Effect of grain size on the competitive ability of wheat

Gurjeet Gill and Michael C. Zerner

The University of Adelaide, Roseworthy Campus, SA 5371. www.adelaide.edu.au
Email gurjeet.gill@adelaide.edu.au michael.zerner@adelaide.edu.au

Abstract

During the growing season of 2005, a field experiment evaluating the effects of grain size on the competitive ability of wheat was undertaken at Roseworthy, South Australia. Competitiveness of five commercial wheat cultivars (cvs. Frame, Janz, Krichauff, Wyalkatchem, and Tamaroi) was evaluated by their ability to maintain yield in the presence of oats (a surrogate for weeds) and the ability to suppress oat seed-set. Wheat seedling establishment across all genotypes was significantly reduced when medium (5%) and small sized (17%) grain were sown. The improved crop establishment and early vigour associated with the larger grain size with all cultivars was reflected in higher early leaf area indices. Large grain was found to increase yields and the ability of wheat to maintain yield in the presence of oats. This was observed across all genotypes, however some cultivars were affected more severely than others by the presence of oats (Frame reduced by 41.7% and Janz by 50.8%). There was a strong relationship between oat seed-set and wheat yield, such that the combinations of cultivar and grain size that yielded higher generally had lower amounts of oat seed-set. This study has shown that the use of larger grain at sowing can significantly benefit wheat yield and aid weed management by reducing the levels of weed seed-set.

Key words

Grain size, early vigour, weeds, competition.

Introduction

Wheat is a known poor competitor with weeds compared to other crop species, causing it to be the weak link in many crop rotations. Improving the competitive ability of wheat with weeds has become more important in recent times due to increasing herbicide resistance. This has lead to greater acceptance of integrated weed management approaches to reduce the current reliance on herbicides. Such approaches have involved the use alternative agronomic (Sloane *et al*. 2004) and breeding (Rebetzke and Richards 1999) strategies to improve the competitiveness of wheat. Large grain in past studies has been shown to improve seedling vigour (De Marco 1990; Richards and Lukacs 2002), leading to potential improvements in competitiveness with weeds through increased early growth rates (Xue and Stougaard 2002). This study measured the impact of grain size of commercial wheat cultivars on their ability to tolerate or suppress weeds.

Materials and Methods

A field study was conducted at Roseworthy, South Australia (34.3^{o}S, 138.4^{o}N) during 2005 to evaluate the competitiveness of four commercial bread wheat (*Triticum aestivum*) cultivars, Frame, Janz, Krichauff, Wyalkatchem and one durum (*Triticum durum*) cultivar, Tamaroi. For each cultivar grain was classified into the three size classes, small, medium and large, relative to the grain size of the cultivar (Average grain sizes were as follows; small: 23-27 mg, medium: 31-37 mg, large: 40-53 mg). The treatments were sown with and without weeds using a strip-plot design. Wheat was sown at 180 viable grains/m^2 with 105 kg/ha of DAP, using a cone seeder and weed treatments had oats (*Avena sativa, cv*. Marloo) sown as the weeds surrogate at a rate of 20 kg/ha. Various measurements were recorded, including plant densities, leaf area index (LAI), number of ears/panicles and yield of wheat and oats. The data was analyzed using analyses of variance with the statistical program, GenStat 6.

Results and Discussion

Grain size had a strong influence on emergence across all wheat cultivars used in the study, with larger grain size significantly improving emergence (Table 1). Treatments were compared for early vigour using two LAI measurements. At 45 days after sowing there were no significant differences in LAI between grain sizes. The follow up measurement at 60 days after sowing showed significant differences between grain sizes across all cultivars (Table 1). Higher LAI was reflective of the higher plant establishment and greater early vigour.

Wheat yields were influenced by the grain size, cultivar and weed status (Table 1). Yields between wheat cultivars were significantly influenced by weed status, indicating the different competitive abilities between each of the cultivars with Frame being the most competitive. There was a significant interaction between grain size and cultivar (p=0.01), which could have been due to high sensitivity of Krichauff to grain size (data not presented). It appears that the early differences in emergence and LAI due to grain size were carried through to grain yield. The results obtained suggest that on-farm yield gains can be achieved by paying attention to the grain size to be used for sowing. Using larger grain sizes improved the competitiveness of wheat with oats, as shown by the significant interaction between grain size and weed status. Therefore increasing the grain size has the potential to improve the ability of wheat to tolerate weed competition (lower yield losses).

The results on oat seed production indicated significant differences between cultivars and grain size but no interaction. Cultivars that suffered greater the yield loss from the presence of weeds, also allowed higher seed production by oats (Table 1). Improved tolerance of wheat to weeds also enhanced its ability to suppress weed seed production. Therefore, increased grain size of wheat not only improved wheat yields through weed tolerance, it also significantly aided weed management through increased weed suppression.

Table 1. Influence of wheat cultivar and grain size on the Leaf Area Index (LAI) and yields of wheat and oats.

Treatment	Emergence	LAI		Wheat grain yield (t/ha)			Oat yield
?	(plants/m^2)	45 DAS	60 DAS	No oats	Oats	Yield loss (%)	(t/ha)
Cultivar							
Frame	157	0.32	2.06	5.3	3.1	41.7	0.58
Janz	154	0.22	1.86	5.3	2.6	50.8	0.86
Krichauff	155	0.21	1.82	4.1	2.1	49.4	0.66
Tamaroi	135	0.24	1.72	5.6	3.1	45.3	0.92
Wyalkatchem	140	0.18	2.01	5.8	2.9	49.4	0.95
l.s.d. (*P*<0.05)	NS	0.09*	0.22*	0.23*	0.23*	-	0.10***

Grain size							
Large	160	0.33	2.05	5.4	3.2	39.9	0.71
Medium	152	0.22	1.92	5.4	2.7	49.3	0.77
Small	133	0.16	1.71	4.9	2.3	53.1	0.91
l.s.d. (*P*<0.05)	18.2*	NS	0.17*	0.76*	?0.76*	?-	0.15*

NS: Not significant; *: Significant at *P*<0.05; ***: Significant at *P*<0.001.

Conclusion

Grain size had a strong influence on the competitive ability of wheat. It significantly improved establishment and early leaf area development. These differences in early growth were carried through to benefit crop yields in the presence of weeds. By sowing with larger grain wheat yields were significantly improved in the presence of weeds as a result of improved competitive ability. Large grain also improved the ability of wheat to suppress weed growth as oat yields and panicle densities were reduced. Therefore wheat's ability to tolerate as well as suppress weeds was improved by using large grain. In practical terms, the results indicate that grain selection for sowing can become an important tool in weed management.

References

De Marco, D.G. (1990) Effect of seed weight, and seed phosphorus and nitrogen concentrations on the early growth of wheat seedlings. *Australian Journal of Experimental Agriculture* **30**, 545-549.

Rebetzke, G.J. and Richards, R.A. (1999) Genetic improvement of early vigour in wheat. *Australian Journal of Agricultural Research* **50**, 291-301.

Richards, R.A. and Lukacs, Z. (2002) Seedling vigour in wheat – sources of variation for genetic and agronomic improvement. *Australian Journal of Agricultural Research* **53**, 41-50.

Sloane, D.H.G., Gill, G.S. and McDonald, G.K. (2004) The impact of agronomic manipulation of early vigour in wheat on growth and yield in South Australia. *Australian Journal of Agricultural Research* **55**, 645-654.

Xue, S. and Stougaard, R.N. (2002) Spring wheat seed size and seedling rate affect wild oat demographics. *Weed Science* **50**, 312-320.