NITROGEN (N) MANAGEMENT: DO BARLEY VARIETIES RESPOND DIFFERENTLY TO N?

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TAKE HOME MESSAGES

- In 2013, all barley varieties had a similar yield response to nitrogen (N).
- Commander, La Trobe and Hindmarsh were the highest yielding and subsequently the most profitable varieties.
- 120kg N/ha (260kg/ha urea) was the best rate to achieve the greatest profitability at a very N responsive site at Nhill.

KEY WORDS

Barley agronomy, barley varieties, interaction, nitrogen, management, nitrogen response.

BACKGROUND

This trial was conducted as part of the tri-state funded GRDC barley agronomy project, determining whether new and current barley varieties respond differently to nitrogen (N). A variety that is more 'nitrogen' efficient than another, can achieve a greater yield on the same N supply (assuming everything else is equal). Varieties have different characteristics and growth habits that can influence other factors such as N management and weed competition. Hindmarsh and La Trobe both possess a similar semi-dwarf gene which causes an erect leaf habit and slower early growth. This can favour weed growth and survival as more light is able to penetrate the crop canopy. It has been suggested that varieties with this physiology and phenology need more N upfront to increase early vigour and competition. This paper investigates whether barley varieties respond differently to N applications and whether growers should be implementing N management packages tailored to each variety to ensure they reach their full potential.

AIM

To determine if new and existing barley varieties respond differently to varied nitrogen rates applied at sowing.

METHOD

Location:	Nhill	
Replicates:	Four	
Sowing date:	23 April	
Target plant density:	130 plants/m^2	
Crop types:	Hindmarsh, Skipper, Westminster, Scope CL, La Trobe, GrangeR, Commander, Flinders	
Herbicide:	28 August	Velocity (670ml/ha) + Lontrel (100ml/ha) +Hasten (1%)
	28 August	Axial (600ml/ha) + Adigor (.50%)
Fungicide:	11 September	Prosaro (150ml/ha) + Spreadwet 1000 (0.25%)
	25 September	Prosaro (150ml/ha) + Spreadwet 1000 (0.25%)
Insecticide:	30 September	Alpha Duo (200ml/ha)
Fertiliser:	23 March	Granulock Supreme Z (treated with Flutriafol 400ml/ha) – at sowing
Seeding equipment:	BCG Gason parallelogram cone seeder (knife points, press wheels, 30cm row spacing)	

Table 1. Amount of N per treatment applied prior to sowing and at early tillering (GS15/21).

Treatment	Applied N (kg/ha)		Total N (kg N/ha)	Total Urea (kg/ha)
	Sowing (23 April)	Early tillering (11 July)		
A	0	0	0	0
B	30	0	30	65
C	60	0	60	130
D	90	30	120	260
E	120	120	240	522

All N treatments were applied as urea (46% N) and broadcast using a hand held garden spreader prior to planting and incorporated into the soil by the seeder. Though the site received 15mm of rainfall two days prior to sowing, conditions were still marginal. Despite the presence of moisture at depth, emergence did not occur until late May. The 120 and 240kg N/ha treatments received a second application of N at early tillering (GS15/21) (Table 1). All treatments received sufficient rainfall after each application to ensure N was washed into the soil. The site received above average growing season rainfall (339mm), which was above long-term growing season rainfall (GSR) average for the area. Waterlogging occurred during July and early August during which time accessibility to the site was limited. However, it was not specifically identified that plant growth was affected. The initial site N status was very low (28kg N/ha to 100cm) after being sown to oaten hay the previous year.

Data recorded throughout the season included emergence counts (GS23), Normalised Difference Vegetative Index (NDVI) at GS65 and GS85, head counts, yield and grain quality. NDVI was measured using a hand held GreenSeeker®. NDVI, effectively a measure of the crop's greenness and biomass, is based on an index from 0-1.

'Partial' gross income (yield t/ha x grain price – N cost) was determined after classifying individual plots as malt or Feed, based on quality parameters. Cash prices obtained from Nhill GrainCorp on 27 November were used to establish returns (pp. 18).

Plots were harvested with a Wintersteiger plot harvester and protein was measured using a Foss Infratec NIR whole grain analyser. Yields were corrected to 11.5% moisture. All other quality parameters (retention, test weight and screenings) were also measured with standard procedures.

RESULTS AND INTERPRETATION

The low initial soil N status (due to a hay crop in 2012), combined with above average growing season rainfall, meant the trial was responsive to N. Despite being sown in late April, the trial emerged on 29 May following rainfall on 23 May. Four weeks after sowing, plants in the high N plots (120 and 240kg/ha), were at growth stage GS11-12, whereas plants in the low N plots were not as developed (GS05). Plant counts were also conducted at the mid tillering stage, showing that the low N plots had tillered less than the higher N plots, but there were no significant differences in plant numbers.

Was there a difference between nitrogen rates?

When applying higher rates of N, there were differences in yield, protein, test weight, retention and NDVI, but no differences in head counts and screenings (<7%). Assessments at GS65 showed NDVI increased as applied N increased. This was due to a greater amount of 'canopy greenness' and biomass production with increasing N rates. A similar trend was noted at GS85, but NDVI values were much lower as crop was senescing (at grain filling stage).

As expected, applying a greater amount of N resulted in a higher yield (Table 2). The highest mean yield of 4.8t/ha was achieved at the highest rate of 240kg N/ha.

Table 2. Grain yield and quality with applied urea rates.

Urea rate (kg/ha)	Grain yield (t/ha)	Grain protein (%)	Test weight (kg/hL)	NDVI GS65
0	1.7	10.8	60	0.44
30	2.4	9.9	61	0.58
60	3.2	9.7	64	0.69
120	4.1	10.6	67	0.79
240	4.8	12.8	69	0.85
Sig. diff.	**P<0.001**	**P<0.001**	**P<0.001**	**P<0.001**
LSD (P=<0.05)	**0.2**	**0.3**	**2**	**0.03**
CV%	**11.2**	**6.2**	**5.7**	**8.1**

Changes in protein significantly reflected increases in N rates. Figure 1 illustrates the amount of N that moves into the grain at the different N rates, thus contributing to yield and protein. When there is less available N (e.g. low N plots), the initial plant response to N is higher. N is then efficiently converted into yield, which means that less is used for protein. As N supply increases, so also does yield and with it a dilution of grain protein (lowering protein at 60kg N/ha application rate). When the N rate increases (in excess) and is no longer being used as efficiently for increasing yield, the amount converted to protein increases. At highest rate of 240kg N/ha, the amount of N being moved into the grain is very high and, as yield potential is reached, high protein develops

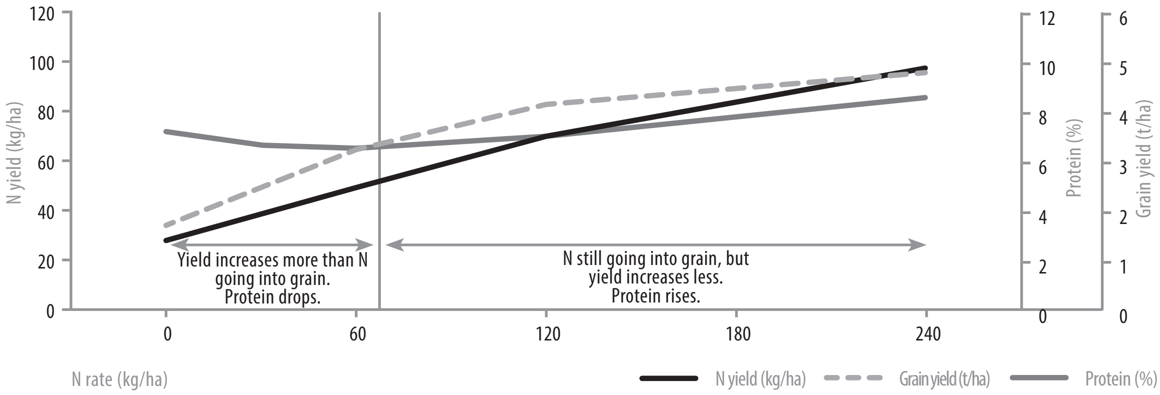

Figure 1: Relationship between N yield (kg/ha), yield (t/ha) and protein %.

Test weight was reduced when applying insufficient N (low N rates), but increased with higher N application (Table 2). It was observed that grains were smaller and there were more defective grains (small, black tipped and shrivelled) throughout the low N treatments, consequently resulting in lower test weights. The 0, 30 and 60 N rates were all below malt specification requirements (<65kg/hL). To achieve Malting quality, in terms of test weight, requires higher application rates of N. Correspondingly, retention also increased with a higher applied N rate, indicating that grain size also was slightly larger with the higher N status.

Figure 2 shows the relationship between yield and partial gross margin when N rate increases. While the highest yield occurred at the 240kg N/ha rate, the greatest yield response was seen at the 120kg N/ha rate (as response starts to ease when applying a higher rate). Consequently, partial gross income was greatest also when applying 120kg N/ha. This indicates, that aside from the highest yield being achieved at the 240kg N/ha rate, it was more profitable to apply 120kg N/ha (highest partial gross margin) as there was not sufficient yield benefit to warrant adding extra N.

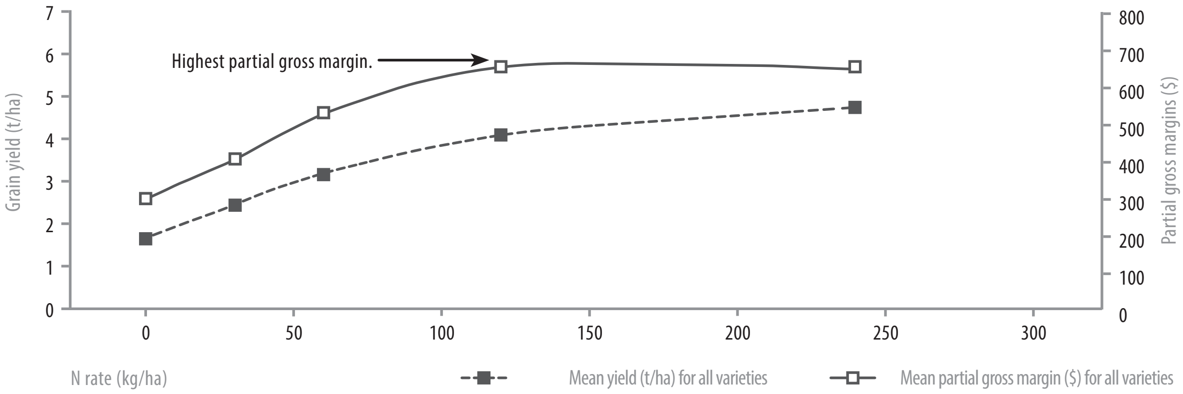

Figure. 2 Relationship between yield (t/ha) and partial gross margin ($) when applying N. (Significant difference, rate (yield) P<.001, LSD=0.18, CV11.2%, rate (partial gross margin) P<0.001, LSD=39.7, CV15.9%)

Did varieties respond differently?

Despite there being a positive response to applied N, no variety responded significantly differently from another in terms of yield, test weight, screenings and retention. For example, when applying 60kg N/ha to Hindmarsh, the response in yield was similar for all varieties at that rate.

There were significant interactions in protein status between varieties and N rate. Among the malting varieties, GrangeR at 60kg N/ha had higher protein (9.4%) than Commander (8.2%), which inheritantly has a lower protein, similar to Gairdner (Table 3). This suggests that Commander may need more N than GrangeR to ensure achieving Malting quality (between 9-12%).

Economic comparisons between varieties showed the partial gross margin of each variety increased with higher rates of N (Table 3). The most profitable rate of N across most varieties was achieved at the 120kg N/ha rate (260kg/ha urea).

Table 3: Summary of varieties x N rate for yield and grain quality, 'partial' gross margin and return on investment ($). Bolded values indicate the highest gross margin value. Note: the cost of N was the only cost incurred in this partial gross margin.

Variety	N rate (kg N/ha)	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Income ($/ha)	Cost of urea ($/ha)	Partial gross margin ($/ha)
Hindmarsh (Food)	0	2.0	10.3	60.9	342	0	348
	30	2.5	9.5	64.6	474	34	444
	60	3.4	9.5	65.5	658	68	591
	120	**4.6**	**10.7**	**69.1**	**952**	**136**	**818**
	240	5.1	13	69.8	1015	271	745
Skipper (Feed)	0	1.8	10.7	59.3	322	0	323
	30	2.5	9.8	60.8	438	34	403
	60	3.3	9.9	64.6	595	68	525
	120	**4.1**	**10.6**	**65.9**	**767**	**136**	**630**
	240	4.7	13	66.5	871	271	597
Westminster (Feed)	0	1.5	10.2	65.2	272	0	272
	30	1.9	11	58.2	341	34	306
	60	2.5	10.7	60.4	439	68	371
	120	3.2	11.5	62.9	572	136	435
	240	**4.3**	**12.6**	**69.3**	**796**	**271**	**523**
Scope CL (Malt)	0	1.6	11.3	58.1	288	0	288
	30	2.6	10.3	58.5	460	34	426
	60	3.0	10	61.6	553	68	481
	120	**3.9**	**10.6**	**64.6**	**743**	**136**	**607**
	240	4.5	12.6	64.9	841	271	569
La Trobe (Feed)	0	1.9	10.1	58.8	331	0	331
	30	2.7	9	63.2	490	34	453
	60	3.6	9.1	67.1	666	68	597
	120	4.4	9.6	68.7	819	136	680
	240	**5.7**	**12.1**	**69.6**	**1047**	**271**	**774**
GrangeR (Malt)	0	1.5	11.1	58.2	266	0	265
	30	2.4	9.8	56.6	437	34	403
	60	3.2	9.4	61.4	559	68	489
	120	4.0	11	65.6	738	136	600
	240	**4.6**	**13.7**	**68.3**	**906**	**271**	**639**
Commander (Malt)	0	1.7	10.3	56.9	306	0	305
	30	2.8	8.8	61	509	34	475
	60	3.8	8.2	66.1	774	68	704
	120	**4.7**	**9.4**	**68.5**	**985**	**136**	**849**
	240	5.1	12	69.8	1078	271	805
Flinders (Feed)	0	1.2	12.1	58.9	222	0	223
	30	2.1	11.3	61.1	375	34	340
	60	2.7	10.8	63.0	486	68	417
	120	**4.1**	**11.5**	**68.6**	**753**	**136**	**615**
	240	4.4	13.4	69.9	816	271	542

Variety	N rate (kg N/ha)	Yield (t/ha)	Protein (%)	Test weight (kg/hL)	Income ($/ha)	Cost of urea ($/ha)	Partial gross margin ($/ha)
Sig. diff.							
Variety	P<0.001	P <0.001	P=0.003				P<0.001
Nitrogen	P<0.001	P <0.001	P<0.001				P<0.001
Variety x N	NS	P=.027	NS			P=0.03	P=0.03
LSD (P=0.05)							
Variety	0.2	0.42	2.32				51
Nitrogen	0.2	0.3	1.8				40
Variety x N	–	0.9	–				113
CV%	11.2	6.2	5.7				15.9

Note: Prices for malt, were based on Commander price only, as no prices for GrangeR and Scope CL were available at the time (refer to pp. 18). All feed varieties listed are undergoing malt accreditation.

COMMERCIAL PRACTICE

In 2013, all varieties had a similar yield response to the application of different N rates. High N input costs can be potentially risky, particularly in the event of a dry finish to the season. Fortunately, due to the exceptional amount of growing season rainfall experienced at Nhill, this was not the case and yields were greatest when applying high N rates. Corresponding to this, higher N rates were also the most profitable, with the best rate of N to apply being 120kg N/ha to achieve the highest gross margin. Each variety (except Commander), achieved adequate N to achieve malt at the lower rates of N (0, 30 and 60kg N/ha rates). When the highest rate of N (240kg N/ha) was applied, the maximum protein level for malt (12%) was exceeded when the yield potential was met.

In a high rainfall and high yielding area, Commander, La Trobe and Hindmarsh achieved the greatest yields and were the most profitable. The choice between growing Hindmarsh and La Trobe or Commander, largely comes down to the price differential between malt and Food/Feed barley. With this in mind, select a barley variety that is best suited to your farm (in terms of soil type, rotational history, rainfall, environment and market availability). Given the variability in seasons, gaining a better understanding of soil N prior to sowing, the amount of N required to achieve maximum yield potential and timing of N applications, will contribute to better crop management and increased yields and profit.

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