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Evaluating weed competitiveness of eighteen barley varieties in the presence of oats – Condobolin 2016

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Key findings

- The presence of oats reduced barley yields from no significant reduction up to 31.27%.
- Varieties Fathom$^{\phi}$ and Commander$^{\phi}$ were the most effective varieties at suppressing oat development.
- Bass$^{\phi}$ and Buloke$^{\phi}$ demonstrated no significant yield reduction in the presence of oats.

Introduction

Herbicide options for in-season control of grass weeds in cereal crops can be limited. While some products are marketed specifically for wild oat control in cereals, herbicide applications must be timed correctly, or they can be ineffective, damage the crop, and encourage herbicide resistance in future weed generations. One cultural, non-chemical management strategy is to select a cereal variety with sufficient early season vigour to out-compete weeds, precluding, or reducing reliance on herbicide use. This experiment used oat weed surrogates to assess the competiveness of 18 commercial barley varieties for their capacity to suppress or out-compete weeds during the season.

Site details

Location	Condobolin Agricultural Research and Advisory Station
Soil type	Red–brown chromosol
Soil nitrogen	30 kg/ha (0–10 cm), 39 kg/ha (10–60 cm)
Experimental design	Randomised complete block design, varieties, and weed treatments randomised within three replicates
Sowing date	23 May 2016
Sowing	The experiment was sown using a six-row DBS plot seeder at 30 cm row spacings 70 kg/ha mono-ammonium phosphate (MAP) was applied at sowing
Weed control	Pre-emergent weed control: WipeOut 450® 2 L/ha
Pest control	Targeting aphids: Primor WG® 150 g/ha
Growing season rainfall	467 mm (long-term average is 192 mm)

Treatments

Weed surrogate

Wintaroo oats (*Avena sativa* L.) were used as a surrogate for wild or black oats (*Avena fatua*, L.). Seeds were distributed onto the surface of experimental plots with a DBS plot airseeder with raised tines at a target plant density of 60 plants/m^2 before sowing. As plots were sown, some oat seeds were incorporated into the soil, simulating natural weed seed distribution. Barley varieties were sown in accordance with regional farming practices at a target density of 125 plants/m^2.

Varieties

Bass$^{\phi}$, Buloke$^{\phi}$, Commander$^{\phi}$, Compass$^{\phi}$, Fathom$^{\phi}$, Flinders$^{\phi}$, Gairdner$^{\phi}$, GrangeR, Hindmarsh$^{\phi}$, La Trobe$^{\phi}$, Maritime$^{\phi}$, Oxford, Rosalind$^{\phi}$, Scope CL$^{\phi}$, Spartacus CL$^{\phi}$, Urambie$^{\phi}$, Wesminster$^{\phi}$, Wimmera

Methodology

A 1.2 m² section of each plot was harvested by hand. Oat and barley tillers were separated, counted and threshed. Following machine harvest, plot grain yields were weighed, and a representative sub-sample was taken with oat and barley grains separated by hand. The subsequent ratio of barley to oats was used to calculate barley plot yields.

Results

Grain yield

As oat biomass increased per square metre, barley yields decreased (Figure 1). There was no significant difference in total biomass/m² in the presence or absence of oats ($P = 0.43$), although the number of total tillers (barley and oats) decreased in the presence of oats ($P = 0.07$). There was a significant effect on the yield in oat-affected plots compared with the control (oat free) plots ($P<0.001$) (Table 1). All varieties had a yield penalty in the presence of oats apart from Bass$^{\Phi}$ and Buloke$^{\Phi}$, which showed no significant yield difference. The most affected varieties were GrangeR, Spartacus CL$^{\Phi}$ and Urambie$^{\Phi}$ (Table 2).

Table 1. Performance of barley yield components in the presence and absence of Wintaroo oats. ANOVA F probabilities for variety (V), oat treatment (T), and interaction.

Yield component	Weed treatment		ANOVA F probability[a]		
	Nil	Oats	V	T	V × T
Grain yield (t/ha)	4.28	3.45	NS	**	NS
Tillers (number/m²)	647	516	**	**	NS
Grain weight (mg)	47.29	46.34	**	**	NS
Grains/tiller	18.35	19.51	**	*	NS
Grain weight per tiller (g)	0.87	0.90	**	NS	NS
Grain number/m²	11649	9904	NS	**	NS
Dry matter/m²	1018	787	**	**	NS
Dry matter/tiller (g)	1.051	0.976	**	**	NS
Harvest index	0.45	0.48	**	**	NS

[a] NS = not significant; * and ** = at the 0.05 and 0.01 levels of probability respectively.

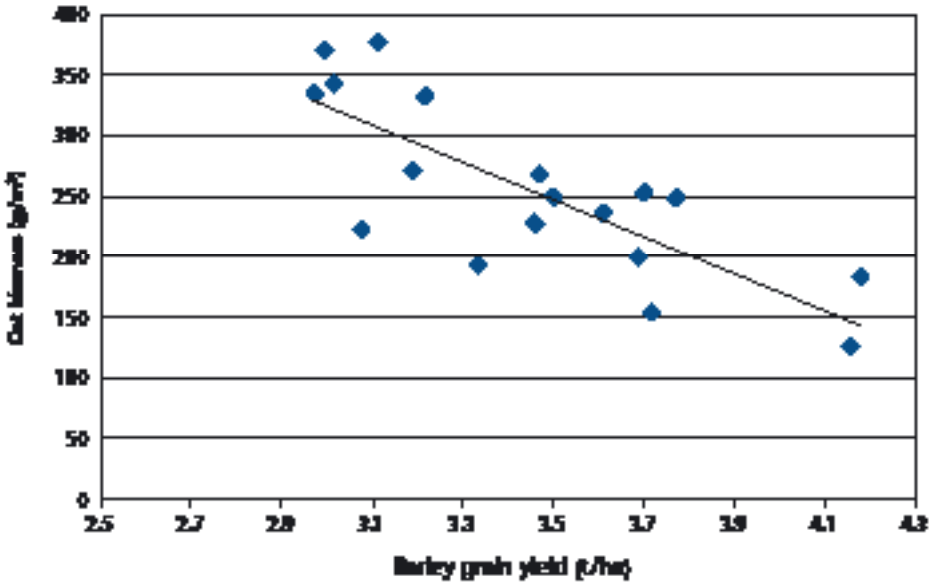

Figure 1. Relationship between oat biomass collected from experimental plots and barley yield ($r^2 = 0.62$).

Yield component analysis

The presence of oats significantly influenced all yield components except for grain weight per tiller (Table 1). Varietal competitiveness was assessed by comparing the percentage change in yield component due to the presence of oats (Table 2) compared with oat-free control plots.

Table 2. Percentage change in yield components in the presence of oats.

Variety	Yield	Grain weight	Tillers/m²	Grains/tiller
Bass	0.2	−0.8	−11.4*	15.8*
Buloke	−0.6	−2.2*	−23.8*	18.3*
Commander	−15.4*	0.0	2.9	−9.7*
Compass	−19.3*	−3.1*	−9.9*	−19.1*
Fathom	−13.3*	1.0*	−26.3*	−0.1
Flinders	−12.4*	0.6	−16.1*	−2.2
Gairdner	−13.1*	−0.3	−13.0*	4.8*
GrangeR	−32.4*	−4.8*	−23.5*	−2.2
Hindmarsh	−18.5*	−0.5	−15.1*	4.4
La Trobe	−16.8*	−0.6	−13.7*	14.6*
Maritime	−10.5*	−3.2*	−21.5*	8.1*
Oxford	−23.1*	−4.5*	−26.6*	12.9*
Rosalind	−29.5*	−3.3*	−36.7*	6.1*
Scope CL	−14.24*	−1.4*	−20.1*	15.2*
Spartacus CL	−31.27*	0.8	−43.5*	23.3*
Urambie	−29.84*	−3.9*	−14.1*	8.9*
Westminster	−28.95*	−5.1*	−34.7*	8.5*
Wimmera	−29.74*	−5.1*	−5.3	−4.3

* indicates a significant ($P = 0.05$) treatment effect.

Varietal capacity to supress oats

Measuring dry oat biomass/m² at harvest demonstrated some correlation ($r^2 = 0.41$) with yield. While the capacity to suppress weed development is associated with reduced yield losses, some varieties, such as Flinders(ф) and Gairdner(ф) demonstrate small yield reductions with average oat suppression. Meanwhile, Fathom(ф) and Commander(ф) demonstrated the strongest capacity ($P<0.001$) to suppress oat development, although ranked sixth and eighth for yield losses in the presence of oats ($P = 0.007$) (Figure 2).

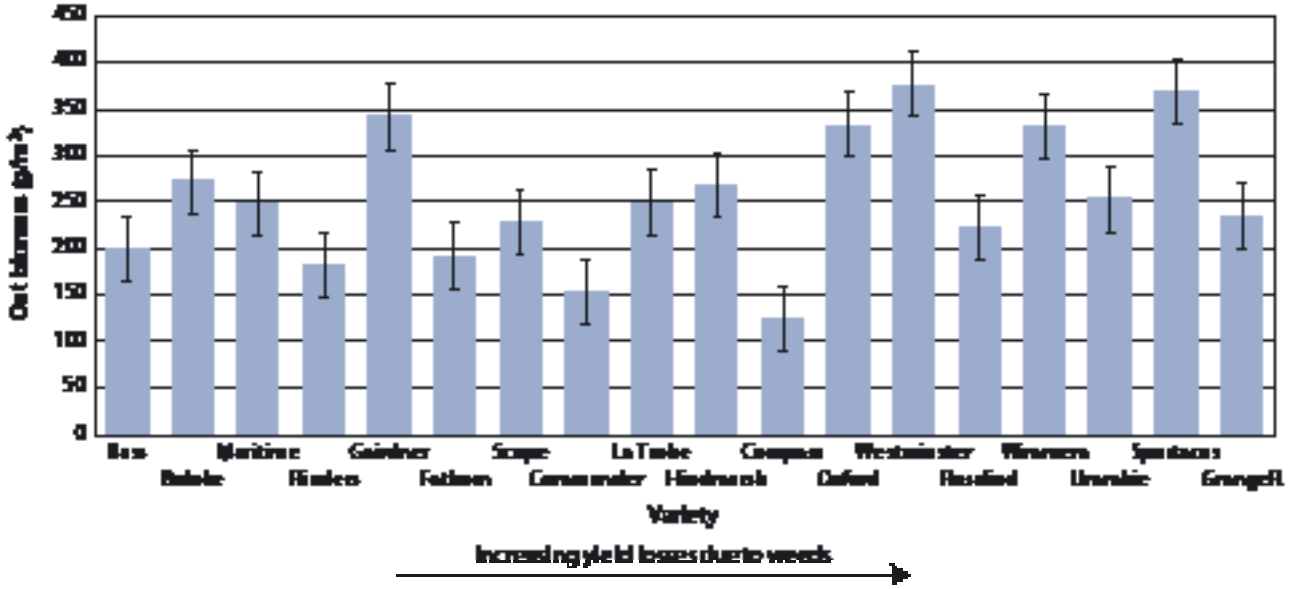

Figure 2. Total biomass of oats recorded within experimental plots. X axis ranked in order of the percentage yield loss for each respective variety in the presence of oats. Error bars indicate 5% l.s.d. between varieties for total oat biomass present per square metre.

While early season oat suppression is important for maximising yield, other mechanisms contribute to specific varieties' capacity to perform in the presence of oats. The normalised difference vegetation index (NDVI) was recorded for each plot on 11 June, at approximately GS21 with a Trimble hand-held GreenSeeker unit. NDVI can be used to assess photosynthetic

biomass, providing an indication of early season vigour. No correlation was found between early season NDVI scores and changes in yield and tillering as a result of oat presence, when compared with control, non-oat plots.

Summary

Water limitation at grain fill is commonly a major yield determinant in central western NSW, although record rainfall in June and September favoured longer-season varieties in 2016 in contrast to early-flowering varieties, which perform well in average rainfall seasons.

The barley varieties used in this experiment varied widely in morphology and phenology. Despite this variation and yield losses in oat treatments, there was no single trait that led to superior oat suppression. While oat suppression and high competitiveness in barley have previously been correlated with early season vigour and plant height (Watson et al. 2006), this experiment indicated that a combination of traits such as early season vigour, shading effects and environmental suitability contribute to oat suppression through diverse mechanisms.

References

Watson, PR, Derksen, DA & Van Acker, RC (2006). The ability of 29 barley cultivars to compete and withstand competition. *Weed Science* 54: 783–792.

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