ROOT LESION NEMATODE AND CROWN ROT – DOUBLE TROUBLE !

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Background

NGA have been involved in 22 field trials since 2007, in collaboration with I&I NSW, evaluating the impact of crown rot (CR) on a range of winter cereal crop types and varieties. This work has greatly improved our understanding of crown rot impact and variety tolerance, but also indicates we may be suffering significant yield losses from another 'disease' - that often goes unnoticed. Although the trials were not designed to focus on nematodes, a convincing trend was apparent after 2008 that indicated the root lesion nematode *Pratylenchus thornei (Pt)* was having a frequent and large impact on wheat variety yield.

Nematode assessments

Routine trial site characterisation included soil tests for background CR level, as well as a range of other pathogens including nematodes. PreDicta B (DNA extraction) was used on all samples with DEEDI also conducting 'manual' nematode counts on soil samples collected in 2008 and 2009. The correlation between the two tests has been good with both tests always indicating *Pt* presence at the same site (Figure 1 shows the 2009 data). However one difference is that the DNA assessment is on a 0-15 cm soil fraction whilst the manual count has been performed in layers from 0-90 cm (0-30 cm results in figure 1 and full 0-90 cm profiles in figure 2).

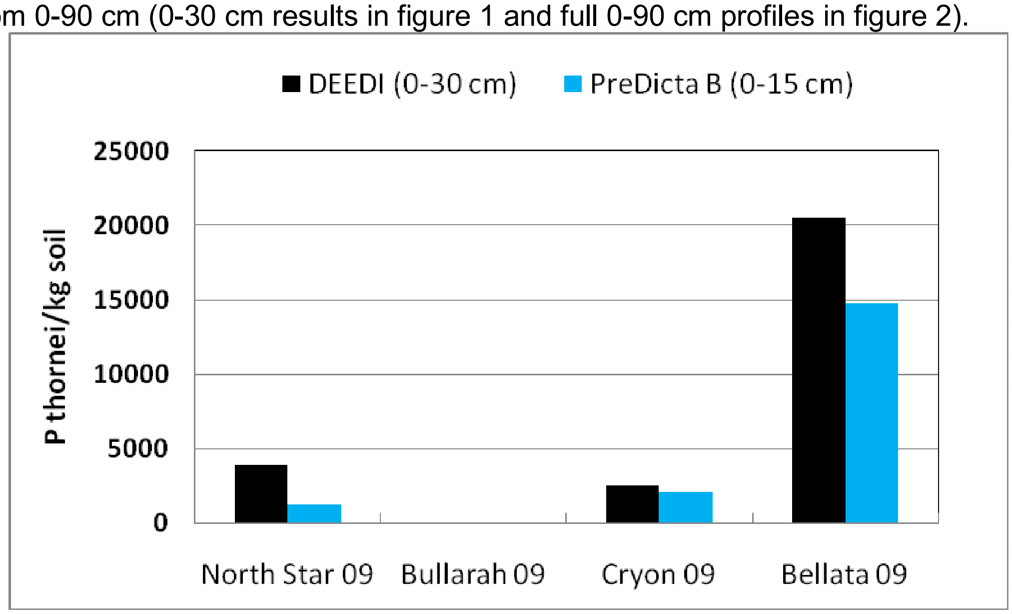

Figure 1. *Pt* assessments 2009: manual count v DNA extraction
NB soil sample depth differs between methods

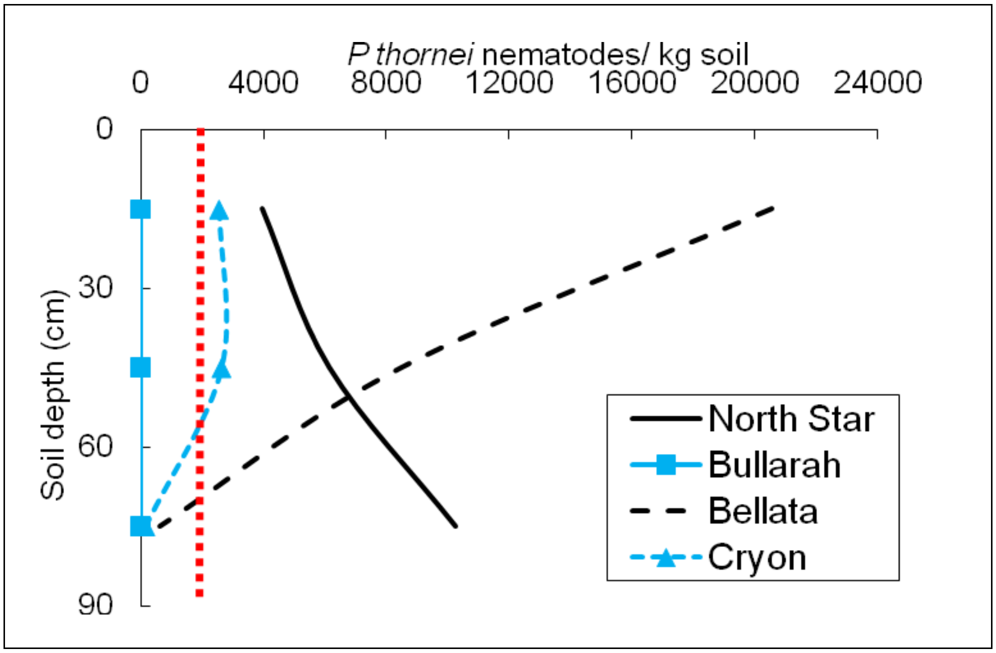

Figure 2. *Pt* assessments 2009: population profiles across sites
Vertical line = DEEDI threshold (~2000 *Pt*/ kg soil) for yield loss in intolerant varieties

NB although both techniques provided a similar absolute count of nematodes/kg soil, the interpretation of 'risk ratings' was very different between the two testing agencies. At all three sites, populations were above the 2,000 *Pt*/kg soil considered a threshold for yield loss for intolerant wheat varieties in the northern region (Thompson *et al.* 2009) and considerably higher at two of the sites. In contrast, even at the Bellata site, PreDicta B test indicated only a 'low risk' of yield loss. There is ongoing work to refine the 'risk ratings' associated with the PreDicta B test.

What is the yield impact of *Pt* ?

During 2007 & 2008 a common series of 5 bread wheat varieties, 4 barley varieties and 1 durum were evaluated in all 18 trials (NB only 17 yield results are presented as barley varieties were selectively and heavily grazed by emus at 1 site in 2008). Variety yield as % of a 'standard' was calculated to allow comparison across sites. Skiff barley was used as the standard and has the highest *Pt* tolerance rating of VT (very tolerant). EGA Wylie is currently considered the most tolerant commercial bread wheat variety in the northern region and is rated as T (tolerant) (Thompson *et al.* 2009).

Figure 3 shows the wheat variety yield performance compared to Skiff over all 17 trials. Wheat varieties are listed from left to right in decreasing tolerance of *Pt*. Ten trials had no *Pt* detected with 7 sites having *Pt* present (*Pt* were present at 5 of 10 sites in 2007 and 2 of 7 sites in 2008, PreDicta B *Pt* levels ranged from 1000-7000/kg soil in 2007 and 4000-5000/kg soil in 2008). 2007 was a high CR yield loss year with average bread wheat yield loss of ~25% and at the worst site even EGA Wylie lost 50% yield to CR. In contrast 2008 was a very low CR yield loss year with average bread wheat yield loss of only ~1%.

The four lines show the yield performance of each variety as a % of Skiff with:

1. 'No constraint' (no added CR, no *Pt* present at site)
2. 'Added CR' line (**CR inoculum added at planting**, no *Pt* present at site)
3. '*Pt* present' line (no added CR, ***Pt* present at site**)

4. 'Added CR + *Pt* present' line (**CR inoculum added at planting**, ***Pt* present at site**)

NB There was naturally occurring CR present at low levels at all sites

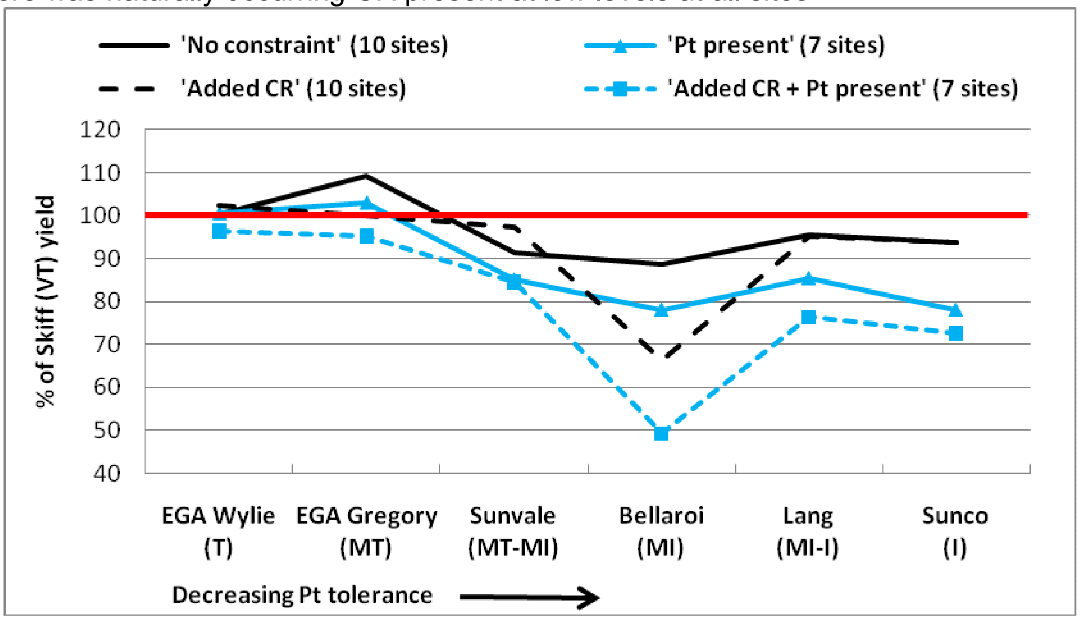

Figure 3. 2007 & 2008 wheat variety yield as a % of Skiff barley

Letters indicate variety *Pt* tolerance rating eg MT moderately tolerant, MI moderately intolerant

Key points:

1. The difference between **'No constraint'** and **'Added CR'** indicates **relative CR tolerance** between varieties eg Bellaroi showed the largest fall, followed by EGA Gregory. NB this is not a true representation of actual yield loss to CR (Skiff or EGA Wylie can still lose up to 50% yield due to CR) rather it **reflects variety yield performance in the presence of CR relative to Skiff barley or EGA Wylie.**
2. The difference between **'No constraint'** and **'*Pt* present'** indicates **relative *Pt* tolerance**. All varieties fell compared to Skiff (and EGA Wylie) with most impact on Bellaroi, Lang and Sunco.
3. The 'Added CR + *Pt* present' line shows the performance when both constraints were present. This data suggests an additive effect of variety CR loss PLUS *Pt* impact
4. **Generally a flat response in yield between bread wheat varieties under CR pressure alone (all were 91-97% of EGA Wylie yield)**
5. **Wider yield range from bread wheat varieties in response to *Pt* tolerance alone (ranged from 78-102% of EGA Wylie yield)**

Barley varieties are generally considered to have increased levels of *Pt* tolerance. Comparison of barley performance over the same trials is seen in Figure 4.

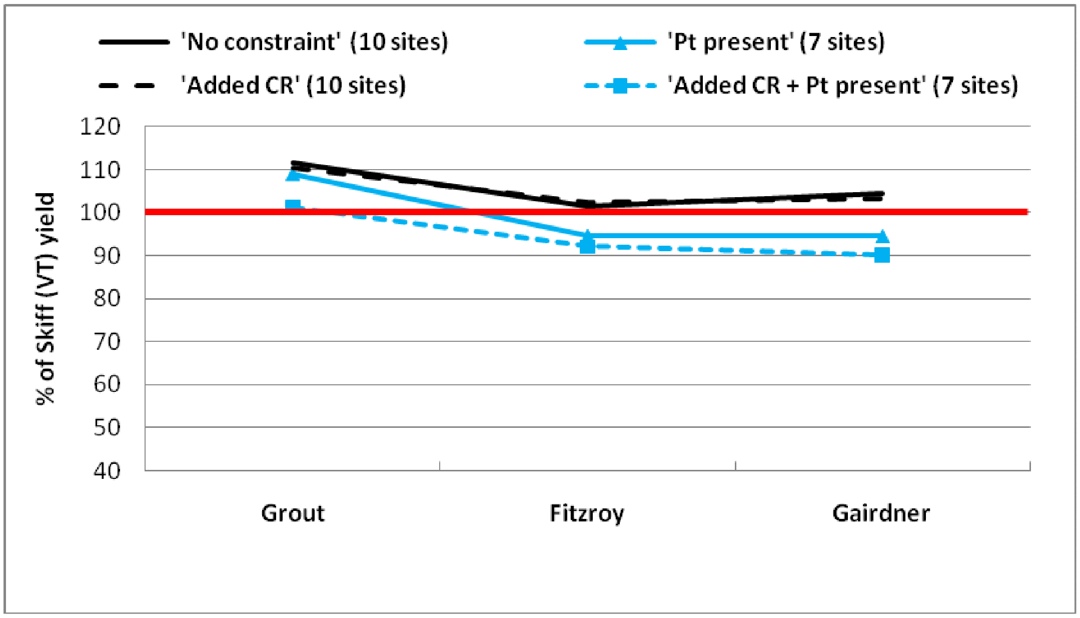

Figure 4. 2007 & 2008 barley variety yield as a % of Skiff

Key points:

1. Negligible apparent difference in barley variety CR tolerance
2. Less apparent range in variety *Pt* tolerance than seen for bread wheat

Figure 5 shows the variety yield performance compared to EGA Wylie for all wheat varieties evaluated in both 2008 and 2009. There was no *Pt* detection at 6 sites, with 5 sites having *Pt* present (NB site selection biased to *Pt* presence in 2009). 2008 was a very low CR yield loss year with average bread wheat yield loss of ~1% with low to moderate CR losses in 2009 with an average bread wheat yield loss of ~8%.

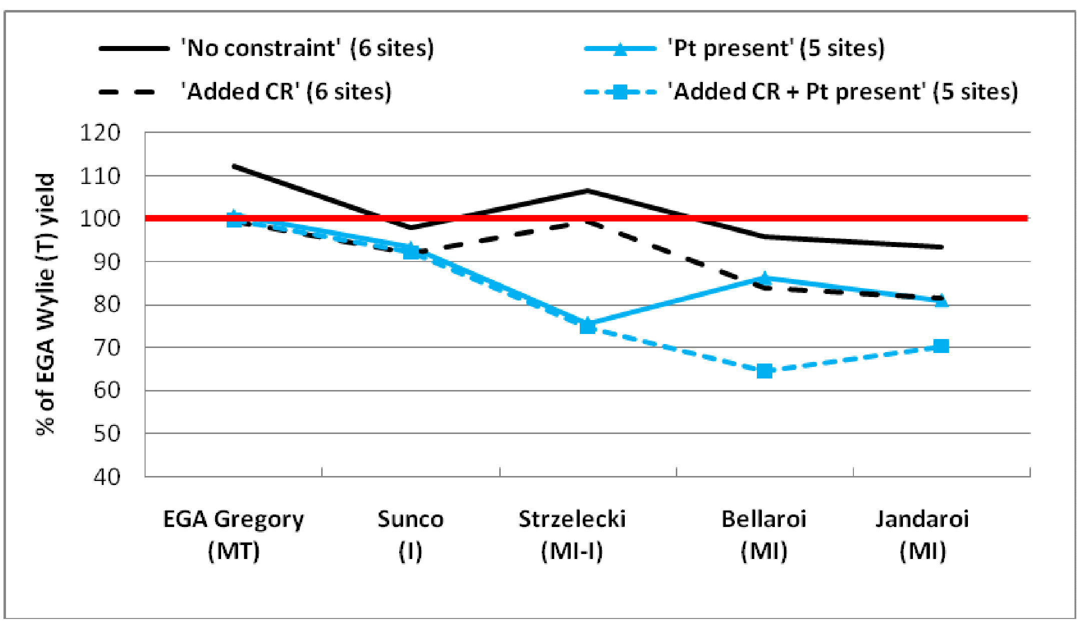

Figure 5. 2008 & 2009 wheat variety yield as a % of EGA Wylie (NB lower CR yield loss seasons)

Key points:

1. Less varietal CR tolerance difference evident, as expected, in lower CR yield loss years
2. Poor relative yield performance from Strzelecki, Bellaroi and Jandaroi at sites with both *Pt* presence and CR added

The impact of variety choice on *Pt* population

The data above has indicated the level of yield impact of *Pt* on less tolerant varieties. However there is a second varietal characteristic which appears equally important in overall nematode management. This is the level of resistance of the individual crop or variety as shown by the degree of build-up (or retardation) of the nematode population. Ratings have been published by DEEDI for a number of years showing both the tolerance (yield impact under nematode pressure) and resistance (impact on nematode build-up) of a wide range of wheat varieties.

In May and June 2010, soil samples were taken for nematode assay from three of the crown rot trial sites conducted in 2009 and tested using the PreDicta B DNA extraction method. These sites were sampled ~ six months after harvest and indicated the population of nematodes that had built up on each wheat variety during the growing season and that had survived through to the next potential planting opportunity. The data presented in this paper is for the eight varieties that were grown and sampled at all three sites.

Figures 6-8 shows the *Pt* detections across these trial sites. Both Bellata (Figure 6) and Coonamble (Figure 7) had very high *Pt* pressure with in excess of 30,000 *Pt*/kg soil detected following a very susceptible variety, even after ~six months fallow. Although consistent differences in remaining *Pt* population were measured, even the more resistant varieties still recorded populations greater than the 2,000 *Pt/*kg threshold level at both of these sites. Two key points: 1) the two durum varieties, Bellaroi and Jandaroi, trended to the lowest surviving *Pt* populations at both high pressure sites 2) the greatly increased level of *Pt* following the more susceptible varieties is likely to significantly increase yield loss in following crop sequences.

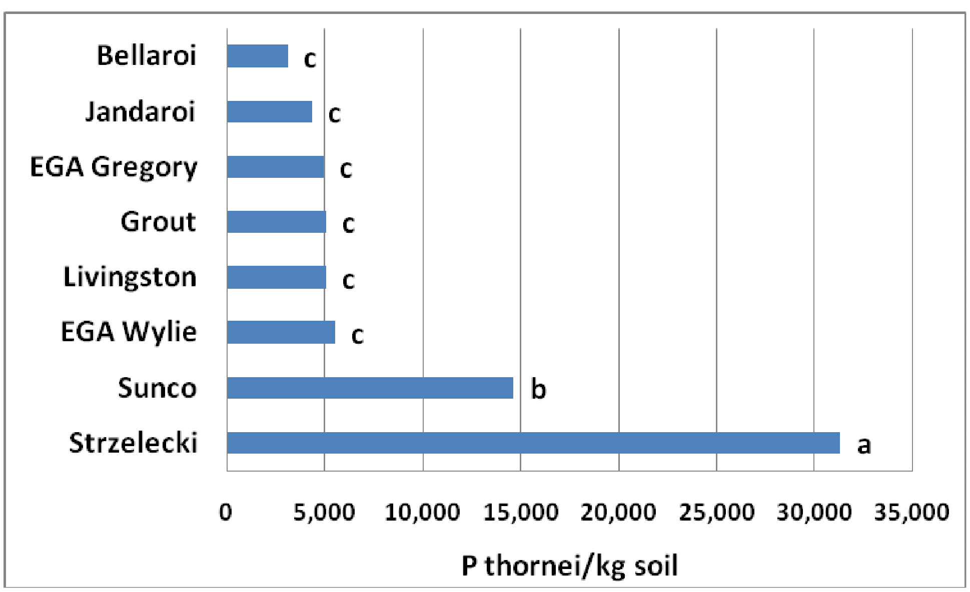

Figure 6. Impact on *P thornei* population from 2009 cereal variety at Bellata (sampled 19/5/10)

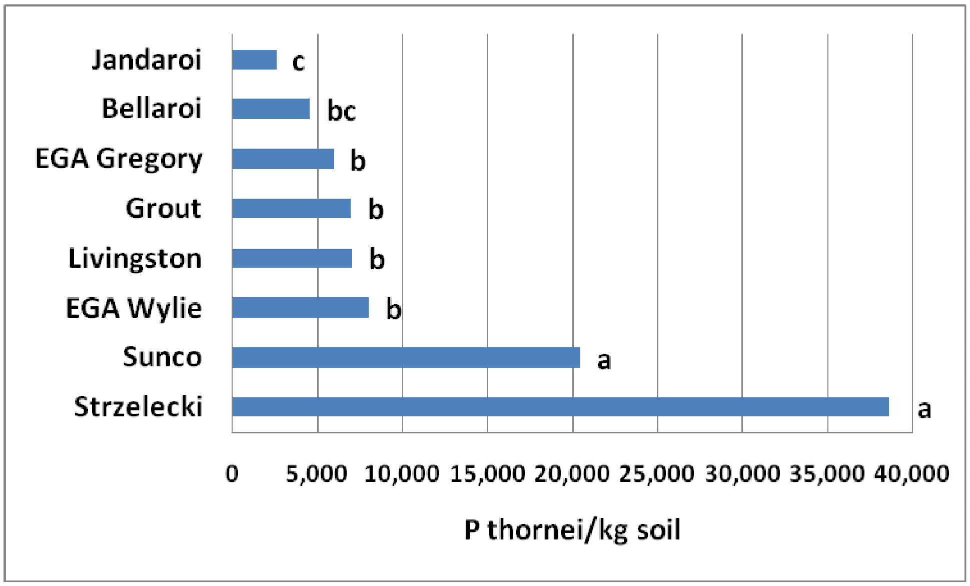

Figure 7. Impact on *P thornei* population from 2009 cereal variety at Coonamble (NSW I&I, sampled 8/6/10)

At North Star (figure 8) much lower *Pt* populations were measured but with similar overall varietal performance.

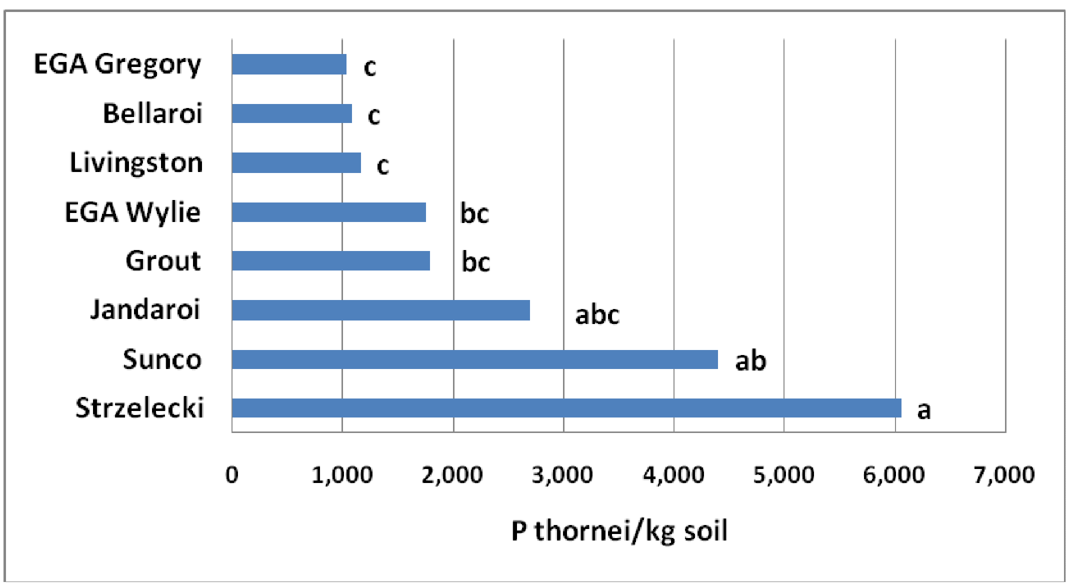

Figure 7. Impact on *P thornei* population from 2009 cereal variety at North Star (sampled 10/6/10)

Summary

CR impact and variety choice

There are clear differences in levels of CR tolerance between bread wheat varieties. However the relationship between CR tolerance rating and actual final yield has been poor ie inherent variety yield potential and local adaptation has generally been more important than CR rating.

The performance of EGA Gregory is a good example. Under CR pressure, EGA Gregory will certainly show more disease symptoms than Sunco but has still significantly outyielded Sunco in 10 of 22 trials. There was no situation when Sunco significantly outyielded EGA Gregory. EGA Gregory is NOT better than Sunco for CR tolerance but is a higher yielding, widely adapted variety. This demonstrates the relatively small progress and the difficulty of breeding for CR tolerance. Furthermore, pre-breeding programs have traditionally focused more on CR resistance rather than CR tolerance under field conditions. **Bread wheat variety choice cannot be your major CR management tool. However, changing from a durum variety, which are highly susceptible to CR, to a bread wheat or barley variety will assist in limiting losses.**

Pt impact and variety choice

The pattern of yield results obtained at sites with *Pt* presence, generally supports the DEEDI (2010) published variety *Pt* tolerance ratings. There appears to be a much stronger relationship between variety *Pt* tolerance rating and final yield under *Pt* pressure than exists for CR. **Bread wheat variety choice on the basis of *Pt* tolerance rating appears a useful tool in *Pt* management and is likely to impact actual yield and economic results.**

The performance of Strzelecki appears a good example. Over the last 2 years at sites without *Pt*, it averaged 6% higher yield than EGA Wylie. However at sites with *Pt* present, it has averaged 24% lower yield. The apparent loss in yield 'potential' has equaled ~1 t/ha. A poor variety choice, in the presence of *Pt* may be costing a grower more than $180/ha.

Recent soil sampling has also supported the existing DEEDI varietal resistance rankings but has indicated that even more difference in nematode field survival may be occurring in our very susceptible varieties eg Strzelecki and Sunco. These intolerant and very susceptible varieties pose an extreme risk in three areas:

1) Yield performance under *Pt* attack in the year of production
2) The build-up of *Pt* populations during the growing season
3) Decreased yields of following crops due to high populations of *Pt* remaining in the soil.

***Pt* intolerant/susceptible varieties should only be grown in paddocks where growers are confident there is no *Pt* risk.**

Conclusions

These trials were designed to evaluate the impact of CR on variety yield and quality. However they strongly suggest that *Pt* is also having a significant impact on yield performance. **The results do not compare the actual levels of yield loss due to the two diseases** but indicate there is a greater range in variety *Pt* tolerance than currently exists for CR tolerance. **Put simply, variety choice appears a more valuable tool when under *Pt* pressure than as a tool for CR management.** It may be a co-incidence but four of the most widely adopted and successful varieties in the north (EGA Wylie, EGA Gregory, Baxter and Sunvale) are the varieties with the highest currently available level of *Pt* tolerance.

Root lesion nematodes are a ‘disease’ that have no obvious visual symptoms in the paddock. To improve our management of this ‘disease’ we must take more advantage of nematode testing. An increase in level of awareness of *Pt* status in individual paddocks and across properties will assist to:

1) Develop sound hygiene practices to help limit further spread and reduce the risk of new infestations.
2) Provide a measure of the impact of varying management approaches designed to limit or reduce nematode build-up.

This knowledge is also likely to provide direct economic gains from sound varietal and crop rotation choices. Soil testing for nematodes may also provide benefits in the identification of other plant parasitic species not covered in this paper eg *Pratylenchus neglectus* and *Merlinius brevidens*.

Thompson J, Owen K, Clewett T, Sheedy J, and Reen R (2009) Management of root-lesion nematodes in the northern grain region. Information Brochure, 8 pp. The State of Queensland Primary, Department of Employment, Economic Development and Innovation, Brisbane. http://www.dpi.qld.gov.au/26_17480.htm

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<u>Consultant's View</u>

Avoid the 'double whammy - understanding the Nematode/Crown Rot interaction.

By Stuart Thorn, MCA Goondiwindi

The effect of root-lesion nematode impact on yields in wheat has been widely discussed with current data suggesting yield reduction of up to 50% from poor variety choice where nematodes are present. Where crops are already under stress from nematodes, the compounding effect of crown rot under dry finishes would have a 'double whammy' impact on growers' crop yields. Consultants are now able to provide clients information on nematode populations and crown rot levels via sampling during the fallow period which would provide a useful benchmark of paddock health status prior to planting the following crop.

With previous NGA work, in collaboration with I&I NSW, showing the additive impact of losses due to both 'diseases', prior certainties on their interaction have been challenged. Analysis of stubble provides useful data on crown rot status and risk whilst monitoring nematode population requires a simple & reliable soil test, such as analysed by DEEDI at Leslie Research Centre, to provide data that is critical in understanding the distribution & identification of nematodes across paddocks. Once the crown rot and nematode risk is identified, variety selection and yield potential can be more reliably targeted and managed.

Results from MCA Goondiwindi P/L testing this winter have reinforced the role variety selection plays in managing root-lesion nematode populations. Data collected has also shown the value of the winter fallow period, before and after summer crop, on reducing nematode numbers. Our sampling results also highlighted how compromised rotations with susceptible varieties have led to alarmingly high nematodes population, particularly *Pratylenchus thornei*. Given the absence of ability to currently manage crown rot and nematodes in-crop, having knowledge of starting levels during the fallow period, would seem fundamental in making appropriate variety choices.

The importance of ongoing sampling and monitoring will be critical to avoid cropping catastrophes and improve the cropping options available to growers. Similar to an annual check-up by a GP, a paddock health status schedule would assist growers and consultants in the construction of a reliable rotation. Continued practical research by NGA and plant pathologists at DEEDI QLD and I&I NSW should increase our knowledge of the impact on yields of these two significant ‘diseases’ and more importantly help to design the risk management strategies necessary to limit yield and economic impacts.