High crown rot risk – should growers plant barley or wheat?

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Abstract

Twenty replicated field trials were conducted between 2009 and 2014 where both the bread wheat variety EGA Gregory and the barley variety Commander were included. All trials had inoculated versus un-inoculated treatments for crown rot with two separate sowing dates in five trial sets. In total this provided 23 comparisons between EGA Gregory and Commander in the presence of high crown rot infection. In 13 of 23 comparisons (57%), Commander provided a yield benefit over growing EGA Gregory (range +0.28 to +2.20 t/ha; avg. +0.95 t/ha). In 7 of 23 comparisons (30%), the difference in yield between Commander and EGA Gregory was not significant. In three comparisons (13%), Commander was significantly lower yielding than EGA Gregory (range -0.33 to -0.77 t/ha, avg. -0.48 t/ha), likely due to stress occurring earlier in the season. Barley tends to yield better in the presence of crown rot infection due to its earlier maturity relative to bread wheat, providing an escape mechanism which reduces its exposure to evaporative stress during grain filling. Delaying the sowing time of barley can remove this escape mechanism. If forced into planting a cereal crop in a high crown rot risk situation then some barley varieties may provide a yield advantage over bread wheat in that season, provided evaporative stress during vegetative growth stages does not occur. However, this decision will only potentially maximise profit in the current season. Growing barley over bread wheat will not assist with the reduction of crown rot inoculum levels as barley is very susceptible to infection.

Introduction

Crown rot caused predominantly by the fungus *Fusarium pseudograminearum (Fp)*, is a major disease of wheat and barley crops in the northern grains region (NGR) of Australia, and is estimated to cost growers around $97m annually (Murray and Brennan 2009, 2010).The NSW Department of Primary Industries has pioneered the evaluation of relative yield responses of bread wheat, durum and barley varieties to crown rot in the NGR since 2004, using an inoculated versus uninoculated trial design. In a preliminary study conducted in the NGR, Daniel and Simpfendorfer (2008) observed that the average yield loss from crown rot was 20% in barley (4 varieties), 25% in bread wheat (5 varieties) and 58% in durum (EGA Bellaroi). The aim of this paper was to compare the relative benefit of growing barley or wheat in the presence of crown rot infection, based on data collected from 20 replicated field trials conducted between 2009 and 2014.

Key words

Yield benefit, inoculum load, resistance, tolerance, crown rot, variety.

Method

Between 2009 and 2014, 20 replicated small plot field trials that included the bread wheat variety EGA Gregory, a widely grown cultivar across the NGR, and the dominant malting barley variety Commander, were conducted by NSW DPI. All trials were replicated, and had uninoculated vs. inoculated (2 g inoculum/m row) treatments at sowing using sterilised durum grain colonised by five isolates of *Fp* as described by Dodman and Wildermuth (1987), with five trial sets including a sowing date component. If the interaction of sowing date was significant ($P< 0.05$) data from both dates was presented, if the effect of sowing time was not significant (ns) the average yield result across both planting times is presented. In total this provided 23 comparisons between EGA Gregory and Commander across seasons. As the focus is in the relative performance of barley vs. wheat in the presence of *Fp* infection, only yield results from treatments inoculated with *Fp* are presented. Consequently, this is a comparison across sites and years under high crown rot pressure. The emphasis being on the actual yield achieved under high *Fp* infection levels, rather than percentage yield loss from crown rot, given that yield is a main determinant of profitability for growers.

Replicated trials were also conducted at Tamworth and Garah in 2014 where a range of barley and wheat varieties were evaluated for their relative yield in the presence of high levels of *Fp* infection using an inoculated vs. uninoculated trial design. Data on the relative yield of wheat and barley varieties only in the presence of crown rot is presented.

Results

In 13 of 23 comparisons (57%) Commander provided a yield benefit over growing EGA Gregory (range +0.28 to +2.20 t/ha; avg. +0.95 t/ha) (Table 1). In 7 of 23 comparisons (30%) the difference in yield between Commander and EGA Gregory was not significant (ns). In three comparisons (13%) Commander was actually significantly lower yielding than EGA Gregory (range -0.33 to -0.77 t/ha, avg. -0.48 t/ha). In 2011 at both sites, mild conditions in terms of temperature and adequate soil moisture limited the expression of crown rot with no significant yield difference between inoculated and uninoculated treatments. In all other trials seasonal conditions favoured varying but significant levels of crown rot expression.

Table 1. Yield of barley cv. Commander compared to wheat cv. EGA Gregory in NSW DPI trials inoculated with *Fp* from 2009-2014

Year	Location	Sowing date	Commander (t/ha)	EGA Gregory (t/ha)	Yield Commander vs Gregory
2009	Coonamble	24 June	3.64	3.12	+0.52
	Tamworth	8 July	4.93	4.06	+0.87
2011	Mungindi	10 May	3.98	4.35	-0.37
		2 June	4.13	4.23	ns
	Coonamble	20 May	4.35	4.71	ns
		22 June	3.09	3.37	ns
2012	Walgett	30 Apr/28 May	6.20	4.00	+2.20
2013	Rowena	30 May	1.81	1.44	+0.37
	Garah	1 May	3.09	2.21	+0.88
		31 May	2.58	2.23	+0.35
2014	Tamworth	20 May/10 June	3.89	2.44	+1.45
	Garah	2 May/12 June	1.17	0.89	+0.28
	Narrabri	15 May	5.62	5.42	ns
	Terry Hie Hie	29 May	1.66	1.99	-0.33
	Spring Ridge	14 May	4.75	4.17	+0.58
	Bithramere	5 June	3.25	2.40	+0.85
	Gilgandra	16 May	5.39	4.12	+1.27
	Coonamble	21 May	5.05	4.82	ns
	Mungindi	16 May	0.77	0.65	ns
	Macalister, Qld	25 May	1.48	2.22	-0.74
	Westmar, Qld	15 May	2.03	1.72	ns
	Trangie	15 May	2.87	1.39	+1.48
	Tamworth	29 May	4.30	3.10	+1.20

Barley is generally considered more tolerant of crown rot (reduced yield impact) than bread wheat (Liu *et al.* 2012) as it tends to escape severe evaporative stress, which exacerbates expression, by maturing earlier. However, as the two sowing times at Garah in 2013 highlighted, this escape mechanism is dependant on sowing time with all four barley varieties in the trial (including Commander) suffering a much higher percentage yield loss from crown rot on the later sowing time (20-30%) relative to the earlier timing (6-11%) (data not shown). Barley is very susceptible to infection by the crown rot fungus and if sown later in its planting window will be filling grain under adverse conditions which may lead to significant yield loss from crown rot. Despite this, Commander is still likely to be higher yielding than EGA Gregory, as can be seen from the trial results for Coonamble 2009, Tamworth 2009 and 2014, and Bithramere in 2014 (Table 1).

Recent research conducted across 11 sites in 2013 and 12 sites in 2014 has highlighted that some of the more recently released bread wheat varieties produced higher yield in the presence of crown rot infection than the widely grown, but more susceptible variety, EGA Gregory. Data on the relative yield of barley varieties in the presence of crown rot is however, more limited. Replicated trials were conducted at Tamworth and Garah in 2014 where a range of barley and wheat varieties were evaluated for their relative yield in the presence of high levels of crown rot infection. The impact of crown rot on yield was determined through the comparison of yield between plots either inoculated or uninoculated with *Fp* at sowing.

Trial results from Tamworth in 2014, found that *Fp* infection caused yield losses in the barley varieties ranging from 10% in La Trobe up to 29% in Oxford. In the bread wheat varieties yield loss ranged from 14% in Spitfire up to 23% in EGA Gregory. There were however, low to moderate background levels of crown rot across the site which potentially reduced the differences in yield loss. Hence, only the actual yields of each variety measured in the inoculated *Fp* treatment (high infection level) are presented (Figure 1).

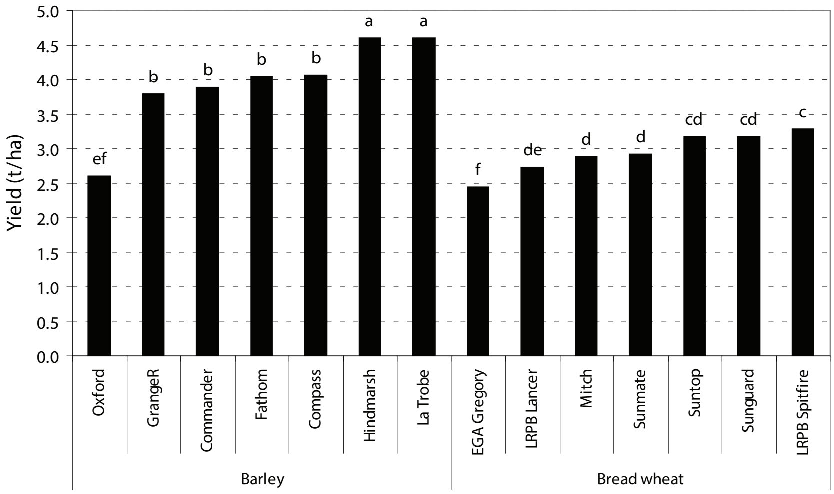

Figure 1. Yield of seven barley and seven bread wheat varieties in the presence of high crown rot infection – Tamworth 2014 (Values are the average of 20 May and 10 June sowing dates; bars followed by the same letter are not significantly (P<0.05) different).

With the exception of Oxford, all barley varieties were higher yielding than EGA Gregory in the presence of high levels of crown rot infection (Figure 1). The reduced biomass barley plant types, Hindmarsh and La Trobe produced higher yield than the other barley varieties being 0.71 t/ha and 0.72 t/ha higher yielding than Commander, respectively. All of the newer wheat varieties were higher yielding than EGA Gregory in the presence of high levels of *Fp* infection. Suntop (0.73 t/ha), Sunguard (0.74 t/ha) and LRPB Spitfire (0.85 t/ha) provided the greatest yield advantage over EGA Gregory (Figure 1). However, even the best bread wheat variety LRPB Spitfire was between 0.51 to 1.32 t/ha lower yielding than all of the barley varieties, with the exception of Oxford.

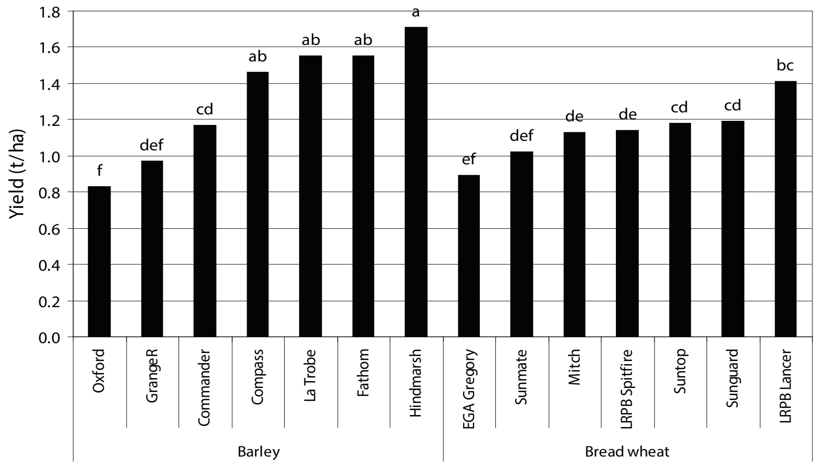

Figure 2. Yield of seven barley and seven bread wheat varieties in the presence of high *Fp* – Garah 2014. (Values are the average of 2 May and 12 June sowing dates; bars followed by the same letter are not significantly (P<0.05) different)

Although Garah was a considerably lower yielding site than Tamworth, encouragingly, the trends in varietal yield performance in the presence of crown rot were fairly consistent with Tamworth. *Fp* infection caused yield loss in the barley varieties ranging from 17% in Hindmarsh up to 31% in GrangeR. In the bread wheat varieties yield loss ranged from nil in LRPB Lancer up to 40% in EGA Gregory. Actual yield of each variety measured in the inoculated *Fp* treatment (high infection level) is presented below (Figure 2).

With the exception of Oxford and GrangeR, all barley varieties were higher yielding than EGA Gregory in the presence of high levels of crown rot infection with Compass (0.29 t/ha), La Trobe (0.38 t/ha), Fathom (0.38 t/ha) and Hindmarsh (0.54 t/ha) all providing significant yield benefits (Figure 2).The best barley variety Hindmarsh was 0.30 t/ha higher yielding than the best bread wheat variety LRPB Lancer (Figure 2).

Conclusions

Barley tends to yield better in the presence of crown rot infection due to its earlier maturity relative to bread wheat, providing an escape mechanism which reduces its exposure to evaporative stress during the critical grain filling stage. This is often referred to as tolerance. To some extent this may also be why the barley variety Oxford, which has a longer maturity, does not yield as well as other barley varieties in the presence of crown rot infection. The tolerance mechanism is lost through the delayed maturity. It is critical that growers do not continue to confuse tolerance with resistance when considering crown rot. Barley is likely to provide a yield advantage over wheat in the presence of high crown rot infection due to better tolerance to this disease. Importantly however, barley will not reduce inoculum levels for subsequent crops as it does not have improved resistance to crown rot infection compared to bread wheat (Liu *et al.* 2012).

If forced into planting a cereal crop in a high crown rot risk situation some barley varieties may provide a yield advantage over bread wheat in a given season, due to better disease tolerance. Importantly, some of the newer bread wheat varieties do appear to be closing this gap to some extent. Nevertheless, a key message is that this decision is only potentially maximising profit in the current season. Growing barley over bread wheat will not assist with the reduction of crown rot inoculum levels as barley is very susceptible to infection. Significant yield loss is still occurring in the best of the barley and bread wheat varieties in the presence of high crown rot infection. Crop and variety choice is therefore not the sole solution to crown rot but rather just one element of an integrated management strategy to limit losses from this disease.

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