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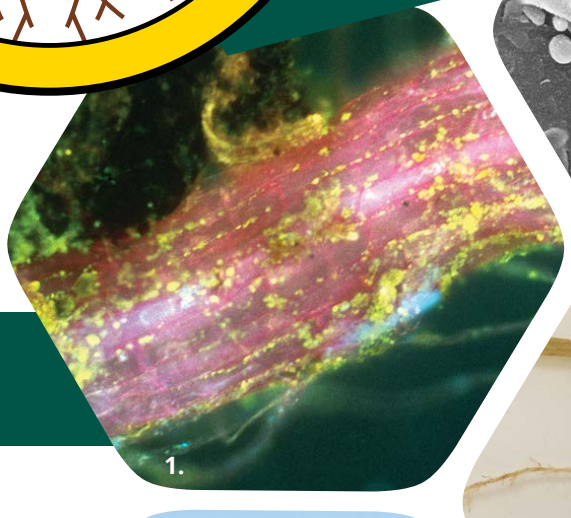
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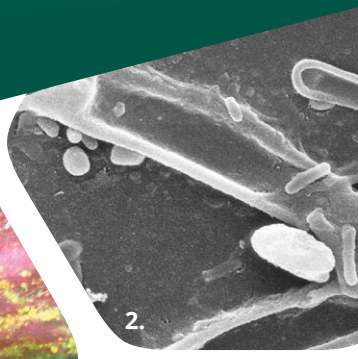
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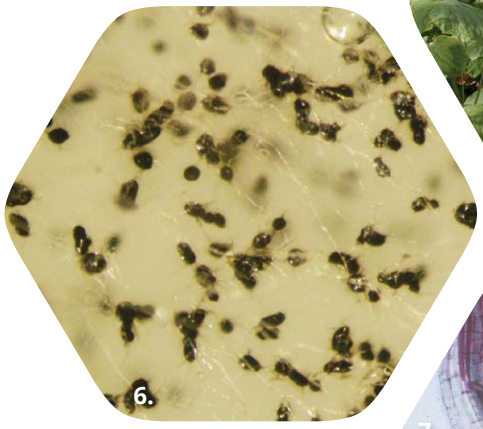
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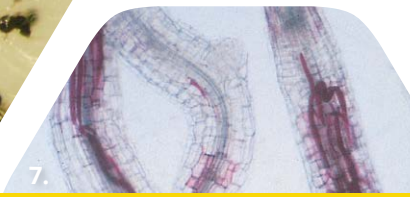
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Are oats an effective break crop for crown rot?

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INTRODUCTION

The oat industry in Western Australia (WA) is expanding its' production, both within traditional oat production areas and into adjacent medium-low rainfall areas. Increased export demand provides oat grain and hay producers the opportunity for enhanced economic returns.

Fusarium crown rot, caused predominantly by the stubble-borne fungus *F. pseudograminearum*, is one of the major root and crown disease constraints on cereal production in Australia. In 2009, it was estimated to cost WA grain growers $7 million annually in wheat and barley (2, 3). Expression of the disease occurs most commonly in the low rainfall areas, a region where oats have not been grown traditionally and no information is available on crown rot impacts on oat yield in this area. A cereal stubble survey conducted in 2013 and 2014 by DPIRD under the national crown rot project DAN00175 identified crown rot infected stubble across the cereal producing areas of WA including in the medium to high rainfall areas. *F. pseudograminearum* was identified from this survey as the primary pathogen; however, in the medium to high rainfall area which is the traditional oat growing region, *F. culmorum* was also isolated.

Small field trials in 2005 and 2008 showed that oats had yield losses of up to 16% which was comparable to susceptible bread wheat yield losses (Evans, personal comm.). Additionally, trials in SA and Vic in 2003 and 2004 found that levels of *F. culmorum* DNA were similar after oats and barley, but levels of *F. pseudograminearum* DNA were lower after oats than after barley (1). They concluded that the level of resistance in oat cultivars and the role of oat crops in building-up levels of crown rot inoculum are unclear and requires more research.

With the recent increases in milling prices for oats and the growers from the non-traditional growing region (low rainfall areas) interested in growing oats, there is an increased need to evaluate varietal tolerance to crown rot in the field to demonstrate economic benefits of adoption to growers. Additionally, there is a need to provide information on the effect of new varieties on crown rot inoculum given that many growers are likely to use oats as an additional crop in their rotations.

MATERIALS AND METHODS

Field experiments with oat and wheat varieties: The resistance/tolerance of oats to *F. pseudograminearum* and *F. culmorum* was determined through two seasons of field experimentation in two inoculated trials in 2016 and 2017 (total of four trials) on six oat varieties/site (Bannister, Carrolup, Durack, Kojonup, Mitika, Williams and Yallara) and two wheat check varieties (Mace and Emu Rock). Plots were 10 m x 1.8 m. Grain yield (t/ha) from each plot/trial was recorded and stubble samples were collected at post-harvest for disease assessment. No crown rot DNA was detected in the soil tested by PREDICTA® B prior to sowing at all four trial sites. Trials were located at Merredin and Pingelly in 2016, and Merredin and Muresk in 2017. Merredin is located in the low rainfall area, while Pingelly and Muresk are in the medium to high rainfall area.

The two trials from 2016 were soil sampled at pre-sowing for DNA testing of *F. pseudograminearum* and *F. culmorum* levels using PREDICTA® B to determine the inoculum production of oat varieties and then over-sown with wheat (Mace) in 2017 to determine the impact of inoculum levels on grain yield and crown rot disease.

Disease assessment: Basal browning was assessed on 30 pieces of stubble/plot collected from each trial. Crowns were scored using the 0–3 rating scale (0= no browning and 3 = >6 cm of basal browning). The crown rot index, a visual measure of crown rot impact based on the incidence and severity of browning of infected primary stems, was calculated on a plot basis using a sample of 30 primary stems per plot.

Statistical analyses: There were 4 replicates for all treatments in field experiments. Statistical analyses of all results were conducted using the GenStat® 18th Edition statistical software (VSN Intl. Ltd).

Economic analysis: Gross margins for oats were calculated based on three prices per tonne ($90, $180 and $270/t) and for wheat at one price of $270/t. Input costs for chemicals, seed, fertiliser, lime, fuel, labour, and insurance were included in the analysis.

RESULTS AND DISCUSSION

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 (S) and Emu Rock (MS). In fact, average yield losses for oats were about four times lower than those measured in wheat (Figure 1). For *F. culmorum*, oat and wheat had lower levels of yield loss than for *F. pseudograminearum* especially for wheat. 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 non-host rotational options are limited, then oats appear to be a better choice than wheat in terms of limiting the extent of yield loss.

The crown rot index had a strong correlation between the two trials located in the same rainfall zone and so results are presented as the combined data for the two *Fusarium* species for trials in same rainfall zone (Figure 2). Yallara had the highest crown rot index in the low rainfall trials and the lowest in the medium/high rainfall trials (Figure 2). The wheat varieties remained consistent in their index for all four trials.

At both sites pre-sowing inoculum levels in 2017 were not significantly different among wheat and oats, or varieties sown in 2016. The inoculum averaged 2.2

log_{10} (pg DNA/g soil sample +1) at Merredin and 1.7 log_{10} (pg DNA/g soil sample + 1) at Pingelly, which is in the medium and low PREDICTA® B risk level, respectively. This means that oats cannot be used as a break crop to reduce crown rot inoculum as both crops had similar inoculum levels in 2017. If the management strategy is to reduce crown rot levels in a paddock then a non-cereal crop such as canola or lupin will need to be used with good grass weed control.

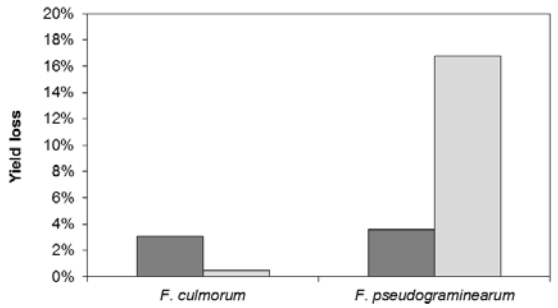

Figure 1. Average yield loss to *Fusarium culmorum* and *F. pseudograminearum* in four inoculated field trials for oats (dark grey bars) and wheat (light grey bars).

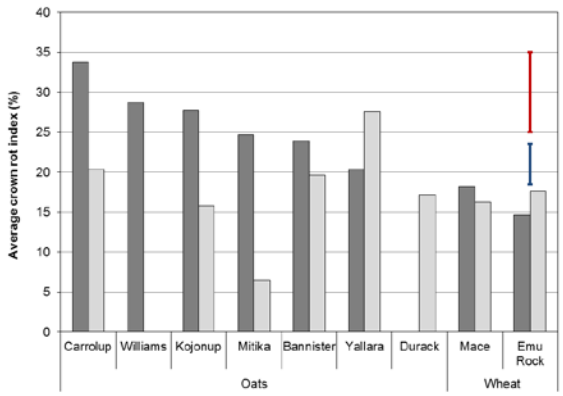

Figure 2. Crown rot index for *Fusarium pseudograminearum* and *F. culmorum* combined at post-harvest from stubble of oat and wheat varieties in medium to high rainfall (dark grey bars) and low rainfall (light grey bars) areas. Red bar is 5% LSD for comparing varieties from medium/high rainfall areas, and blue bar is 5% LSD for comparing varieties from low rainfall areas.

There was no significant difference in the effect of the 2016 oat varieties on crown rot index on wheat in 2017 for both sites. For grain yield in 2017, there was no significant effect from the 2016 treatments at Pingelly. However, at Merredin there was a significant negative effect of *F. pseudograminearum* on yield (0.96 t/ha *F. pseudograminearum* vs. 1.07 t/ha Nil), a significant effect of 2016 crop type (0.98 t/ha oats vs. 1.18 t/ha wheat), and significant differences between 2016 oat varieties (Mitka 1.10 t/ha and Yallara 1.06 t/ha had significantly higher yield than Carrolup 0.83 t/ha). Given that were no differences in pre-sowing inoculum levels and crown rot disease index among wheat and oats or oat varieties, the differences in yield observed in one trial for crop type and oat varieties appears to be due to factors other than crown rot disease. **Economic analysis:** The gross margins for oats compared to wheat showed that only at a price of $270/t were oats more profitable than wheat assuming stable wheat prices of $270/t at all 3 locations (Table 1). At Muresk and Pingelly, the medium to high rainfall zones, oats were more profitable than wheat in the presence of crown rot at a price over $180/t for oats. The economics of oats compared to wheat become more attractive in the presence of high crown rot. It is therefore important for growers with paddocks that have high crown rot risks to select the most appropriate cereal crop based on the forecast season and yield potential.

Table 1. Gross margins for oats relative to wheat at three oat prices and the yield differences between oats and wheat for three locations in the absence and presence of *Fusarium pseudograminearum*. Wheat price was $270/t.

		Oat prices/t			
Location	**Crown rot**	**$270**	**$180**	**$90**	**Grain yield difference in t/ha (oats - wheat)**
Merredin	Nil	$142	-$125	-$393	0.58
	Present	$170	-$84	-$337	0.71
Muresk	Nil	$160	-$198	-$556	0.62
	Present	$356	$11	-$334	1.52
Pingelly	Nil	$316	-$73	-$462	1.41
	Present	$415	$27	-$360	1.85

SUMMARY

- *F. pseudograminearum* caused average yield losses of 4% in oat varieties tested, which is four times lower than the check wheat varieties Mace and Emu Rock which had an average yield loss of 17%. There was 3% or less yield loss in wheat and oats to *F. culmorum*.
- Oats may be more profitable than wheat depending on region and the presence of high levels of crown rot which has a larger impact on wheat than oats.
- Oats are not a good break crop for reducing crown rot levels in a paddock as inoculum levels were not significantly different among wheat and oats.
- There was no difference in disease in the next year's wheat following different oat varieties or cereal type.

ACKNOWLEDGEMENTS

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