# Barley varieties do not differ in their weed competitiveness at low yield loss

**Blakely Paynter[1], Raj Malik[2] and Jeremy Curry[3]**
Department of Agriculture and Food Western Australia, [1]Northam, [2]Katanning and [3]Esperance WA.

## Key messages

- Despite establishing >100 ryegrass plants/m$^2$ or >40 oat plants/m$^2$ in this weed competition study, the level of barley yield loss measured was less than 10%.
- At this low level of yield loss the barley varieties tested did not differ in their ability to suppress weed tiller production or in their grain yield loss due to the weed competition.
- At this low level of yield loss we were also unable to establish if varieties differed in their competitive ability against ryegrass versus against oats.
- Weed competition studies in eastern Australia using oat as a competitor suggest that barley varieties may differ in their weed competitiveness and that varieties like Compass and Fathom appear to be able to suppress oat production more than other barley varieties whilst maintaining their grain yield.

## Aims

Sowing competitive crops is one way of reducing weed seed set and the impact of weeds on crop performance. Barley is a competitive crop, being regarded as more competitive than wheat (Cousens 1996). When sowing barley you can increase its competitiveness by sowing it at a narrow row spacing (Figure 1), sowing it at a higher seeding rate (Figure 2) and by choosing a competitive variety (Paynter and Hills 2009). Paynter and Hills (2009) found that Baudin, Flagship, and Hamelin were more competitive with ryegrass than Buloke, Gairdner, and Vlamingh. The average yield loss of the more competitive varieties was 19±1% compared to 23±1% for the less competitive varieties. There was also a general trend of fewer ryegrass tillers in the more competitive varieties than in the less competitive varieties, although this trend was not observed at all sites.

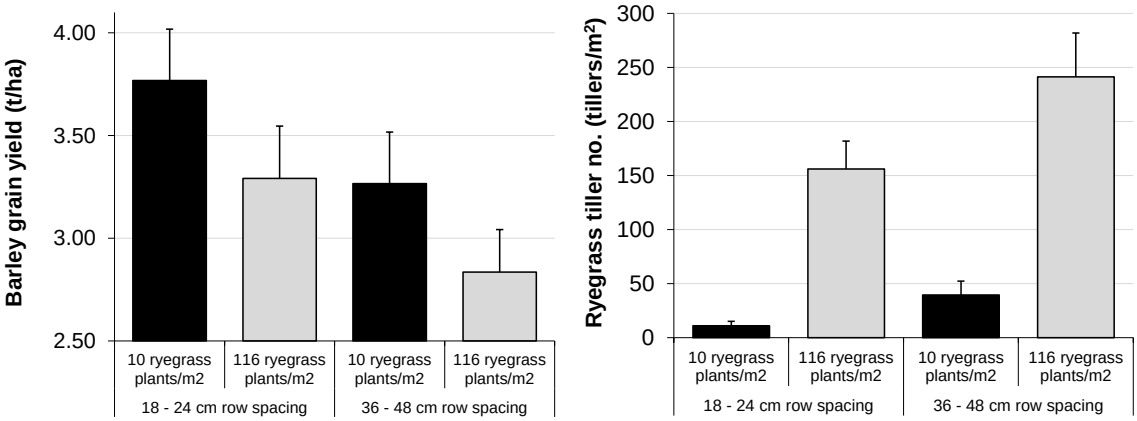


**Figure 1. Narrow row spacing increased barley grain yield and decreased ryegrass tiller number (Paynter 2010).**

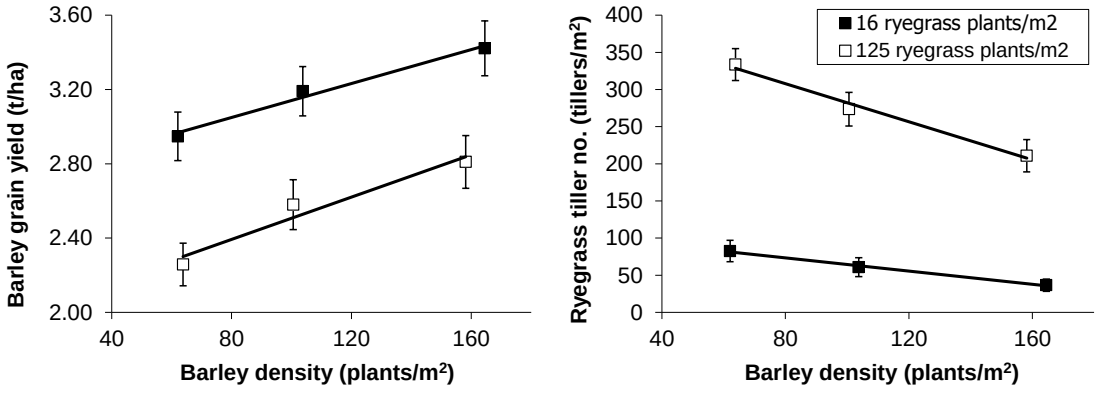


**Figure 2. Increasing barley plant density increased barley grain yield and decreased ryegrass tiller number (Paynter and Hills 2009).**

With a new suite of barley varieties (ie. Bass, Compass, Fathom, Flinders, Granger, La Trobe and Scope CL) now being grown, farmers are questioning the competitiveness of these new varieties. A common comment at field days is that Hindmarsh and La Trobe appear to be the least competitive against weeds. The aim of this study was to establish weeds, as per Paynter and Hills (2009) and Paynter (2010), to firstly look at the ability of different barley varieties to suppress weed seed set (through a reduction in tiller number), and secondly assess if current barley varieties differ in their grain yield loss in the presence of weed competition.

In the aforementioned studies conducted in Western Australia, ryegrass was the only species used as a competitor. In this study, oat was also added as a competitor due to results from a sister barley agronomy project (DAN00173) in eastern Australia that demonstrated differences in varietal competitiveness when 75 oat plants/m$^2$ were added to the plots (Craig *et al*. 2013; Porker and Wheeler 2013, 2014a, 2014b; Goss and Wheeler 2014, 2015). Their research suggests that the more competitive barley varieties against oat include Commander, Compass, Fathom and Fleet, whereas less competitive varieties include Gairdner, Granger, Hindmarsh and La Trobe (Figure 3). A third aim of this study therefore was to evaluate if the ranking of varieties for their competitiveness against oat was the same as against ryegrass.

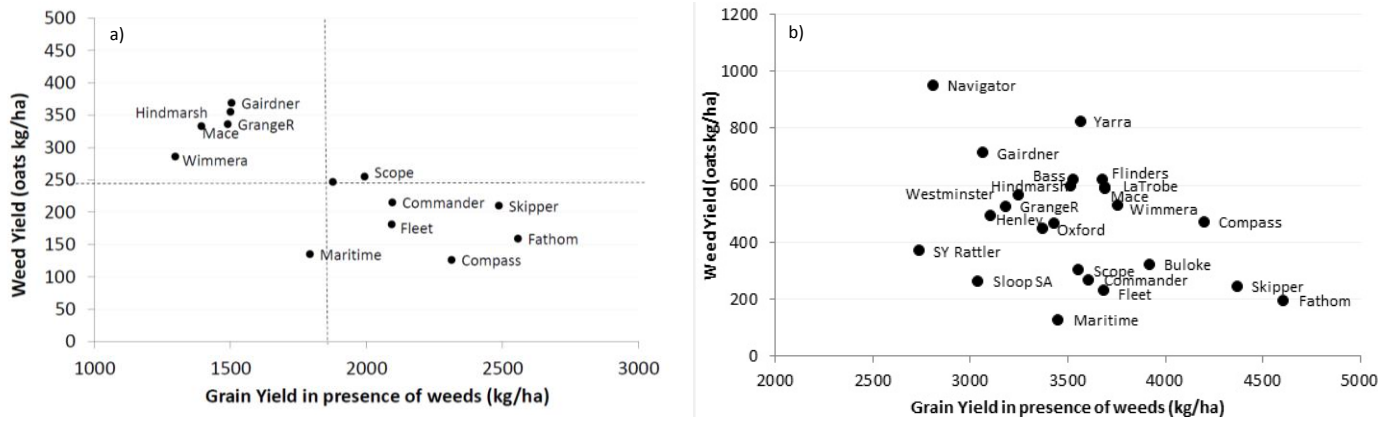


**Figure 3. Example of differences in the grain yield of barley varieties sown with oats at a) Karoonda, South Australia in 2013, barley LSD(p=0.05) = 325kg/ha and oat LSD(p=0.05) = 85kg/ha (Porker and Wheeler 2014a); and b) Turretfield, South Australia in 2013, barley LSD(p=0.05) = 445kg/ha and oat LSD(p=0.05) = 218kg/ha (Porker and Wheeler 2014b).**

## Method

Weed competition trials were established at nine sites (one in 2012, one in 2013, four in 2014 and three in 2015) to compare up to 12 barley varieties against three or four levels of weed competition. Common spring barley varieties sown at all nine sites were Bass, Compass, Flinders, Granger, La Trobe and Scope CL (Buloke sown in 2012 and 2013 instead of Scope CL). Other varieties assessed (at between one to six sites) included Baudin, Commander, Fathom, Henley, Hamelin, Skipper, Vlamingh and Wimmera. Only data for the six common varieties is presented.

Each site was sown into canola stubble (targeting a low background grass burden) and was sprayed with a knockdown herbicide before seeding but no IBS or post-emergent grass-selective herbicides were applied. Each site was direct-drilled with a small plot air-seeder using knife points and on-row packing (press wheels). Weeds were top dressed in front of the seeding bar and the fungicide treated barley seed (targeting an establishment of 150plants/m$^2$) was placed at 2–3cm depth. Target weed densities were nil weeds, 100 ryegrass plants/m$^2$ (cv. Safeguard), 200 ryegrass plants/m$^2$ (cv. Safeguard) and 75 oat plants/m$^2$ (cv. Williams or Wintaroo). Safeguard ryegrass was used as it has a flowering date similar to the native ryegrass ecotype Wimmera and has no known resistance to grass selective herbicides (Abul Hashem, pers. comm.). An NPK blended fertiliser was banded below the seed. Plots were hand top dressed with nitrogen as urea at four to eight weeks after sowing (WAS). Post-seeding a broadleaf only herbicide was used to control canola and other broad leaf weeds. Leaf diseases were controlled as required.

After seeding barley (2 WAS) and weed (4 WAS) establishment counts were conducted. Plots were assessed by NDVI at 6, 10 and 14 WAS using a hand-held Greenseeker®. In spring, weed suppression was determined by measuring barley and weed tiller numbers in three 50cm x 50cm quadrats per plot. At harvest, weed competition was measured by determining barley plant height (to base of ear), barley grain yield and assessing the barley grain for grain quality (sample >1.5mm). In plots containing oat as a weed competitor, the barley and oat grain were separated by hand from the harvest collected sub-sample to calculate the grain yield of oat and the grain yield of barley. The cleaned barley sample was then used for grain quality analysis.

Data was analysed within Genstat (VSN International 2013) with a treatment structure of 6 or 12 varieties x 3 or 4 weeds, a block structure of (rep+colrep)/variety/weeds and a treatment structure of variety*weeds. Each site was sown as six banks of 10m plots with two banks per replicate and a total of three replications per treatment.

## Results

### *Weed establishment*

Background grass weed levels (typically ryegrass) at all sites except 14GS28 were low, averaging 5 grass weeds/m$^2$ (Table 1). 14GS28 was excluded from further analysis in this paper due to the high background grass weed burden. Average weed establishment in the 100 ryegrass treatment was 131 ryegrass plants/m$^2$ (average of eight sites) (Tables 1 and 2). Unfortunately in 2014, the second bag of ryegrass seed sourced for packing the 200 ryegrass treatment had low viability resulting in a low germination. Average weed establishment (excluding the 2014 season sites) in the 200 ryegrass treatment was 277 ryegrass plants/m$^2$ (average of five sites). In the 2014 and 2015 season trials, where oat was also included as a weed competitor, average weed establishment in the 75 oat treatment was 47 plants/m$^2$ (average of six sites).

**Table 1. Trials details for the nine barley agronomy weed competition trials.**

| Trial number | Location | Sown | May-Oct rainfall | Grass weed establishment (plants/m$^2$) | | | | Soil type |
|---|---|---|---|---|---|---|---|---|
| | | (date) | (mm) | nil | 100 ryegrass | 200 ryegrass | 75 oats | |
| 12GS33 | Katanning | 28-Jun-12 | 274 | 15 | 85 | 171 | - | dark brown shallow sandy duplex |
| 13GS43 | Katanning | 05-Jun-13 | 353 | 2 | 48 | 82 | - | brown duplex sandy gravel |
| 14WH20 | Wongan Hills | 16-May-14 | 276 | 0 | 135 | 13 | 64 | brown sandy earth |
| 14NO41 | Cunderdin | 13-May-14 | 195 | 0 | 113 | 1 | 72 | alkaline grey shallow sandy duplex |
| 14GS28[1] | Katanning | 30-May-14 | 372 | 176 | 252 | 301 | 215 | brown shallow sandy duplex |
| 14ED29 | Gibson | 02-Jun-14 | 433 | 0 | 75 | 4 | 40 | pale sandy earth |
| 15WH19 | Wongan Hills | 22-May-15 | 315 | 0 | 217 | 391 | 28 | brown sand over lateritic gravel |
| 15NO23 | Cunderdin | 21-May-15 | 167 | 21 | 269 | 455 | 50 | yellow sandy earth |
| 15ES12 | Gibson | 07-May-15 | 314 | 2 | 111 | 206 | 28 | grey deep sandy duplex |

[1]14GS28 excluded from further analysis due to high background weed burden.

### *Biomass and plant growth*

Adding weeds (ryegrass or oat) to the barley plots increased the number of weeds that emerged in the treated plots (Table 2), increased plot biomass (as measured by NDVI), increased the number of weed tillers present during spring, but had no effect on the establishment of barley (data not shown). Weed biomass and weed tiller number was not influenced by the variety sown (despite differences in their early vigour), nor did varieties differ in their decline in tiller number due to the weed competition. Weed competition had minimal effect on barley height and its risk of lodging.

Oat and ryegrass tiller number measured in spring was similar to the number of emerged plants (Table 2). Doubling the density of ryegrass sown resulted in double the number of ryegrass tillers, but only a 5% decrease in the number of barley tillers produced (averaged across five sites). The 75 oat treatment had a larger effect on barley tiller numbers than the 100 ryegrass treatment, being significant at 50% of sites (14WH20, 14NO41 and 15ES12).

**Table 2. a) likelihood of variety, weed competition and their interaction being significant (p<0.05) on plant growth traits across eight trials (excluding 14GS28). Significance: rarely = occurred in ≤20% trials, occasionally = 20-40% trials, 50% chance = 40-60% trials, often = 60-80% trials and consistently = ≥80% trials significant; and b) NDVI and plant growth in the absence or presence of weeds (average of Bass, Compass, Flinders, Granger, La Trobe and Scope CL).**

| **a) Likelihood of variety, weed competition and their interaction being significant (p<0.05)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Crop | Weeds | Barley | Barley | Barley | Barley | Weeds | Barley | Barley |
| Trait | Weed number | NDVI - 6 WAS | NDVI - 10 WAS | NDVI - 14 WAS | Tiller number | Tiller number | Plant height | Lodging |
| Source | (plants/m$^2$) | (0-1) | (0-1) | (0-1) | (tillers/m$^2$) | (tillers/m$^2$) | (cm, ear base) | (9-0) |
| Variety (V) | rarely | consistently | consistently | often | often | occasionally | consistently | consistently |
| Weeds (W) | consistently | often | 50% chance | often | often | consistently | occasionally | rarely |
| V x W | rarely | rarely | occasionally | rarely | rarely | rarely | rarely | rarely |
| **b) Average biomass and plant growth in the absence or presence of weeds** | | | | | | | | |
| 8 sites (2012, 2013, 2014 and 2015) | | | | | | | | |
| Nil weeds | 5 | 0.477 | 0.699 | 0.679 | 515 | 6 | 62 | 7.8 |
| 100 ryegrass | 131 | 0.483 | 0.705 | 0.695 | 502 | 125 | 62 | 7.7 |
| 5 sites (2012, 2013 and 2015) | | | | | | | | |
| Nil weeds | 7 | 0.437 | 0.727 | 0.730 | 552 | 9 | 67 | 7.5 |
| 100 ryegrass | 157 | 0.445 | 0.732 | 0.737 | 544 | 152 | 66 | 7.5 |
| 200 ryegrass | 277 | 0.458 | 0.740 | 0.744 | 520 | 274 | 66 | 7.4 |
| 6 sites (2014 and 2015) | | | | | | | | |
| Nil weeds | 4 | 0.530 | 0.739 | 0.716 | 579 | 3 | 63 | 7.7 |
| 100 ryegrass | 152 | 0.535 | 0.744 | 0.733 | 572 | 146 | 63 | 7.6 |
| 75 oats | 47 | 0.543 | 0.744 | 0.730 | 547 | 42 | 63 | 7.5 |

*Grain yield and grain quality*

Weed competition consistently reduced grain yield, with the reduction in grain yield averaging 4% in the 100 ryegrass treatment (average eight sites), 5% in the 200 ryegrass treatment (average five sites) and 7% in the 75 oat treatment (average six sites) (Table 3). At this low level of yield loss, there was no evidence of differences in grain yield decrease due to the weed competition in the barley varieties evaluated.

At the sites where both the 100 and 200 ryegrass treatment established, the average yield loss (average five sites) in the 100 ryegrass treatment was 3% compared to 5% for the 200 ryegrass treatment (Table 3). The yield loss in the 200 ryegrass treatment was significantly higher in two of the five sites (13GS43 and 15ES12) and the same in the other three sites.

Despite averaging less than the target density of 75 oat plants/m$^2$ (Table 1), the 75 oat treatment (six site average of 47 plants/m$^2$) was similar to or more competitive than the 100 ryegrass treatment (six site average of 152 plants/m$^2$). The average yield loss (average six sites) in the 75 oat treatment was 5% compared to 3% for the 100 ryegrass treatment (Table 3). The yield loss in the 75 oat treatment was significantly higher than the 100 ryegrass treatment in two of the six sites (14ED29 and 15ES12) and the same in the other four sites.

Whilst there was a trend towards reduced kernel weight, decreased hectolitre weight and increased screenings in the presence of weed competition, the impact was small and present at 50% or less of the sites. There was little effect of weed competition on grain protein and grain brightness, but grain protein yield declined in line with the decrease in grain yield.

**Table 3. a) likelihood of variety, weed competition and their interaction being significant (p<0.05) on grain yield and grain quality traits across eight trials (excluding 14GS28). Significance: rarely = occurred in ≤20% trials, occasionally = 20-40% trials, 50% chance = 40-60% trials, often = 60-80% trials and consistently = ≥80% trials significant; and b) grain yield and grain quality in the absence or presence of weeds (average of Bass, Compass, Flinders, Granger, La Trobe and Scope CL).**

| **a) Likelihood of variety, weed competition and their interaction being significant (p<0.05)** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Crop | Barley | Oat[1] | Barley | Barley | Weeds | Barley | Barley | Barley |
| Trait | Grain yield | Grain yield | Kernel weight | Hectolitre weight | Screenings | Grain brightness | Grain protein | Protein yield |
| Source | (t/ha) | (t/ha) | (mg, db) | (kg/hL) | (% < 2.5 mm) | ('L*) | (%, db) | (t/ha) |
| Variety (V) | 50% chance | occasionally | consistently | consistently | consistently | consistently | often | occasionally |
| Weeds (W) | consistently | consistently | 50% chance | 50% chance | 50% chance | rarely | occasionally | often |
| V x W | rarely | occasionally | occasionally | rarely | occasionally | rarely | rarely | rarely |
| **b) Average grain yield and grain quality in the absence or presence of weeds** | | | | | | | | |
| 8 sites (2012, 2013, 2014 and 2015) | | | | | | | | |
| Nil weeds | 4.00 | - | 41.1 | 71.2 | 16.4 | 60.3 | 10.9 | 0.44 |
| 100 ryegrass | 3.83 | - | 40.7 | 71.0 | 17.0 | 60.4 | 10.8 | 0.42 |
| 5 sites (2012, 2013 and 2015) | | | | | | | | |
| Nil weeds | 4.37 | - | 39.9 | 70.9 | 25.6 | 61.8 | 11.8 | 0.51 |
| 100 ryegrass | 4.22 | - | 39.6 | 70.7 | 26.5 | 61.8 | 11.8 | 0.50 |
| 200 ryegrass | 4.14 | - | 39.7 | 70.8 | 25.5 | 61.9 | 11.6 | 0.48 |
| 6 sites (2014 and 2015) | | | | | | | | |
| Nil weeds | 4.02 | 0.00 | 40.9 | 71.1 | 17.1 | 60.2 | 11.1 | 0.46 |
| 100 ryegrass | 3.86 | 0.00 | 40.6 | 70.9 | 17.6 | 60.3 | 10.9 | 0.44 |
| 75 oats | 3.74 | 0.15 | 40.2 | 71.2 | 17.2 | 60.3 | 11.1 | 0.43 |

[1]six sites only.

## Conclusion

At low levels of yield loss (<10%), no differences between a range of new barley varieties, including Hindmarsh and La Trobe, were observed in terms of their ability to suppress weed seed set (through reduced tiller number), their grain yield loss in the presence of weeds, or in their response to the competition from oat versus ryegrass.

Based on previous research (ie. Paynter and Hills 2009 and Paynter 2010), yield losses in excess of 10% would have been expected given the densities of ryegrass and oat established in the plots. It is postulated that with the drier starts to the seasons of 2012 to 2015 the barley seed was sown into sufficient moisture which allowed it to germinate ahead of the weed seeds in the drier surface soil, giving the emerging barley a competitive advantage relative to the weeds. Despite high numbers of weed tillers being recorded in spring, the early competitive advantage of barley carried through resulting in minimal yield losses and a minimal change in grain quality in the presence of weeds. Burke (2009) and Hashem *et al*. (2010) also found it difficult to detect varietal differences in weed competition or variability in competitiveness across sites. At higher yield losses we postulate that we may have observed differences in weed competitiveness between varieties.

Given that the 75 oat treatment was similar to or more competitive than the 100 ryegrass treatment (noting the low yield losses observed in this study), future weed competition studies could use oat as the competitor as sowing oat is more amenable for on-farm testing than sowing ryegrass. Research in eastern Australia has shown that varietal differences in competitiveness do exist when under sown with oat. Craig *et al*. (2013); Porker and Wheeler (2013, 2014a, 2014b) and Goss and Wheeler (2014, 2015) suggest that Compass and Fathom are generally more grass weed competitive than Granger, Hindmarsh and La Trobe. It is worth noting, however, the variability in their site to site and season to season observations. Whilst differences in barley's competitiveness may be observed, integrated weed management packages which reduce weed seed set and therefore the number of weeds that emerge in-crop will ensure that barley's yield and grain quality is maximised given seasonal constraints.

Should further studies be undertaken to assess the weed competitiveness of different barley varieties using oat as the competitor two things should be considered. Firstly, the target density of oat should be increased from 75 to 150 plants/$m^2$, due to the low germination of topdressed oat in a minimal disturbance seeding system. Secondly, as the separation of oat from barley in the harvested sub-sample is a time consuming job, optical sorters should be evaluated as they may reduce the time required to accurately separate the oat and barley kernels.

Whilst not addressed in this study, previous research in Western Australia has suggested that early biomass and plant height may not be primary contributors to the barley phenotype that is competitive against weeds like ryegrass, with Paynter and Hills (2009) suggesting that allelopathy may be a key factor in the ability of different barley varieties to suppress weeds.

## References


Burke K (2009). Management effects on barley varieties – row spacing, nitrogen and weed competition. BCG 2009 season research results pp. 84-96.

Cousens RD (1996). Comparative growth of wheat, barley and annual ryegrass (*Lolium rigidum*) in monoculture and mixture. *Australian Journal of Agricultural Research* 47:449–464.

Craig S, Walters L and Jones B (2013). Is Hindmarsh really a poor weed competitor? BCG 2013 season research results pp. 76-80.

Goss S and Wheeler R (2014). Weed competitiveness of barley varieties. Mallee Sustainable Farming research archive. Available: msfp.org.au/wp-content/uploads/Goss_Weed-Competitiveness-of-Barely-Varieties.pdf.

Goss S and Wheeler R (2015). Using crop competition for weed control in barley and wheat. 2015 GRDC SA Grains Research Update, Adelaide, SA, 10-11 Feb 2015.

Hashem A, Borger CPD and Riethmuller G (2010). Weed suppression by crop competition in three crop species in Western Australia. 17th Australasian Weeds Conference, Christchurch, New Zealand, 26-30 Sept 2010.

Paynter BH and Hills AL (2009). Barley and rigid ryegrass (*Lolium rigidum*) competition is influenced by crop cultivar and density. *Weed Technology* 23:40–48.

Paynter BH (2010). Wide row spacing and rigid ryegrass (*Lolium rigidum*) competition can decrease barley yield. *Weed Technology* 24:310–318.

Porker K and Wheeler R (2013). Barley agronomy update. Mallee Sustainable Farming research archive. Available: msfp.org.au/wp-content/uploads/2013-Karoonda-FD-Booklet.pdf.

Porker K and Wheeler R (2014a). Barley varieties differ in weed competiveness. Mallee Sustainable Farming research archive. Available: msfp.org.au/wp-content/uploads/Barley-Varieties-differ-in-weed-competiveness.pdf.

Porker K and Wheeler R (2014b). Getting the best from barley; agronomy and management. 2014 GRDC SA Grains Research Update, Adelaide, SA, 25-26 Feb 2014.

VSN International (2013). GenStat for Windows 16th Edition. VSN International, Hemel Hempstead, United Kingdom.



## Key words

Barley, weed competition, ryegrass, oat

## Acknowledgments

Technical support was provided by Sue Cartledge, Rod Bowey and Rachel Brunt and the DAFWA Technical Service teams at Wongan Hills, Northam, Katanning and Esperance. The research conducted at the DAFWA's research farms at Wongan Hills, Katanning and Gibson and Chris Syme, Cunderdin. This research is supported by the Department of Agriculture and Food Western Australia with co-funding from the Grains Research and Development Corporation. Linda Walters, BCG and Georgie Troup, DAFWA provided feedback on a draft of this paper.

**GRDC Project Number: DAW00224**