Agronomic responses of six barley varieties to different plant populations - an old question revisited

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Abstract

Final grain yield and associated grain quality are influenced by field plant population of commercial barley crops. Anecdotally, commercial plant populations range from 0.5 to 1.0 million plants per hectare, and are often at the lower end of the range, limiting potential yield and having a negative effect on grain quality. In 2002 and 2003 replicated barley yield and grain quality trials with different plant populations were conducted in Southern Queensland and Northern New South Wales, with different plant populations. Each trial had six entries of released or soon to be released barley cultivars, planted at targeted field plant populations of 0.4, 0.8, 1.2, 1.6, and 2.0 million plants per hectare. Grain quality parameters measured were plump grain, screenings and protein. The different plant populations had a significant effect on yield, protein, plump grain and screenings. Further trials are being planned for 2004 to clarify this response with regard to specific barley cultivars.

Media summary

Commercial field plant populations in barley crops are being investigated to support specific varietal management recommendations. Differences were found between six barley cultivars and research directed towards more definitive cultivar differences is continuing in 2004/5.

Key Words

Plant population, yield, grain protein, plump grain, grain screenings, varietal differences.

Introduction

Although awareness of the effect of plant population on barley grain yield and quality has been part of crop management decisions in the past, the GRDC funded Eastern Barley Agronomy Research Project, which commenced in July 2002, has identified grower and adviser concerns with quantification of this effect across the suite of commercial barley varieties in the Northern Region. The project hopes to define how this specific agronomic parameter can be better used as a successful tool in improved on farm profitability and long term economic sustainability. Trial results from 2002 at Formartin and Roma in Southern Queensland suggested further work on barley plant populations was justified. A decision was made to plant barley population yield trials at Tara on the Western Downs and Clifton on the South-eastern Downs, as well as Breeza in NSW. The Tara site is a grey vertosol derived from brigalow scrub and Clifton is a site with heavy alluvial soil showing some level of salinity at 0.8 metres below the soil surface (Dalgliesh and Foale 1998). Barley is a commonly grown winter cereal in the Clifton area, while in the Tara area barley is becoming attractive in comparison to wheat as a winter cereal, due to decline in the natural fertility of cropping soils, and increased promotion of barley as a preferred grain in beef cattle feedlots. Information from the plant population trials is to be incorporated into varietal management guidelines, following the West Australian model for specific varietal wheat recommendations for the different WA soil and rainfall environments.

Methods

Site characterisation and logistics of trial implementation

In 2003 soil measurements of site N and P were taken to a depth of 1.2 metres at both QLD sites with additional measurement of Cl, Ec and pH at Clifton. The Clifton site has been known to always have some level of subsoil hostility due to marginal salt toxicity, which is why a barley/sorghum rotation has historically been the most popular choice of local producers. A photo of the Clifton site is included below.

The Tara site was not tested for subsoil constraints, although recent communication with a soil research scientist suggests the area around the trial site has potential to develop problems, and is classified with concern on the recent Qld salinity hazard map. Agronomy trial sites in 2003 were positioned as an extension of barley breeding trial sites to take advantage of logistic efficiency when travelling, maintaining and harvesting the agronomy trials. The Breeza site is at the Northern end of the Liverpool Plains in NSW. The site is on a research station and is an alluvial soil with access to flood irrigation whenever necessary.

Trial design and preparation before planting

The plant population trial plots in Qld were 2.1m x 12 m (harvested), while those in NSW were similar dimensions. The plant populations were 0.4, 0.8, 1.2, 1.6 and 2.0 million plants/ha. Having the breeding trials immediately adjacent to the agronomy trials, and planted at a targeted population of 1.0 million plants/ha, allowed for useful visual comparisons. Site nitrogen nutrition was targeted for a maximum yield of 4t/ha, and phosphorus was applied as superphosphate at planting at Tara, so as to be at >20 units/ha. The site at Tara and the surrounding area normally shows a response to applied P, with historical soil levels in the top 10 cms being typically 7-10 units/ha. The Clifton site is naturally high in phosphorus.

All barley cultivars were germination tested to ensure the accuracy of the targeted trial plant populations was maximised. The barley cultivars in the trial, with some comment, are listed below.

Binalong- NSW feed
Cowabbie- Potential NSW malting
Gairdner- WA malting
Grimmett- Qld malting
Mackay- Qld feed
Cameo*Arupo 31-04- Potential Qld feed and Domestic malting.
Grain protein is expressed as a percentage (dry basis), screenings is % by weight below a 2.2 mm screen, and plump grain is % by weight retained on a 2.5 mm screen.

Results

The plant population by genotype trials at the three sites showed a significant genotype effect on yield and the three quality characteristics, and a significant plant population effect on yield and the three quality characteristics. One of the analysis tables (Table 1.) below illustrates the analysis for the yield (t/ha) at the Queensland site of Tara. Similar tables are available to confirm the same significance for genotype and plant population with regard to grain protein (dry basis), plump grain and grain screenings. The combined analysis of the three sites (Breeza, Clifton and Tara) for Genotype*Plant Population interaction concluded there was evidence of a Genotype*PP interaction that was similar across all sites, but this was not statistically significant for either the individual or combined sites.

Graphs were generated for the four characteristics to illustrate the different responses to plant population at the different sites. (Figure 1.) These are included on page 4. Graphs have also been generated showing how each of the different varieties responded to plant population with regard to each of the four measured characteristics. These are not included due to space limitations. This information is to be used in the barley management packages developed at the end of the GRDC Eastern Barley Agronomy Research Project.

Table 1. Grain yield of genotypes for combined plant populations and plant populations for combined cultivars - Tara

Genotype	Yield (t/ha)	
COWABBIE	1.6935	
CAMEOA3104	2.0855	
GRIMMETT	1.8754	sig
GAIRDNER	1.8106	
MACKAY	1.9719	
BINALONG	1.7729	

SED: Overall Standard Error of Difference 0.5553E-01

Plant Population **x 10^6/ha**	**Yield**	
0.4	1.6909	sig
0.8	1.8934	

1.2	1.9386
1.6	1.9373
2	1.8814

SED: Overall Standard Error of Difference 0.5314E-01

Conclusion

There was a significant genotype effect, and plant population effect on yield The graphs shown below for the yield and quality illustrate barley is responsive to plant populations between 0.8 and 1.2 million plants /ha (the responses extended beyond these Plant Populations) with a fairly flat response at the lower yielding sites of Clifton and Tara. Yield at the irrigated Breeza site was the most responsive to plant population. This general trend contrasts with a wheat response that is usually more flat and shows more compensation in tiller number at different plant populations. (Butler, G., Sturgess, J., et al 2004) In a general sense grain protein remained flat or decreased with increasing plant population, screenings increased and plump grain decreased. Yield plateaued at a plant population of 1.2 million plants/ha. The increase in measured grain protein at the 0.8 million plants/ha population at Tara could be seen as the effect of a scrub soil that shows reasonable nitrogen fertility and a response to applied phosphorus. Anecdotally Qld barley trials grown on sites with non limiting N and P still result in grain protein only slightly above the malting maximum of 12% protein on a wet grain basis. Those grown with adequate N and limiting P have a higher relative grain protein. The high grain protein at the Clifton site reflects a very low yield for this environment, while the yield and protein at the Tara site are average for a June planted trial, on a scrub soil suffering from gradual fertility decline.

Although not illustrated in graphs, the six different varieties showed differences between varieties with regard to the four characteristics. One particular difference was the capacity of Cameo*Arupo 31-04 to deposit approximately a 1% lower grain protein under both high and low applied fertilizer regimes (Figure 2). This characteristic is important if the variety is to be accepted as a domestic malting variety. Although these results are not unexpected, they are very important as a basis for developing specific varietal management packages, which is the main aim of the future work in the Eastern Barley Agronomy Project.

References

Butler G, Sturgess J et al. (2004). “Wheat and Barley Trials in 2003, Interactions with N rate, plant population and sowing date. GRDC Grains Research Update

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Figure 1. Yield and Quality Parameters at 2002/03 Barley Agronomy Sites

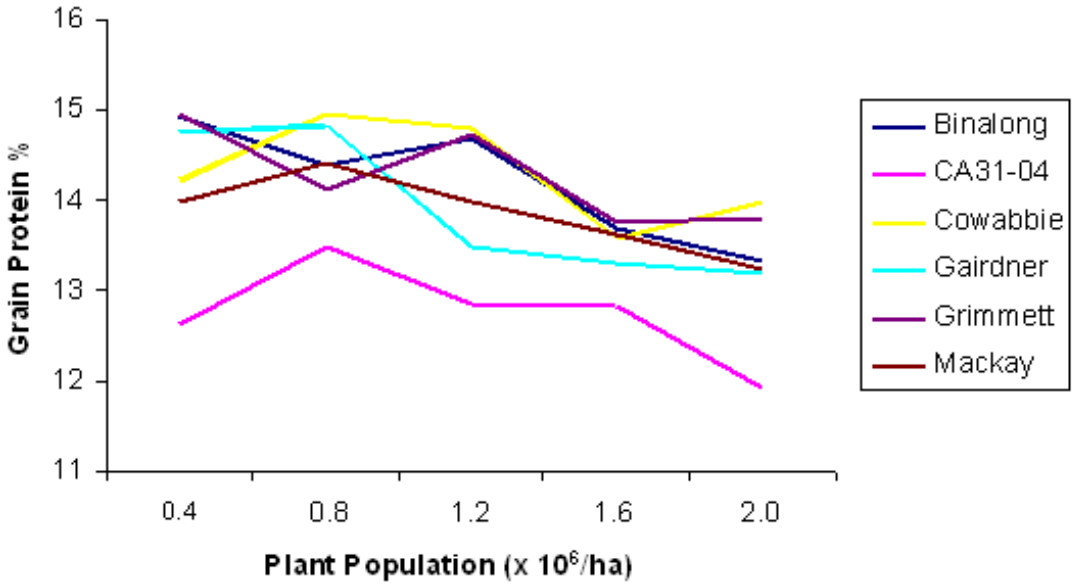

Figure 2. Plant Population x Genotype Interaction for High N Agronomy Site