

Oats, pastures and other legumes – Are rotations offering breaks for root lesion nematodes or crown rot?

Sarah Collins, Carla Wilkinson, and Daniel Hüberli, DPIRD, South Perth.

Key messages

- Some pasture crops are effective for reducing root lesion nematode (RLN; *P. neglectus* and *P. quasitereoides*) populations in a season, but others can greatly increase RLN populations.
- Oats are not a good break crop for reducing *P. neglectus* or crown rot levels in a paddock. However, for *P. neglectus*, oats are less susceptible than wheat and variety choice makes a difference. For crown rot, oats can increase inoculum levels similar to wheat.
- *Fusarium pseudograminearum* caused average yield losses of 4% in oat varieties tested, which is four times lower than check wheat varieties Mace[Ⓛ] and Emu Rock[Ⓛ] which had an average yield loss of 17%.

Background and Aims

Root lesion nematodes (RLN; *Pratylenchus*) and crown rot (*Fusarium pseudograminearum* and *F. culmorum*) can cause large yield losses in broad-acre crops in Western Australia (WA). They are soilborne and compromise a plant's ability to access water and nutrients; by feeding on roots (RLNs) or clogging the root vascular tissues (crown rot). Both are widespread throughout the grain-belt and it has been established that wheat and barley are susceptible (meaning that populations of RLN and crown rot are increased) and cause yield losses. This is also the case for canola for the main species of RLNs in WA. Luckily this pest and disease can be effectively managed by rotation strategies that reduce or maintain populations at levels that do not impact crop yields. We have been working to increase the range of proven strategies that are viable for growers across the range of environments in the WA grain-belt.

The aims of this research are to provide useful information for:

- Crown rot or RLN (*P. neglectus*) resistance; ability of the pathogen and pest to increase their populations in current oat varieties.
- Oat variety tolerance to crown rot; the plant's ability to grow and yield well when the pathogen is present at high levels in the soil.
- Identify pasture alternatives to reduce RLN populations (*P. neglectus* or *P. quasitereoides*).

This research enables growers to make better informed decisions on the likely impact oats or pastures have to reduce these soilborne disease and pest issues in their paddocks and the effect they may have on future crop rotations. Although cereals are susceptible to both crown rot and RLNs, resistance can vary between varieties. Hence this research may also enable growers to choose crops or oat varieties that are suited to maximise yield potentials in current and future seasons in infested paddocks. RLN survey and glasshouse experimentation builds on information developed in earlier glasshouse trials at DPIRD, adding weight to preliminary resistance ratings and building confidence in the usefulness of some pasture options.

Method

Root lesion nematodes

The resistance of oat crops to *P. neglectus* and initial variety data has been developed via two glasshouse trials over two years. Information of the resistance of selected pasture species to RLN was developed by glasshouse experimentation for *P. neglectus* (2007, 2008 and 2017) and through a field survey for *P. quasitereoides* (2013-17). In the glasshouse, test plant species were grown for 10 weeks after being inoculated with *P. neglectus*. The roots of each plant were then washed free of soil and nematodes manually counted after being extracted from the roots over a 4 day period using DPIRD's mister system. All experiments were adequately replicated to account for the high levels of variation inherent in nematode multiplication.

Crown rot

The resistance/tolerance of oats to crown rot was determined through two seasons of field experimentation in two inoculated trials/ year (total of four trials) on six oat varieties (including Bannister[Ⓛ], Carrolup, Durack[Ⓛ], Kojonup[Ⓛ], Mitika[Ⓛ], Williams[Ⓛ] and Yallara[Ⓛ]) with two wheat check varieties (Mace[Ⓛ] and Emu Rock[Ⓛ]). Additionally, variety trials from 2016 were soil sampled for DNA testing of *Fusarium pseudograminearum* and *F. culmorum* levels using PREDICTA[®]B to determine the inoculum production of oat varieties and then over-sown with wheat in 2017 to determine the impact of inoculum levels on yield (data not yet available).

Results and Discussion

Root lesion nematodes

Pastures

A range of pasture crops and some specific pasture varieties show good levels of resistance to WA's common RLNs; *P. quasitereoides* and *P. neglectus* (Table 1 and 2). This means for cropping rotations using susceptible crops like wheat, barley or canola, these pastures will limit RLN multiplication and reduce the chance of damage to a subsequent susceptible crop. Serradella varieties have proven to be resistant in the glasshouse to *P. neglectus* and in grower paddocks for *P. quasitereoides* (Table 1 and 2). In fact, *P. quasitereoides* population reduction under serradella was better than lupin in the same paddock in Gibson (Table 2, Lupin data not shown). Casbah biserrulla and Dalkeith subterranean clover showed good levels of resistance to *P. neglectus* in glasshouse experiments conducted in 2017 and 2008 but were susceptible in a 2007 experiment (Table 1). This indicates that in cropping rotations, Casbah biserrulla and Dalkeith subterranean clover are likely to decrease *P. neglectus* populations in a season, but they may also increase numbers in some circumstances.

Conversely, a number of clover species significantly increased *P. neglectus* populations in all three glasshouse experiments. Species from popular pasture types, Balansa, Persian and Gland clovers for example, were as bad as the susceptible wheat control in terms of increasing *P. neglectus* populations in their root systems (Table 1). Therefore these clovers are likely to contribute to increased *P. neglectus* populations in cropping paddocks and should be avoided in rotation for infested paddocks.

Table 1. *Pratylenchus neglectus* resistance profiles for pasture species from DPIRD glasshouse experiments in 2017, 2008 and 2007.

Crop type	Variety	2017	2008*	2007**
Serradella	Cadiz	R	MR	MR
Serradella	Margurita	R	R	R
Serradella	Santorini	R	MR	MR
Biserrulla	Casbah	R	MR	S
Lupin	Lupin (R Control)	MR	R	R
Subterranean clover	Dalkeith	MR	MR	S
Eastern star clover	Sothis	MR	S	S
Arrow-leaf clover	Cefalu	S	S	S
Balansa clover	Frontier	-	S	S
Persian clover	Nitro Plus	SVS	S	S
Gland clover	Prima	SVS	-	SVS
Wheat	Wheat (S Control)	SVS	S	S

R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, SVS = susceptible to very susceptible.

* Vanstone *et al.* 2008. **Vanstone *et al.* 2009.

Table 2. *Pratylenchus quasitereoides* levels and multiplication in paddocks before and after a French serradella crop.

Location	Season	Paddock	Before Serradella RLN/g soil	After Serradella RLN/g soil	Multiplication (RLN resistant at <1.0)
Pingelly	2015	1	21	4	0.16
	2015-16	2	45*	1	0.03
Gibson	2013	1	4	1	0.19

* Sample collected at the end of the previous season directly after oats crop

Oats

All oat varieties tested were more resistant to *P. neglectus* than Mace^ϕ, which is moderately susceptible (MS) and the most commonly grown wheat variety in WA (Figure 1). Field pea and canola showed better resistance to *P. neglectus* than oats (Figure 2). In turn, oats trended towards being more resistant than wheat and barley which are both susceptible crops, but this difference was not statistically significant ($p > 0.05$; Figure 2). While oats are a susceptible crop and are likely to increase *P. neglectus* when grown in infested paddocks, there was a range in the resistance of

oat varieties with some varieties performing well relative to other cereal varieties (Figure 1). For example, Mulgara^ϕ, Wombat^ϕ, Williams^ϕ and Tungoo^ϕ were comparable to Yenda^ϕ (MR), which is the most resistant wheat variety (Figure 1). So whilst oat varieties are likely to increase nematode levels in a paddock within a growing season, they appear to be a more effective cereal option within rotations to manage *P. neglectus* levels.

To verify our findings we are testing a selection of eight oat varieties for resistance to both *P. neglectus* and *P. quasitereoides* under field conditions.

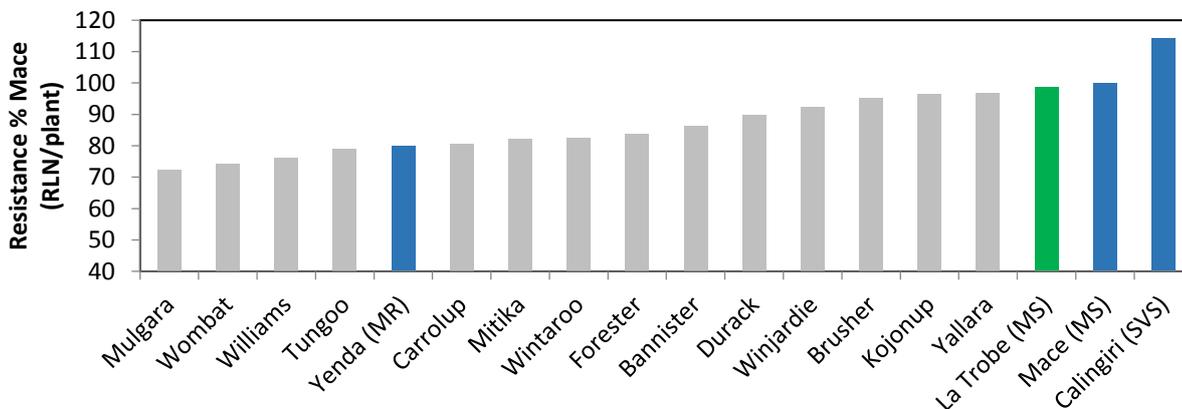


Figure 1. Resistance of oat varieties to *Pratylenchus neglectus* expressed as a percentage of RLN/plant detected in Mace^ϕ, the most commonly grown wheat variety in Western Australia. Grey bars represent oats, blue are wheat and green barley varieties. Data is a mean for two glasshouse trials. *P. neglectus* resistance ratings given for wheat and barley; SVS=susceptible to very susceptible, MS=moderately susceptible, MRMS=moderately resistant to moderately susceptible, MR=moderately susceptible.

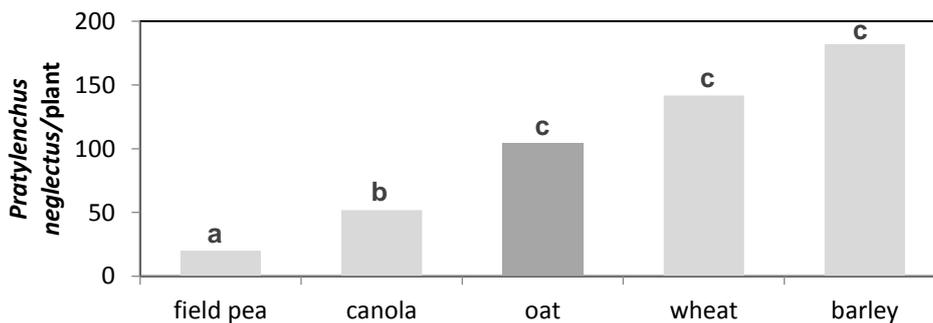


Figure 2. Relative resistance of oats to *Pratylenchus neglectus* in a glasshouse trial. Letters denote significant difference in nematode levels between crops ($p < 0.05$) using Fishers LSD test on $\ln(x+1)$ transformed data.

Crown rot

Oats

All oat varieties tested were more tolerant to *F. pseudograminearum*, which is the predominant crown rot pathogen occurring across the WA grain-belt, than the check wheat varieties, Mace^ϕ (S) and Emu Rock^ϕ (MS). In fact, average yield losses for oats were about four times lower than those measured in wheat (Figure 3). Furthermore, for *F. culmorum*, which occurs primarily in the southern regions, oat and wheat had lower levels of yield loss. There were no oat varietal differences in yield responses to crown rot. This is good news for growers because it means there is a more tolerant cereal crop option that can be used in rotations where crown rot is a problem. So in paddocks where crown rot risk is high, and a cereal must be sown, then oats appear to be a better choice over wheat in terms of limiting the extent of yield loss.

Inoculum levels of *F. pseudograminearum* at pre-sowing in 2017 on the previous year's oat variety trials were found to be similar in all oat varieties and the check wheats at both locations (Figure 4). For *F. culmorum* inoculum, levels were higher in oats than wheat. This means that oats cannot be used as a break crop to reduce crown rot inoculum. If the management strategy is to reduce crown rot levels in a paddock then a non-cereal crop (canola or lupin) will need to be used with good grass weed control as all grasses and cereals host the crown rot fungus. Broadleaf pasture such as serradella may also be good break crops, however, this has yet to be confirmed in field trials.

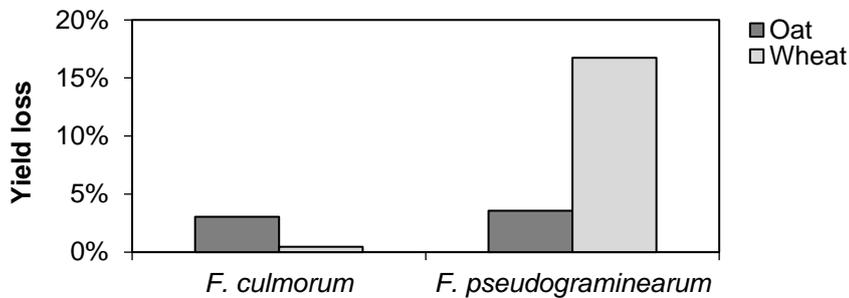


Figure 3. Yield loss to *Fusarium culmorum* and *F. pseudograminearum* in four inoculated field trials for oats and wheat.

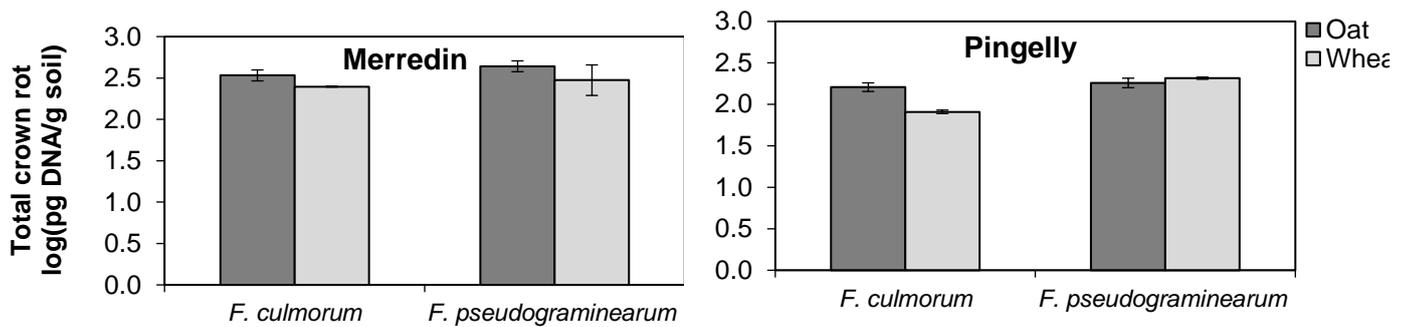


Figure 4. Level of *Fusarium culmorum* and *F. pseudograminearum* inoculum in the soil prior to sowing in 2017 for two oat variety trials conducted in 2016.

Conclusion

For the Western Region, proven resistance of serradella pastures to our common RLNs, *P. quasitereoides* and *P. neglectus*, offers growers with infested paddocks new management options. Serradella can be used as a cleaning phase for RLN as well as introducing nitrogen naturally to the soil (Loi *et al.* 2005). This conclusion is drawn from three replicated glasshouse experiments (*P. neglectus*) and paddock testing (*P. quasitereoides*) in two port zones. Biserrulla and subterranean clover also show potential to reduce RLN but more experimentation is necessary to clarify resistance for *P. neglectus* and *P. quasitereoides* as well as testing a larger range of varieties for more resistant options. Clovers on the other hand vary greatly in resistance to *P. neglectus* from very susceptible to moderately resistant so clover type and variety choice needs to be handled with care until more conclusive recommendations can be drawn.

For cereals, some oat varieties add viable rotation options that reduce RLN in infested paddocks. Glasshouse trials have shown that there is a range of resistance levels to *P. neglectus* in commonly grown oat varieties. All oat varieties had better resistance than the most commonly grown wheat variety, Mace[Ⓛ] which is moderately susceptible to this RLN. However, overall oats are not resistant to *P. neglectus* and will likely cause nematode levels to increase in a paddock. This increase in *P. neglectus* levels may lead to yield loss in subsequent crops. The most resistant oat varieties tested appear to be Mulgara[Ⓛ], Wombat[Ⓛ], Williams[Ⓛ] and Tungoo[Ⓛ]. Resistance ratings are being confirmed in field trials.

For crown rot, oats were found to be about four times more tolerant than Mace[Ⓛ] (susceptible) and Emu Rock[Ⓛ] (moderately susceptible), and no varietal differences in yield loss were found amongst the oat varieties tested. This means that if a cereal is to be sown into a paddock with high levels of crown rot, then oats could be a better choice over wheat. However, oats are not break crops and will increase crown rot inoculum levels similarly to wheat. If the crown rot inoculum levels are high, then the best rotation option remains to grow non-cereal break crops such as canola or pulses.

References

- Loi A, Howieson JG, Nutt BJ, Carr SJ (2005). A second generation of annual pasture legumes and their potential for inclusion in Mediterranean-type farming systems. *Australian Journal of Experimental Agriculture* 45: 289-299.
- Vanstone V, Bhatti A, You M (2008). The role of pastures in hosting root lesion nematode (RLN, *Pratylenchus neglectus*). GRDC Agribusiness Crop Updates. Perth, Western Australia, Department of Agriculture and Food, Western Australia.
- Vanstone V, Hunter H, Kelly S (2009). Screening cereal, canola and pasture cultivars for root lesion nematode (*Pratylenchus neglectus*). GRDC Agribusiness Crop Updates. Perth, Western Australia. p. 119-122.

Acknowledgments

Angelo Loi, Ron Yates (DPIRD pasture management) and Georgie Troup (DPIRD oats breeding), Pamela Zwer (SARDI) provided seed and advice for growing pastures and oats. DPIRD plant pathology assisted in glasshouse and field trials and data analysis: staff Sean Kelly, Miriam Connor, Helen Hunter, Kris Gajda and Lucy DeBrincat. Data analysis of the crown rot oats trials was conducted by DPIRD biometrician, Andrew Van Burgel. DPIRD region research units managed all field experiments: Merredin RS, Shari Dougall, Tracey Mouritzen and Rob de Gruchy. The research undertaken is made possible by the significant contributions of growers through both trial cooperation and COGGO, DPIRD Boosting Grains and GRDC investment. We would like to thank them for their continued support.

COGGO: Resistance of milling and hay oats to root lesion nematodes *Pratylenchus neglectus* and *P. quasitereoides* in Western Australia

DPIRD through the Boosting Grains R&D Project: Tolerance and resistance of oats to crown rot in WA (FFPjP03) which aligns with the GRDC national crown rot program (DAN00175)

GRDC: 'National nematode epidemiology and management program' (DAV00128)

Paper reviewed by: Steven Simpfendorfer (NSW DPI)