3.4.3 Capstan barley nitrogen response trial - Dunkeld, Vic

Location:
Dunkeld Research Site.

Funding:
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Background/Aim:
Nitrogen plays a key role in canopy production, and hence final grain yield and protein. Therefore, it is vital that nitrogen is managed to optimise the conversion of available soil moisture to grain. As a result, nitrogen inputs need to be carefully managed in relation to the product, rate and timing to achieve the desired outcome for the given conditions. Additionally, the sharp increase in fertiliser prices has put a greater emphasis on nitrogen budgeting, and hence nitrogen inputs on the bottom line, as profit, not yield drive farmer sustainability.

This trial compared 10 different nitrogen strategies consisting of a number products, rate and timings to determine the optimal strategy for the site and season. Also, an economic analysis was conducted to determine the most effective nitrogen strategy in relation to gross margin ($/ha).

Paddock history:
2005: Pasture, 2006: Pasture, 2007: Canola

Soil type: Sandy clay

Soil nutrients:
N = 45 mg/kg or 58.5 kg N/ha (0-10cm) + 10.1mg/kg or 13.1 kg N/ha (10-60cm),
P = 45mg/kg (Colwell),
K = 0.55 Meq/100g,
S = 21mg/kg,
pH ($CaCl_2$) = 4.7

Take home messages:
- In 2008, the single application treatment of 40kgN/ha (urea) at GS33 achieved the highest yield of 7.18t/ha, however it was not significantly different to any other nitrogen rate treatments within this trial.
- Test weight proved to be a major issue in relation to grain quality, resulting in all of the treatments being downgraded to F2 or F3 classification.
- All 3 of the liquid UAN treatments yielded lower that equivalent treatments using urea, with applied UAN resulting in visible leaf burn, even when using the appropriate streaming nozzles.
- Four of the nine nitrogen strategies made a profit on nitrogen investment, with the single application treatment of 40kgN/ha (urea) at GS33, returning the highest gross margin of $822.65/ha, which equated to a 188% profit on N investment or a treatment return of $130.97/ha above the control.

Trial information:
Trial design consisted of a replicated randomised block design using 4 repetitions, to demonstrate local response to nitrogen. The trial was managed using best practise in relation to weeds and disease. Plot lengths were 13 metres long and 1.45m wide. Rainfall was highly variable throughout the season, with a wet winter, then very dry Spring. Late rainfall in mid December did not contribute to the yield result of this trial.

Rainfall:

Avg. Annual:	612.2mm Hamilton Airport 1991-2008
Avg. G.S.R.:	474.0mm Hamilton Airport 1991-2008
2008 Total:	453.2mm Dunkeld Research Site
2008 G.S.R.:	April – November = 298.1mm[1] (Dunkeld Research Site)

[1] Yield Potential: 1/3 of Dec (72mm), Jan (45.2mm) & Feb (11.4mm) with monthly totals above 20mm + 1/2 March (15.6mm) rainfall when total above 20mm + ((April – November rainfall) – 90mm*) x 20kg/mm/ha. In total December-March adjusted rainfall to stored soil water = 39.1mm, plus April-November = 298.1mm, minus evaporation factor* =>247.2mm. Therefore, for Dunkeld, the water limited yield should be 4.94t/ha, or 247.2mm x 20kg/mm/ha.

Treatment list:
10 different nitrogen strategies, consisting of granular urea and liquid UAN using four rates spread across two application dates. Measurements included yield and grain quality components, including protein, retention, test weight, screenings and resulting classification.

Seeding equipment and row spacing: SFS cone seeder using 2.5cm knifepoints and Janke high V press wheel on 17.12cm (6 ¾ inches) row spacing.

Cultivar: Capstan Barley

Sowing rate:
Seeding rate based on seed weight with a desire to establish 180 plants/m^2.

Sowing date: 23rd May 2008

Harvest date: 6th January 2009

Fertiliser:
- 23/5/08 MAP @ 100kg/ha
- 15/10/08 Coptrel @ 0.4L/ha

Herbicides:
- 23/5/08 RoundUp PowerMax @1.50L/ha + Triflur 480@1.50L/ha + Striker @ 0.10L/ha
- 24/5/08 Dual Gold @ 0.25L/ha + Diuron @ 0.50L/ha
- 28/7/08 Axial @ 0.30L/ha + Precept @ 1.00L/ha + Adigor @0.5%

Fungicide:
- 15/10/08 Tilt @ 0.25L/ha
- 5/11/08 Tilt @ 0.25L/ha

Diseases:
Disease had minimal effect on the trial due to the two spray foliar fungicide program.

Results and discussion:

Overall, the mean yield of the trial was 6.89t/ha, with the single application treatment of 40kgN/ha (urea) at GS33 achieving the highest yield of 7.18t/ha, or 104% of the site mean. The untreated nitrogen strategy yielded 6.82t/ha, which was the 6th highest yield, suggesting that additional nitrogen in higher rate instances may have caused haying off, as additional nitrogen reduced yield for four of the trial treatments. However, in 2008 there was no significant difference between treatments in relation to yield.

Of note, all liquid UAN treatments yielded below the mean with leaf burn visible a day after applications at both GS33 and GS39, even though streaming nozzles were used for application. However, it is difficult to determine exactly what effect leaf burn had on yield.

Table 1: Total Nitrogen & Grain yield, corrected to 12.5% moisture. Plus grain quality specification, including protein, test weight, retention, screenings and resultant grading classification.

Nitrogen Strategy								
GS33	GS37	Total N	Yield (t/ha)	Protein (%)[1]	Test Weight (kg/hl)[1]	Retention (%)[1]	Screenings (%)[1]	Resultant Grading[1]
40 urea	-	40	7.18	12.0	60.7	84	5.0	F2
40 urea	40 urea	80	7.10	12.4	61.4	85	5.7	F2
80 urea	40 urea	120	7.09	13.3	59.4	79	6.5	F3
80 urea	-	80	6.97	12.7	61.3	85	4.3	F2
40 UAN	-	40	6.86	11.5	60.4	83	5.3	F2
-	-	0	6.82	11.6	59.8	80	6.3	F3
40 UAN	40 UAN	80	6.82	12.6	59.8	80	6.0	F3
40 urea	80 urea	120	6.74	12.7	59.9	82	5.9	F3
80 urea	40 UAN	120	6.68	13.6	60.0	78	6.9	F2
100 urea	60 urea	160	6.65	14.0	60.2	77	6.8	F2
Mean			**6.89**	**12.64**	**60.31**	**81.2**	**5.86**	
LSD (P=0.05)			**0.624**	**1.069**	**1.421**	**6.260**	**2.350**	
CV			**6.16**	**5.75**	**1.60**	**5.24**	**27.27**	

[1] Quality parameterisation is based on 2008-2009 NACMA Barley Standards and should be used as a guide only.
Cells with gray covers suggest units outside Feed 1 (F1) specifications.

Test weight proved to be a major issue in relation to grain quality; consequently all of the treatments were downgraded one or more classifications, as all treatments were below the 62.0kg/hl specification for F1. However, conversely screenings and retention had no effect on grain quality, as all treatments achieved the required specifications. Also, protein is of minimal concern, as Capstan is feed variety, and consequently there are no requirements for proteins. Therefore, test weight had most significant effect on grain quality, as all treatments were limited primarily by test weight in relation to grain classification.

In 2008, the highest yield advantage was 356kg/ha above the control, which was achieved by the single application treatment of 40kgN/ha (urea) at GS33. Yield advantage demonstrates an increase or decrease in yield (kg/ha) of each treatment against the control, which allows us to determine the grain:nitrogen ratio. This ratio determines additional grain yield per kg of nitrogen applied. For example, a G:N ratio of 8.90 equates to a 8.90kg/ha yield increase for every 1.0kg/ha of nitrogen applied.

Nitrogen return on investment (N ROI) translates the G:N ratio into an economic value, which determines the dollar return for every dollar of nitrogen invested. For example, an N RIO value of $2.88 translates to a $2.88 return on investment for every dollar of nitrogen invested and hence a $1.88 profit on every dollar invested or a 188% profit on investment. Therefore, 4 of the 10 treatments made a profit on nitrogen investment despite the high nitrogen cost and dry season. The single application treatment of 40kgN/ha (urea) at GS33, returned the highest gross margin of $822.65/ha, which equated to a $130.97/ha increase above the control.

Table 2: Grain yield, yield advantage compared to the control (0 N), additional grain to nitrogen ratio and nitrogen return on investment. Plus, final economic analysis based on NACMA barley standards on a GM/Ha basis (using standard inputs across all treatments of $400/ha).

Nitrogen Strategy								
GS33	GS37	Total N	Yield (t/ha)	[1]Yield Adv. (kg)	[2]G:N Ratio	[3]N ROI	4Gross Margin ($/ha)	GM Rank
40 urea	-	40	7.18	356	8.90	$2.88	$822.65	1
40 urea	40 urea	80	7.10	279	3.49	$1.34	$739.23	3
80 urea	40 urea	120	7.09	270	2.25	$0.21	$526.18	8
80 urea	-	80	6.97	147	1.84	$1.17	$715.47	4
40 UAN	-	40	6.86	35	0.87	$1.90	$759.15	2
-	-	0	6.82	0	-	-	$691.68	5
40 UAN	40 UAN	80	6.82	-4	-0.05	$0.00	$540.45	7
40 urea	80 urea	120	6.74	-80	-0.67	-$0.06	$470.18	10
80 urea	40 UAN	120	6.68	-143	-1.19	$0.52	$587.98	6
100 urea	60 urea	160	6.65	-170	-1.06	$0.38	$519.28	9
Mean			**6.89**					
LSD (P=0.05)			**0.624**					
CV			**6.16**					

[1] Yield Advantage determined as kg above or below untreated nitrogen treatment yield.
[2] Grain:Nitrogen ratio determined by yield advantage /total nitrogen. N:G ratio indicates the yield (kg) advantage per unit of nitrogen applied.
[3] Nitrogen return on investment is determined by (Gross Income – Untreated Gross Income)/ Nitrogen Cost. N ROI indicates cost returned per dollar invested. Numbers in red font equate to a negative return on investment.
[4] Prices for grain were taken as a spot price on the day of harvest supplied by Riordan Grains; Feed2 = $180/t, Feed3 = $160/t. Nitrogen cost estimated at $800/t urea, and $800/KL UAN.

Summary:
In 2008, the optimal nitrogen strategy (post stem elongation) for yield was the single application treatment of 40kgN/ha (urea) at GS33, which yielded 7.18t/ha. Similarly, the optimal strategy for profitability was also the 40kgN/ha (urea) at GS33 treatment, which returned a profit on investment of 188% or $130.97/ha. Therefore, it is reasonable to assume that the profit margin was worth the addition risk and outlay. As growers should be aiming for at least a 50% profit on investment, if not higher. As a result, the 40kgN/ha (urea) at GS33 strategy appeared the most rational decision given the drier than average 2008 season.