3.4.2 Bolac wheat nitrogen response trial - Dunkeld, Vic

Location:
Dunkeld Research Site.

Funding:
This was an SFS Hamilton Branch funded trial.

Researchers:
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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, rates 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).

Take home messages:

- In 2008, the spilt application treatment of 40kgN/ha (urea) at GS33 and 40kgN/ha (urea) at GS39, achieved the highest yield of 5.96t/ha, significantly ($P<0.05$) higher than the untreated control.
- Screenings proved to be a major issue in relation to grain quality, resulting in all of the treatments being downgraded to AGP1 classification.
- All 3 of the liquid UAN treatments yielded in the bottom half of the trial, with leaf burn quite visible post application even though streaming nozzles were used.
- Two of the nine treatments made a profit on nitrogen investment, of which the highest was 40 kgN/ha of urea at GS33 treatment with a gross margin of $1049.29/ha
- Although, the 40kgN/ha (urea) at GS33 treatment, was determined to be the most profitable (profit on investment 15% or $10.76/ha.), it is questionable whether the additional outlay and risk is warranted given marginal profit compared the untreated control, as growers should be aim for at least a 50% profit on investment.

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* =>247.2. Therefore, for Dunkeld, the water limited yield should be 4.94t/ha, or 247.2mm x 20kg/mm/ha., the water limited yield should be 4.94t/ha, or 247.2mm x 20kg/mm/ha.

Treatment list:
10 different nitrogen strategies, consisting granular urea and liquid UAN, applied at GS33 and GS39 were implemented. Measurements included yield and grain quality components, including protein, 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.

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 2008
Cultivar: Bolac Wheat

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 Opus @ 0.25L/ha
- 5/11/08 Opus @ 0.25L/ha

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

Soil type: Sandy clay

Soil nutrients:
N = 45mg/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

Results and discussion:
Overall, the mean yield of the trial was 5.61t/ha, with the spilt application treatment of 40kgN/ha (urea) at GS33 and 40kgN/ha (urea) at GS39 achieving the highest yield of 5.96t/ha, which was 106% of the site mean and significantly (P<0.05) higher than the untreated check. The untreated nitrogen treatment yielded 5.41t/ha, which was the 3rd lowest yield, suggesting that additional nitrogen may have caused haying off in the lowest two yielding treatments.

Of note, all liquid UAN treatments yielded in the bottom half of the trial. Leaf burn was visible a day after application, both at GS33 and GS39 in UAN treatments, even though streaming nozzles were used for application, which may have contributed to yield losses.

Disease:
Stripe rust had negligible effect on final yield due to a combination of Bolac's resistance and the two spray foliar fungicide program.

Table 1: Grain yield, corrected to 12.5% moisture. Quality analysis, including protein, test weight, screenings & resultant grading.

Nitrogen Strategy								
GS33	GS39	Total N	Yield (t/ha)	[1]Sig. Diff.	Protein (%)[2]	Test Weight (kg/hl)[2]	Screenings (%)[2]	Resultant Grading[2]
H1 Specifications					**>13.0**	**>74.0**	**<5.0**	
40 urea	40 urea	80	5.96	a	12.2	75.5	6.5	AGP1
100 urea	60 urea	160	5.80	ab	13.0	75.0	8.1	AGP1
80 urea	40 urea	120	5.79	ab	12.4	76.1	5.8	AGP1
40 urea	80 urea	120	5.74	ab	12.0	76.2	6.5	AGP1
40 urea	-	40	5.71	ab	11.6	75.9	5.8	AGP1
40 UAN	-	40	5.61	ab	11.9	75.1	8.4	AGP1
80 urea	40 UAN	120	5.58	ab	13.2	73.9	9.0	AGP1
-	-	0	5.41	bc	11.5	76.2	6.5	AGP1
80 urea	-	80	5.37	bc	13.5	74.2	8.3	AGP1
40 UAN	40 UAN	80	5.09	c	12.4	75.3	7.8	AGP1
Mean			**5.61**		**12.36**	**75.33**	**7.26**	
LSD (P=0.05)			**0.443**		**0.974**	**2.116**	**2.400**	
CV			**5.68**		**5.39**	**1.92**	**22.60**	

[1] Means followed by the same letter do not significantly differ (P=0.05, LSD).
[2] Quality parameterisation is based on 2008-2009 NACMA Wheat Standards and should be used as a guide only.
Cells with gray covers suggest units outside Hard 1 (H1) specifications.

Screenings proved to be a major issue in relation to grain quality; consequently all of the treatments were downgraded to AGP1 classification, as all treatments were above 5% screenings. However, test weight had minimal effect on grain quality, as only one treatment fell below the 74.0kg/ha threshold, which was 80kgN/ha (urea) at GS33 and 40kgN/ha (UAN) at GS39 treatment. Similarly, all treatments achieved a protein of 11.5% or greater, which means based on protein all treatments were of APW classification or better. Therefore, screenings had most significant effect on grain quality, as all treatments were limited primarily by screenings in relation to grain classification.

In 2008, the highest yield advantage was 552kg/ha above the control, which was achieved by the spilt application treatment of 40kgN/ha (urea) at GS33 and 40kgN/ha (urea) at GS39. Yield advantage demonstrates 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 yielded per kg of nitrogen applied. For example, a G:N ratio of 6.90 equates to a 6.90kg/ha yield increase for every 1 kg/ha of nitrogen applied.

Nitrogen return on investment (N ROI) translates the G:N ratio into economic value, which determines the dollar return for every dollar of nitrogen invested. For example, a N RIO value of $1.06 translates to a $1.06 return on investment for every dollar of nitrogen invested or 6% profit on Nitrogen investment. Two of the nine treatments made a profit on nitrogen investment despite the high price of nitrogen and the dry season. The split application treatment of 100kgN/ha (urea) at GS33 and 60kgN/ha (urea) at GS39 yielded the second highest, but was ranked ninth in terms of gross margin, reinforcing the importance of sound nitrogen investment. The single application treatment of 40kgN/ha (urea) at GS33 was determined to be the most profitable treatment returning a gross margin of $1049.29/ha, which equates to a profit on investment of 15% or $10.76/ha. For the bottom two results, not only did the nitrogen strategy prove inappropriate by not covering any costs, it in fact reduced yield when compared to the control (0kgN/ha strategy), exacerbating the N RIO outcome to be far more than the cost of the strategy.

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

Nitrogen Strategy								
GS33	**GS37**	**Total N**	**Yield (t/ha)**	**[1]Yield Adv. (kg)**	**[2]G:N Ratio**	**[3]N ROI**	**[4]Gross Margin ($/ha)**	**GM Rank**
40 urea	40 urea	80	5.96	552	6.90	$ 1.06	$1,046.23	2
100 urea	60 urea	160	5.80	393	2.46	$ 0.38	$864.81	9
80 urea	40 urea	120	5.80	390	3.25	$ 0.50	$933.57	5
40 urea	80 urea	120	5.74	335	2.79	$ 0.43	$918.94	6
40 urea	-	40	5.71	302	7.55	$ 1.15	**$1,049.29**	**1**
40 UAN	-	40	5.62	212	5.30	$ 0.74	$1,018.73	4
80 urea	40 UAN	120	5.59	177	1.48	$ 0.22	$870.29	8
-	-	0	5.41	0	-	-	$1,038.53	3
80 urea	-	80	5.37	-43	-0.54	-$ 0.08	$887.96	7
40 UAN	40 UAN	80	5.07	-337	-4.21	-$ 0.59	$796.51	10
Mean			**5.61**					
LSD (P=0.05)			**0.443**					
CV			**5.39**					

[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; AGP1 = $266/t. Nitrogen cost estimated at $800/t urea, and $800/KL UAN.

Summary:

In 2008, the optimal strategy for yield was the spilt application treatment of 40kgN/ha (urea) at GS33 and 40kgN/ha (urea) at GS39, which yielded 5.96t/ha. However, the optimal strategy for profitability was the single application treatment of 40kgN/ha (urea) at GS33, which returned a profit on investment of 15% or $10.76/ha. Therefore, it is questionable whether it was worth applying any nitrogen at all in this particular case, as the profit is marginal compared addition risk and outlay. Growers should be aiming for at least a 50% profit on investment, if not higher. As a result, the untreated nitrogen strategy appears the most rational decision given the 2008 scenario.