Barley agronomy – nitrogen management in new barley varieties

Southern Barley Agronomy Project, funded by GRDC
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Key findings

- Higher grain yields were achieved in all varieties from early sowing in 2011.
- Buloke and Commander were not yield responsive to nitrogen despite early biomass responses at both sowing dates.
- Hindmarsh was more responsive to nitrogen than Buloke and Commander, showing an average 0.6 t/ha response to nitrogen across both sowing dates.
- Grain protein exceeded 12% with delayed sowing, while the strategic approach to applied N achieved protein levels less than 12% at earlier sowing in Buloke and Commander.

Why do the trial?

New higher yielding malt varieties Buloke and Commander have been downgraded more frequently for low protein than other varieties in recent years. In order to increase the frequency in which they achieve malt they may require a different approach to nitrogen management. This trial therefore aims to examine the appropriate management combinations of sowing date, nitrogen rate and timing required to maximise yield and quality in new malt varieties and food variety Hindmarsh.

How was it done?

Plot size: 1.4m x 10m
Seeding dates: 20th May (early), 14th June (late)

Fertiliser: single super @ 100kg/ha

The trial was a randomised complete block design consisting of 3 replicates, 2 sowing dates, 3 barley varieties and 6 nitrogen (N) treatments:
2 sow dates – early 20th May, late 14th June
3 varieties – Buloke (malt), Commander (malt) and Hindmarsh (food grade)
6 nitrogen treatments (applied as urea), 100% = 80kgN/ha

1. No applied N (nil)
2. 100% IBS
3. 50% IBS, 50 % GS30
4. 100 % GS30
5. 50%GS30 + 50% GS37

6. Strategic N – NDVI determined rates	Early sowing (20th May)	• Buloke & Commander - 40kgN@GS30 & 20 kgN@GS37 • Hindmarsh - 40kgN@GS30 & 40kgN@GS37
	Later sowing (14th June)	• Buloke & Commander - 40kgN @GS30 • Hindmarsh - 75kg N@ GS30

The 100% N IBS treatment was used in each variety as an N-rich reference treatment for the GreenSeeker NDVI crop sensor. This was used to determine the in season response to N and hence provide an estimate of the likely final yield response to N. Using these references points a N rate recommendation was calculated for the strategic treatment using the following Oklahoma State University methodology:

1. Estimate of yield potential (ie. Yield Prophet)
2. Estimating the Responsiveness to Applied N -
    a. In season response index (RI) = NDVI N-rich/NDVI unfertilised paddock
    b. estimation of yield with applied N = RI x Yield with no N applied
3. N rate to be applied = [Grain N content of fertilised crop – Grain N content of unfertilised crop] / Nitrogen use efficiency (ie. 40% in Australia).

Results

Sowing Date x Variety interactions (Table 1):
When sown on the 20th May, Hindmarsh was highest yielding at 3.8 t/ha while Buloke and Commander yielded similarly at 3.3 and 3.2 t/ha respectively. At later sowing (14th June), the variety rankings were unchanged, but Buloke suffered the greatest yield penalty (0.5 t/ha) and Commander the least (0.3 t/ha).

Relative to 20th May sowing, 14th June sowing increased protein in all varieties to be above the 12% maximum for malting, an increase in Buloke of 1%, 0.8% in Commander, and 0.5% in Hindmarsh.

In the other quality measurements Commander was the only variety unaffected by sowing date. Hindmarsh and Buloke each had slightly higher screenings, lower retentions and lower test weights at early sowing, but not significant enough to change final receival grade.

Table 3. The effect of variety and sowing date on grain yield, protein, screenings, retention, and test weight at Hart, 2011.

Measurement	Sow date	Variety			LSD (5%)
		Buloke	***Commander***	***Hindmarsh***	
Grain Yield (t/ha)	Early	3.2	3.3	3.8	0.24
	Late	2.6	3.0	3.1	
Protein (%)	Early	11.7	11.4	11.5	0.39
	Late	12.7	12.2	12	
Screenings (%<2.2mm)	Early	1.1	0.6	1.1	0.40
	Late	0.8	0.9	0.5	
Retention (%>2.5mm)	Early	77.2	93.4	85.7	3.61
	Late	81.6	92	90	
Test weight (kg/hL)	Early	68.4	69.3	68.7	0.46
	Late	69.5	69	69.5	

Nitrogen x Variety interactions:
For Commander and Buloke there was no significant yield response to N within any treatment, while Hindmarsh was responsive to N in all treatments apart from the later split application of N at GS30 and 37 (Figure 1). All other treatments on average improved yield by approx 0.6t/ha in Hindmarsh. When there was no applied N, Commander and Hindmarsh yielded similarly and likewise Commander and Buloke yielded similarly with the later applications of N. Varieties responded similarly to applied N for all grain quality parameters measured (Table 2).

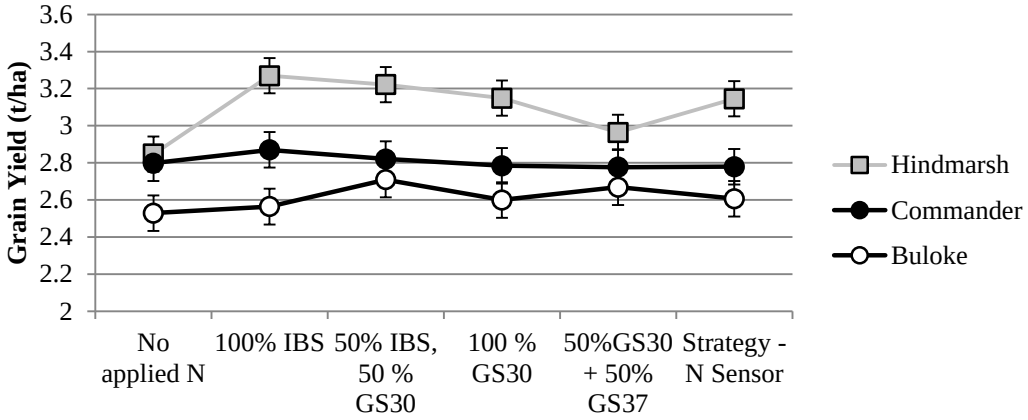

Figure 2. The effect of variety, applied nitrogen rate, and time of sowing on grain yield at Hart, 2011.

Time of Sowing x Nitrogen interactions:

Across all varieties, grain yield responses to nitrogen were similar at each sowing date, concluding that variety had a greater effect on N response than sowing date (Figure 1). Grain protein was the only quality parameter affected by the combination of sowing date and N treatment (table 2). Protein was lower with earlier sowing in all N treatments apart from treatment 3 which exhibited similar protein levels between both sow dates. N was required in order to achieve proteins greater than 9% at early sowing with the GS30 timings increasing protein by the greatest amount. Across both sowing dates other quality parameters were affected by the combined affects of variety (Table 1) and N treatments (Table 2).

Table 4. The effect of sowing date and applied N treatment on grain protein, screenings, retention, and test weight of barley at Hart, 2011

N treatment	Protein (%)		Screenings (%<2.2mm)	Retention (%>2.5mm)	Test Weight (kg/hL)
	Earlier sown	*Later sown*			
1. No applied N	8.8	10.3	0.5	92.8	69.4
2. 100% IBS	11.7	12.6	1.1	83.2	68.5
3. 50% IBS, 50 % GS30	12.1	12.2	0.9	82.0	69.2
4. 100 % GS30	12.5	12.9	1.0	85.5	69.3
5. 50%GS30 + 50% GS37	11.9	12.7	0.7	88.4	69.2
6. Strategic - N sensor	11.9	13.0	0.7	88.0	68.9
LSD (5%)	*0.3*		*0.3*	*3.9*	*0.6*

Summary

At the Hart site time of sowing of barley was important for maximising yield and quality in 2011. Rainfall from mid August to late September was below average leaving crops reliant on stored moisture; this favoured earlier sowing in all varieties. Early biomass responses to N observed in Commander and Buloke, did not translate to yield responses (Figure 2), and led to higher than expected protein levels. To maximise grain yield, sowing date was more important than N management in new malt varieties Buloke and Commander while the combination of sowing date and N management was important in the early maturing food variety Hindmarsh as it was more responsive to N than both Buloke and Commander.

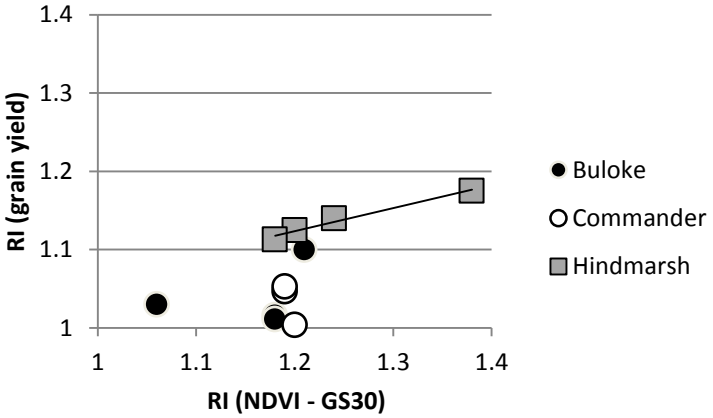

Figure 3. Relationship between the in season response index (NDVI) and final grain yield response index averaged across both sowing dates at Hart, 2011.

In previous wet spring seasons such as 2010 it was difficult to achieve protein levels above the 9% required for malting quality in Buloke and Commander. In such seasons delaying nitrogen with strategic applications (matching growth response to season conditions) across all sowing dates was an effective method to improve protein. Delayed sowing can increase protein; however this strategy is risky as it can result in lower yields by exposing crops to later season moisture stress and higher protein as shown in this trial. Equally, earlier sowing can lead to lower protein level in good years such as 2010.

However at earlier sowing dates there is more opportunity to manipulate the crop canopy with N management to improve protein. Although protein levels were high in 2011, early sowing along with a strategic approach to N still achieved the required protein for malt 1 in Buloke and Commander.

Earlier sowing coupled with a strategic approach to N management may provide the best long term management strategy to consistently achieve max yield and quality requirements in Buloke and Commander. Consistent with other N trials these results imply Hindmarsh is more responsive to N and may require more N than Buloke and Commander at earlier growth stages to fulfil its N requirement in order to maximise yield. Whilst the current demonstrated NDVI method for determining N rates shows promise, work will continue to develop a more reliable tool to determine N rates in barley.

Acknowledgements

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