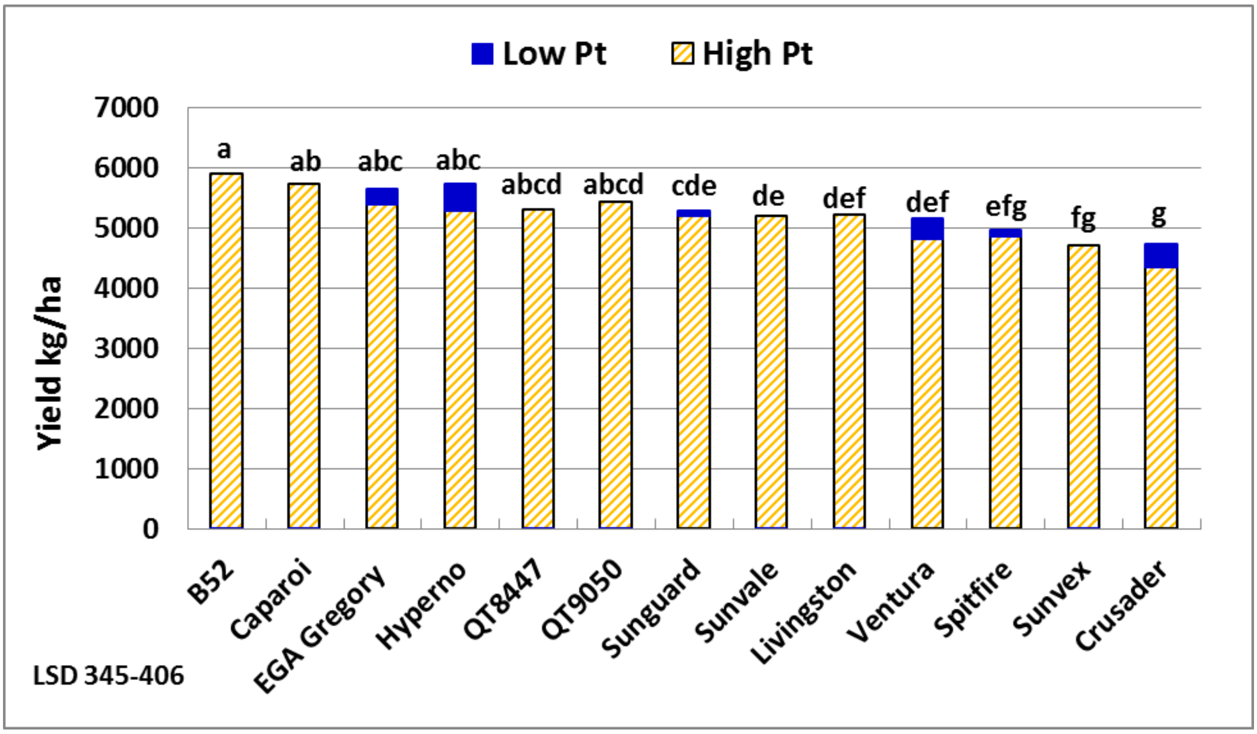

Figure 6: RH1106 - wheat yield

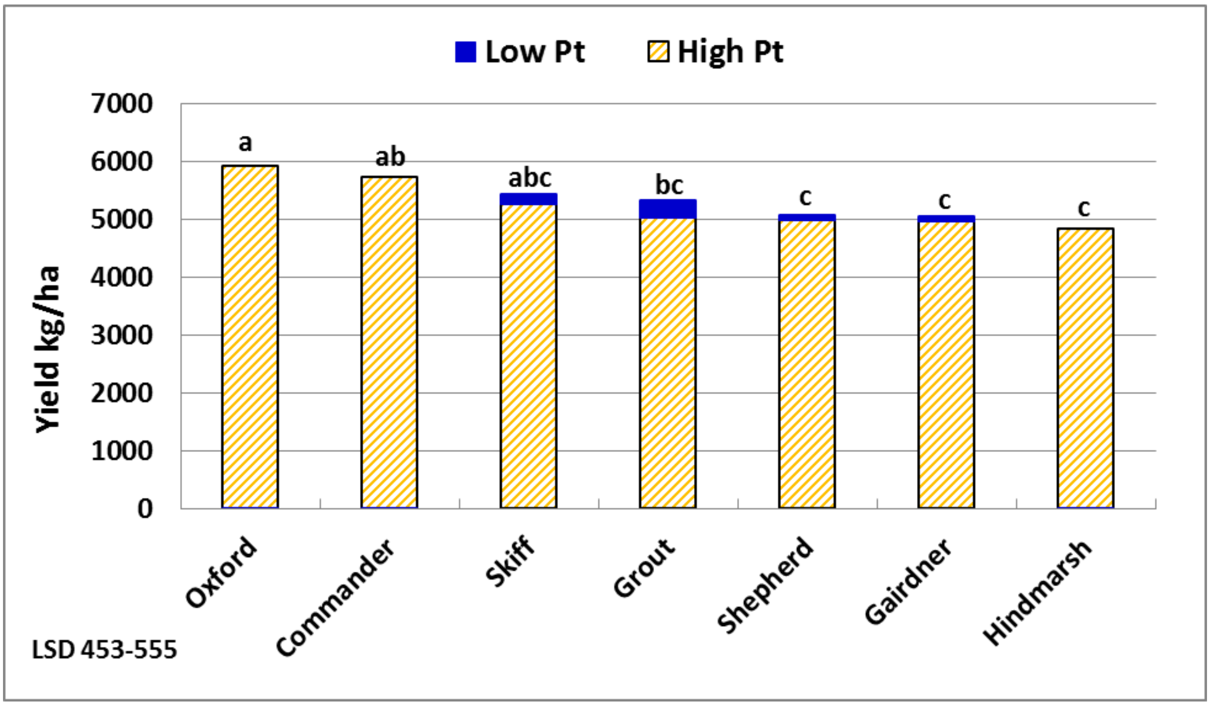

Figure 7: RH1106 - barley yield

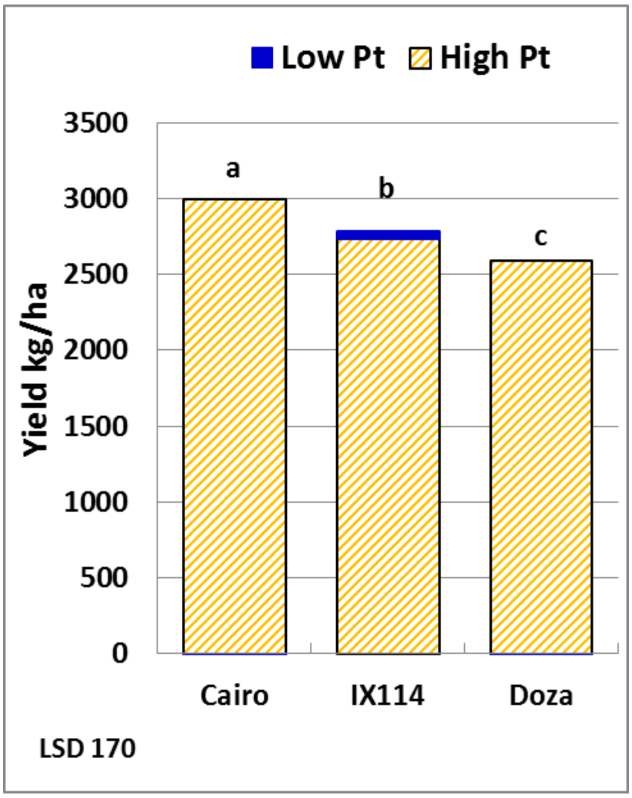

Figure 8: RH1101 – faba bean yield

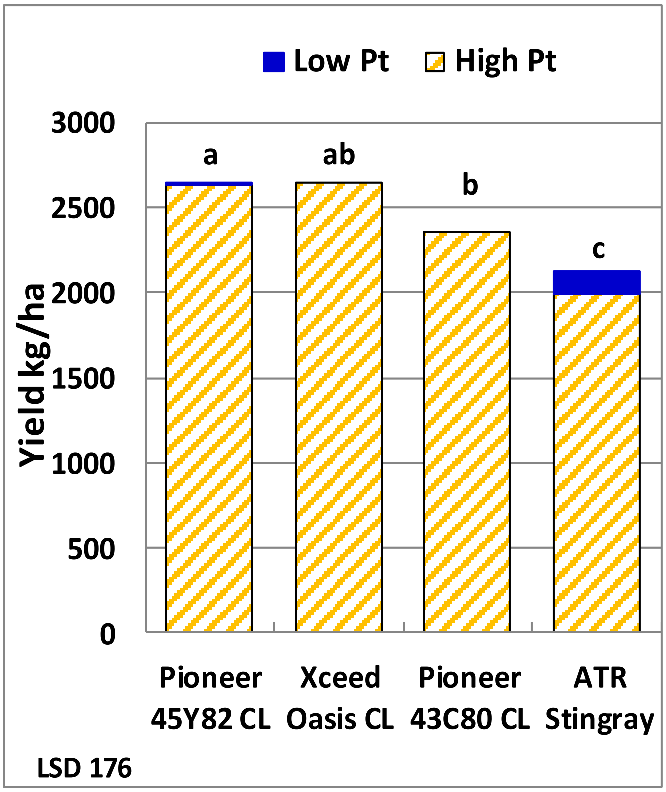

Figure 9: RH1102 – canola and mustard yield

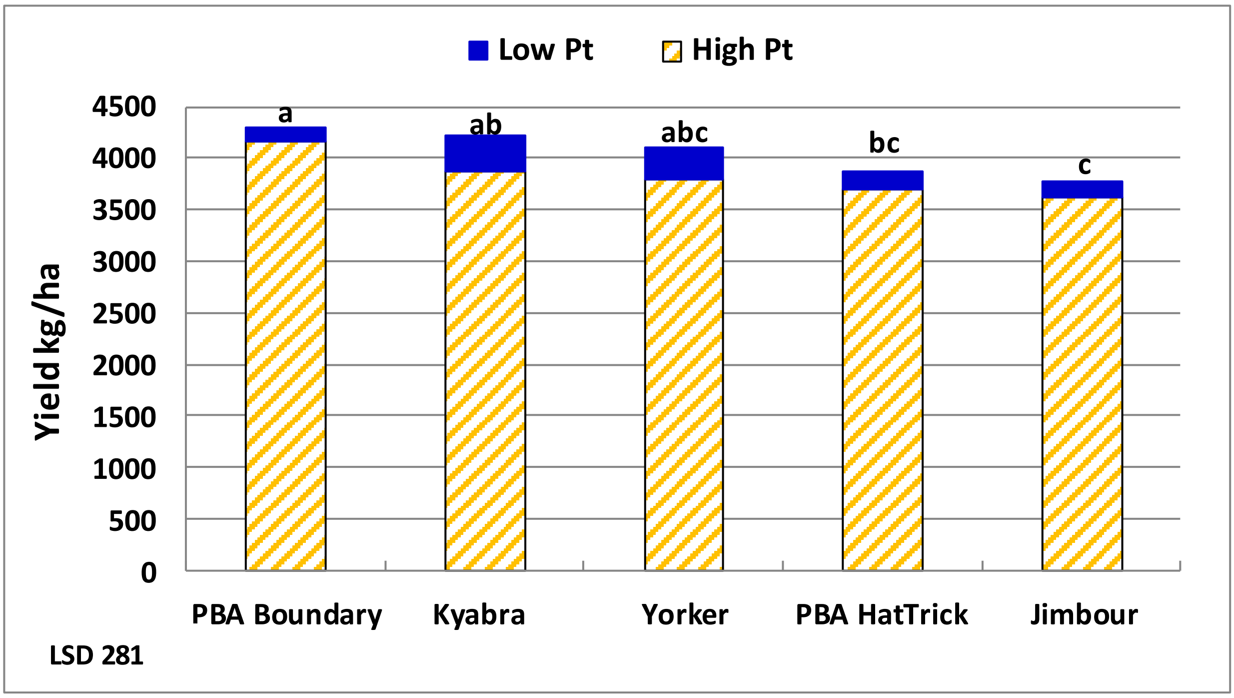

Figure 10: RH1108 - chickpea yield

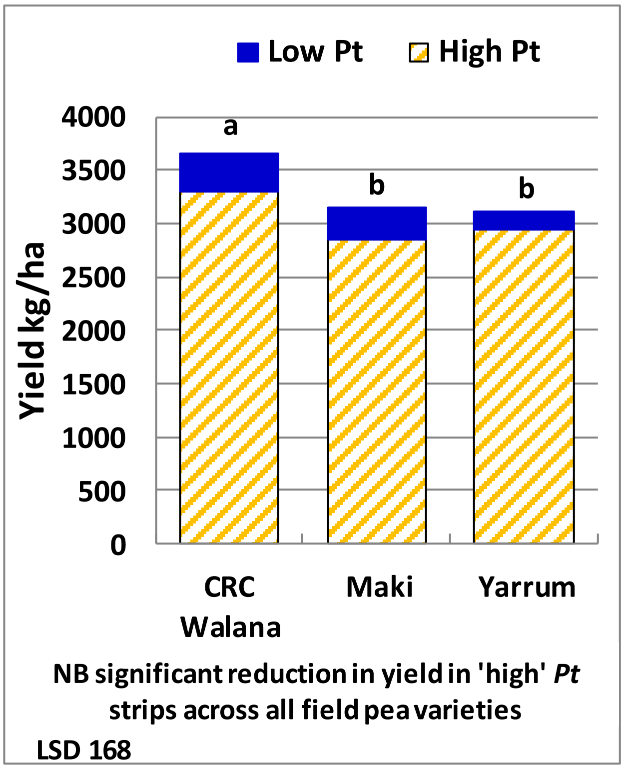

Figure 11: RH1107 - field pea yield

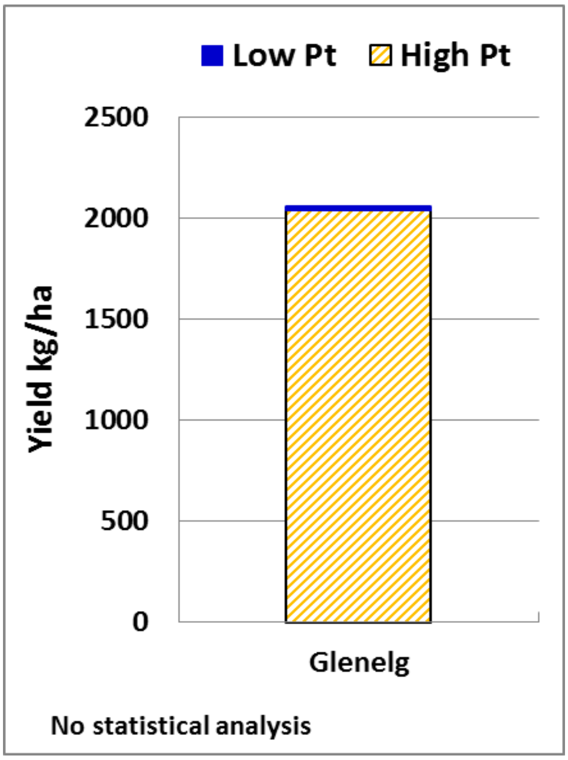

Figure 12: RH1109 - linseed yield

Grain quality

Summary across entire site:

- **Test weight**: excellent for wheat, marginal for barley (bread wheat 77-78kg/hL, durum 78-80kg/hL and barley 61-64kg/hL)
- **Screenings**: very low (< 3% in all varieties)
- **Protein**: very low (ranged from ~10-11.5% in all winter cereals)
- **Total N recovery in grain**: very high (averaged ~98kg N/ha as protein)

Canola and mustard quality data unavailable at time of reporting.

Table 5: Patterns of significant differences in cereal grain quality (2011)

		Significant differences due to:		
Trial#	**Trial**	***Pt*** **'low' v 'high'**	**Variety**	**Crown rot 'nil' v 'added'**
RH1103	Wheat – early varieties	No	***Yes***	-
RH1104	Wheat	No	***Yes***	No
RH1105	Wheat	**Yes**	***Yes***	***Yes***
RH1106	Mixed cereal	No	***Yes***	-

Significant <u>test weight</u> reduction in 'high' *Pt* strips:

- Strzelecki ~2kg/hL lower test weight in 'high' *Pt* strips

Significant <u>test weight</u> reduction in 'added' CR plots:

- Average 0.6kg/hL reduction in RH1105

Economics

Figure 13 shows the net returns for each crop. The chickpea yields were exceptional in 2011 and appear to have benefitted from a prolonged mild and moist spring, combined with narrow row spacings, in a low disease season. Cereal, brassica, field pea and linseed yields were all extremely high. Faba beans were the only crop with disappointing performance. These suffered from an undiagnosed problem in mid-winter (combination of frost/ disease) and struggled throughout the season.

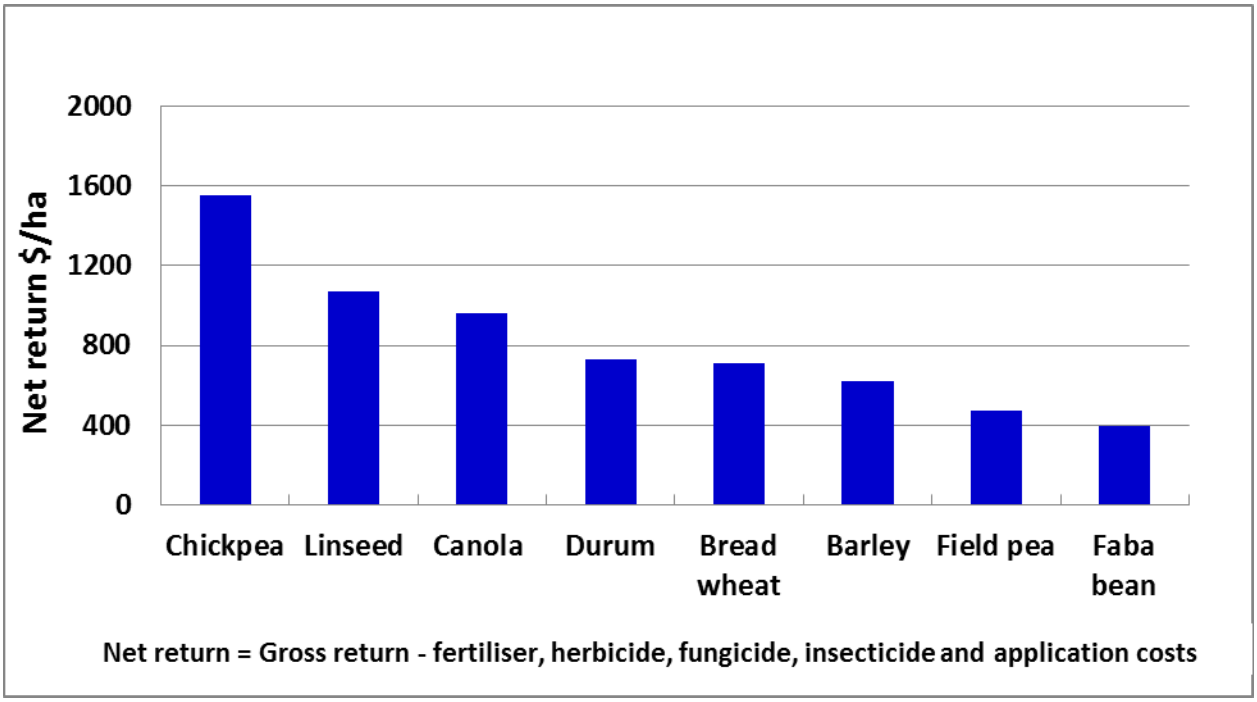

Figure 13: Comparison of net returns

Assumptions

Grain prices: chickpeas $485/t, linseed $700/t, canola $473, DR3 and APW $180/t, F1 barley $160, field peas $220, faba beans $265

Fungicide costs: chickpeas $112/ha (4 applications), faba beans $84/ha (3 applications, cereals $24/ha (2 applications)

Herbicide costs: chickpeas and faba beans $48/ha (2 applications), cereals $61/ha (grass and broadleaf application), field peas $26/ha (1 application, Linseed $22/ha (1 application)

Insecticide costs: chickpeas, faba beans, linseed and field peas $56/ha (2 applications), canola $13/ha (1 application)

Conclusions

This trial was planned to allow a sound scientific evaluation of the impact of *Pt* on the yield of a broad range of winter crops and varieties and subsequently to measure the crop impact on *Pt* population (ie rotational impact and fit). It was expected that a threefold difference in *Pt* population would provide a separation in yields between *Pt* intolerant and tolerant varieties. Differences in NDVI were encouraging, despite no visual differences being apparent.

Varieties such as Strzelecki and Sunco - which are both rated as I-VI (intolerant to very intolerant) - are only expected to average ~60% of the yield of EGA Wylie when grown in fields heavily infested with *Pt* (Thompson J et al 2009). Under these conditions both varieties resulted in ~98-99% of the yield of EGA Wylie or Baxter, even in the 'high' *Pt* strips.

Although the yield differences between 'low' and 'high' *Pt* strips were much lower than expected, there were some key points:

- Field peas had a significant reduction in mean yield between the 'low' and 'high' *Pt* strips
- The five chickpea varieties trended to lower yield although not significantly different
- The apparent yield impacts in field peas and chickpeas are concerning when the impact in intolerant wheat varieties such as Strzelecki and Sunco was extremely low
- There was no apparent impact on yield from increased Pt population in the canola or mustard, faba beans or linseed

Explanations ?

The two most likely explanations for the lack of yield differences are:

1. The yield response curve to *Pt* population is very flat ie the difference in population between our 'low' (at or below threshold) and 'high' (roughly three times that number) wasn't important. Clearly possible but this appears highly unlikely considering the large body of previous *Pt* trial data.
2. The agronomy and conditions experienced dramatically reduced *Pt* impact. This was supported by the lack of any dramatic visual symptoms and the negligible impact on yield, even in intolerant varieties such as Strzelecki and Sunco. This would also explain the lack of significant differences between the 'low' and 'high' *Pt* strips.

If the second hypothesis is correct, the real question is what actually reduced the impact from *Pt*? If we can answer that question we may have other useful tools for *Pt* management.

Possibilities:

- Sowing date - later sowing appears to result in larger yield losses due to *Pt*
- High levels of timely rainfall during late winter and spring – this may have overcome the typical root uptake 'inefficiencies' seen in more normal/drier conditions
- Nutritional status – N, P and Zn deficiency symptoms are often apparent in wheat grown in fields heavily infested with *Pt*

NSW DPI also conducted *Pt* trial work in the Mungindi/ Weemelah area in 2011, ~40km from this site. In a paddock infested with <u>*Pt*</u>, Strzelecki only yielded ~70% of EGA Gregory in a May 10 planting and ~65% of EGA Gregory in a June 2 sowing. This site had similar levels of in-crop rainfall together with a similar May planting date. The most obvious difference between sites is that yields of the highest yielding ‘common’ cereal varieties (EGA Gregory, Hyperno and Oxford) were 25% lower at the NSW DPI site. This suggests that nutritional status (perhaps combined with high levels of soil moisture) may have been a key factor in reducing the yield impact of *Pt* at this site.

Data still to come

Soil coring to determine the impact of the crops and varieties on *Pt* multiplication (the second key trial aim) will be conducted during late summer 2012.

Acknowledgments

This was an exceptional trial in both size and complexity but also in the way it was managed. Sincere thanks to Bill and Andrew Yates - trial co-operators and to Rachel Herron (NGA) and Agritech for field trial activity and their ability to successfully manage the multi-crops grown. We would also like to thank Bruce Haigh and Alan Bowring from NSW DPI for the NDVI assessment and data summaries. Thanks also to AGT, Austgrains, Becker Underwood, DEEDI, NSW DPI, Nuseed, Pacific Seeds, Pioneer, University of Sydney PBI, Seedmark, Seednet and Viterra for providing seed or inoculants.

Reference

Thompson J, Owen K, Clewett T, Sheedy J, and Reen R (2009) Management of root-lesion nematodes in the northern grain region. Queensland Primary Industries and Fisheries, DEEDI, Brisbane and also www.nvtonline.com.au

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Reviewed by

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