Nitrogen timing and sowing date in barley

This trial was funded by the GRDC and conducted in collaboration with SARDI and the Hart Field-Site Group.
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Key findings

- Later applications of nitrogen (GS30 & GS37) were the most profitable with the highest yield and quality, for malt barley in 2010.
- There was no significant differences in yield of varieties between early and later sowings.
- Crop sensors provide a good measure of nitrogen response and can improve nitrogen use efficiency.

Why do the trial?

To improve the nitrogen use efficiency of malt barley by manipulating canopy size and structure by application of nitrogen at different timings across the growing season.
To establish the link between sowing date and nitrogen timing in new malt barley varieties in order to maintain yield and quality.
To assess the value of using optical crop sensors in aiding nitrogen management.

How was it done?

Plot size 1.4m x 10m

Fertiliser DAP @ 90kg/ha + 2% Zn

Sowing dates:

Time of Sowing 1 (TOS 1) - 4th May 2010

Time of Sowing 2 (TOS 2) – 2nd June 2010

Varieties:

Commander

Buloke

The trial was a randomised complete block design with 3 replicates, 6 nitrogen timings, 2 varieties and 2 sowing dates. The early time of sowing occurred on the 4th of May, and the later timing on the 2nd of June. Nitrogen treatments are shown in Table 1. Crop assessments, using the GreenSeeker, were used to adjust the rate of total nitrogen applied based on crop growth and the seasonal conditions.

All plots were assessed for biomass, crop reflectance (NDVI), nitrogen uptake, tiller & head number, grain yield, protein, test weight, screenings (<2.2mm) and grain weight. Edge rows were removed prior to harvest.

NDVI is a comparison of reflectance of red and near infra red wavelengths (NIR-R/NIR+R) and is a good indicator of the crop biomass and nitrogen status.

Table 1. Nitrogen treatments, application timing and total nitrogen applied at Hart 2010.

Nitrogen treatment	Date of application		Total nitrogen (kg N/ha)
	TOS 1 4th May	TOS 2 2nd June	
Nil nitrogen	-	-	0
100% incorporated by sowing (IBS)	4th May	2nd June	60
50% IBS + 50% GS30 (stem elongation)	4th May + 13th July	2nd June + 15th August	60
100% GS30	13th July	15th August	60
50% GS30 + 50% GS37 (tip of flag leaf)	13th July + 15th August	15th August + 6th September	60
Crop sensor TOS 1 = 100% GS37 TOS 2 = 100% GS30	15th August	15th August	46 TOS 1 23 TOS 2

Results

Buloke and Commander malt barley responded similarly to time of sowing and nitrogen application timing. Commander yielded slightly better than Buloke (Table 2).

Table 2. Grain yield of Commander and Buloke malt barley averaged across all nitrogen treatments and time of sowing at Hart, 2010.

Variety	Grain yield (t/ha)
Buloke	5.21
Commander	5.36
LSD (5%)	0.12

For both varieties grain yield in the nil nitrogen treatment increased from 3.98 t/ha with early sowing to 4.33 t/ha for later sowing (Table 3). Grain yield also decreased in the crop sensor treatment at the later time of sowing (2nd June) and reduced nitrogen rate (23 kg N/ha). All other nitrogen treatments did not differ between sowing dates, highlighting the lack of yield penalty or benefit associated with delayed sowing of barley at Hart 2010.

For both sowing dates split nitrogen at GS30 and GS37 and 100% nitrogen at GS30 were the highest yielding treatments. The crop sensor strategy was also the highest yielding for the first time of sowing, even at a lower nitrogen rate (46 kg N/ha) but not quite as effective at the later sowing, with a much less nitrogen applied (23 kg N/ha)(Table 3).

Table 3. Grain yield averaged across Buloke and Commander barley in response to time of sowing and nitrogen timing at Hart, 2010.

Nitrogen treatment	Grain yield (t/ha)			
	TOS 1		TOS 2	
Nil nitrogen	3.98	f	4.33	e
100% IBS	5.13	d	5.29	cd
50% IBS + 50% GS30	5.34	cd	5.45	bc
100% GS30	5.62	ab	5.67	ab
50% GS30 + 50% GS37	5.91	a	5.68	ab
Crop sensor	5.77	a	5.21	cd
Average	5.29		5.27	
LSD (P<0.05) N x TOS	0.3			

During the growing season the GreenSeeker readings produced a good relationship with crop biomass, crop nitrogen uptake (kg N/ha)(Figure 1) and tiller density. This relationship is more significant between late tillering and early stem elongation, an important stage for considering further nitrogen requirements. Nitrogen uptake for the later sowing was slightly higher than early sowing, at growth stages 31 and 37 (Figure 1).

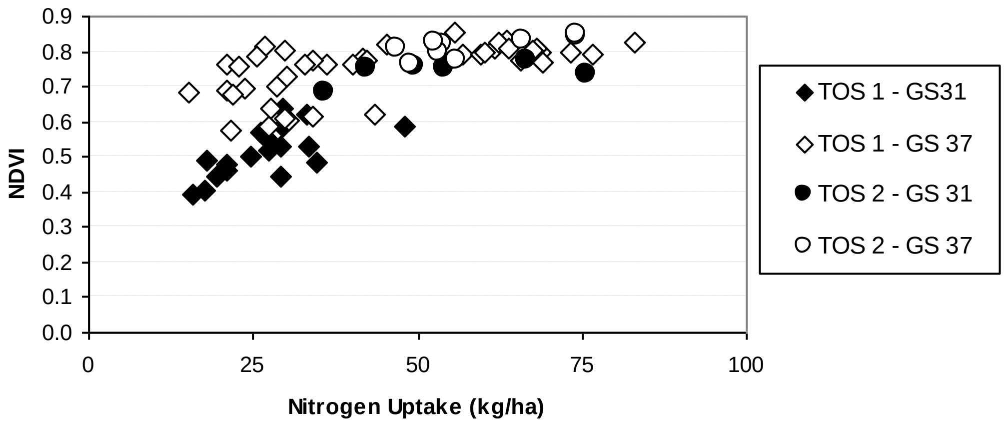

Figure 1. Nitrogen uptake (kg N/ha) and GreenSeeker NDVI across all nitrogen rates and varieties in this trial, Hart 2010 (R^2=0.57).

Tiller density was greatest when nitrogen was applied IBS (Figure 2). This resulted in a higher percentage of tiller death and consequently treatments with IBS applications of nitrogen had reduced head number per square metre compared to treatments with nitrogen applied at or after stem elongation. Time of sowing and variety did not result in differences in tiller and head number.

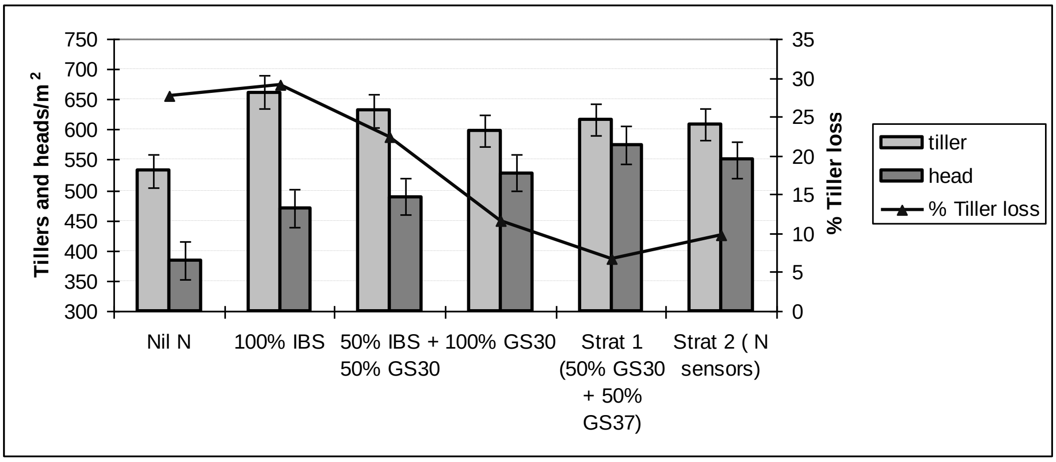

Figure 2. The influence of nitrogen strategy on tiller and head number, and % tiller loss at Hart in 2010.

Grain quality effects were significant for time of sowing, variety, and nitrogen treatments. Grain weight, test weight and screenings were significantly affected by time of sowing and nitrogen timing (Table 4). However, the differences between treatments were not large enough to change receival grades, all being within the malt standards. Variety responses to time of sowing and nitrogen did not differ.

Table 4. The effect of nitrogen timing and time of sowing averaged for Buloke and Commander barley for grain weight, test weight, and screenings at Hart 2010.

Nitrogen treatment	**Grain weight (mg/grain)**		**Test weight (kg/hL)**		**Screenings (%<2.2mm)**	
	TOS 1	**TOS 2**	**TOS 1**	**TOS 2**	**TOS 1**	**TOS 2**
Nil nitrogen	47.6	49.5	68.1	69.5	0.4	0.6
100% IBS	48.2	49.5	68.2	69.6	0.7	0.6
50% IBS + 50% GS30	48.3	48.2	68.4	68.7	0.6	0.9
100% GS30	47.1	47.5	67.9	69.9	0.6	0.8
50% GS30 + 50% GS37)	45.7	48.1	68.8	70.2	0.8	0.7
Crop sensor	46.1	49.1	68.8	69.7	0.7	0.6
LSD (Fpr<0.05) TOS x N	1.2		2.0		0.1	

Grain protein responded to nitrogen application timing and barley variety. Commander produced 9.4% protein for the 100% GS30 treatment compared to 8.7% in Buloke (Table 4). 50% GS30 + 50% GS37 was the only nitrogen strategy to achieve protein readings greater than 9.0% in both varieties.

Table 5. The grain protein response to nitrogen timing in Buloke and Commander barley at Hart 2010.

Nitrogen treatment	Grain protein (%) Buloke	Commander
Nil nitrogen	8.3	8.3
100% IBS	8.7	8.8
50% IBS + 50% GS30	9.0	8.7
100% GS30	8.7	9.4
50% GS30 + 50% GS37	10.0	9.5
Crop sensors	8.6	9.0
LSD (Fpr <0.05) Variety * Nitrogen	0.53	

Grain retention levels were not affected by nitrogen or sowing date, however Buloke had slightly lower retention compared to Commander (Table 5). Variety specific differences in other grain quality factors were significant but small.

Table 6. The grain quality of Buloke and Commander averaged across all nitrogen treatments and sowing dates at Hart 2010.

Variety	Grain weight (mg/grain)	Screenings (<2.2mm)	Retention (%>2.5mm)	Test weight (kg/hL)	Grain protein (%)
Buloke	49	0	92	70	46
Commander	46	1	95	68	47
LSD (Fpr<0.05)	0.6	0.2	1.0	1.1	ns

Summary:

Whilst there was no real yield benefit or penalty from earlier sowing in this trial, the benefits may come in the improved opportunity to manage the crop canopy. The earlier planting (May) had a longer development period and hence greater opportunity to manipulate the crop canopy during the stem elongation period with crop nitrogen applications. Crop sensors provided a good measure of N response and hence are a useful tool in determining the nitrogen requirement.

Differences in tiller/head densities and tiller death highlight the ability to manipulate the crop canopy with post sowing N applications. Greater emphasis on nitrogen upfront created greater tiller numbers but consequently had higher shoot losses between GS31 and grain filling and, hence, lower yields. The GS30 (100%) and later strategic applications of N maintained the highest proportion of tillers and consequently yielded higher than early N applications.

The main grain quality response measured between the treatments was in grain protein. 50% GS30 + 50% GS37 was the only nitrogen regime to achieve the target protein of 9% required for malt in both varieties.

The benefits of a strategic approach to nitrogen management is highlighted by this trial; matching nitrogen inputs to seasonal conditions rather than a predetermined nitrogen strategy proved to be the most profitable (highest yield & quality) across both sowing dates at Hart in 2010.