GOA Site Report

Improving nitrogen fertiliser efficiency by manipulating its positional availability through early summer fallow applications

Trial Code: GONU004163

Year: 2016

Location: "Kurrajong Park", Coolah

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Keywords

GONU004, wheat nutrition, nitrogen rates, fallow nitrogen, Coolah

Take home messages

Increasing rates of N increased yields and grain quality.

In a very wet season delaying N (until Z30) improved grain quality.

Early and mid-fallow nitrogen application did not significantly improve yield or quality, compared to a sowing application at this site.

Background

In recent years, anecdotal reports suggest lower than expected grain protein and yields, despite application of adequate nitrogen to winter crops grown in the GOA region. Seasons with a relatively dry finish are commonly suggested as a major reason for poorer yields and poorer responses to applied N. Other views include, N depletion in the sub-soil, possibly largely because of under-fertilising crops and the gradual move away from lucerne and legume-grass pastures in the crop rotation. Poor responses to N may also be exacerbated by late in-crop application, where there is insufficient rainfall and/or time for N to move deeper into the profile.

It is also felt that while sufficient N was applied to crops, it may only be generally available higher in the soil profile. As crops matures applied N may not be readily available because of dry top soil and because plants are mainly only extracting moisture from deeper in the soil profile where N available may be poor.

It is also possible that nitrogen is lost from the system. Research conducted in South Australia[1] noted that under favourable climatic conditions N losses from volatilisation alone can be as high as 1% per day (not including losses from denitrification or leaching). However, it might also be expected that any residual N in the soil should be available for the subsequent crop, possibly lower in the profile.

[1]http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Nitrogen-decision-Guidelines-and-rules-of-thumb#sthash.w5RNgxB7.dpuf

The trial was designed to assess effect of different N application timing on yield and grain quality, including fallow application, and its movement through the soil profile.

Aims

- Assess the benefit of N application at the start of the fallow period. Early application may facilitate the N movement deeper into the profile as moisture moves deeper as the fallow period and season progresses.
- Determine if deeper N movement into the soil profile offers any improvement in crop yield or protein.
- Assess measurable N recovery rates and movement.
- Assess impact of N movement on higher and lower biomass varieties.

Methods

A full factorial randomized completed block design was used, with 3 replications. Small plots were used approximately 2 by 10 m in size.

Table 1. Trial site details

Trial Establishment Date	Summer 2015/16		
Crop and Variety	Wheat - Gregory$^{\Phi}$ and Lancer$^{\Phi}$	Seeding rate	55 kg/ha
Sowing date	20/5/2016	Harvest Date	6/12/2016
Seedling equipment	Double Boot Tyne	Row Spacing	27.5 cm
Crop Nutrition (kg/ha)	100 Triphos	Soil type	Red Kandosol, sandy clay loam
Previous Crop	Canola	Pre-Sowing stubble management	Direct drilled (windrows burnt)
Soil test results (at sowing)	Colwell P ~ 23 ppm, Sulphur ~ 7 ppm	Nitrogen	0-30cm ~ 42 kg/ha,

The following treatments were assessed:

- **Variety**: high and low biomass, Gregory$^{\Phi}$ and Lancer$^{\Phi}$ respectively
- **Nitrogen rates**: 0, 50, 100 and 200 kg/ha
- **Nitrogen timing:** Early Fallow, Mid Fallow, Sowing and Topdressing (at Z30)

Table 2. Treatment N timings

Fallow	07/01/16
Mid Fallow	21/03/16
Sowing	20/05/16
Topdressing	18/08/16 (Z30)

Results were analysed using ANOVA and treatments compared with LSD method at a 95% confidence interval. Any references to differences between treatments should be assumed to be statistically different unless otherwise stated.

Rainfall 2016[2]:

Month	Rainfall (mm)
Nov-15	55
Dec-15	44
Jan-16	93
Feb-16	55.9
Mar-16	5
Apr-16	22
May-16	73
Jun-16	95
Jul-16	69
Aug-16	49
Sep-16	169
Oct-16	117
Nov-16	30

Rainfall comments:

- 339 mm fallow rainfall (1 Nov 15 – 20 May 16)
- 538 mm in-crop rainfall (21 May 16 – 30 Nov 16)

Soil cores to 90 cm were collected at sowing from the 'Fallow' and 'Mid Fallow', where 0, 100 and 200 kg N/ha was applied to Gregory treatments. These cores were split into 3 depths (0-30, 30-60 and 60-90 cm from the soil surface) and tested for Nitrate Nitrogen and Ammonium Nitrogen. Soil cores were collected from directly over the drill line (i.e. where the urea was initially placed).

Results

Soil test analysis confirmed the site status was low in N and showed an increase is soil nitrates in line with fertiliser treatments. Proportionally, more N was detected in the mid fallow application compared to the early fallow. More N was detected where greater rates were applied.

Early fallow N treatment tended to have higher nitrate in the 30-60 cm depth layer than either the mid fallow or the UTC. There were negligible differences in soil N between the treatments below 60 cm (Figure 1).

[2] APSIM weather station number = 055017, station name = Premer (Edan Moor)

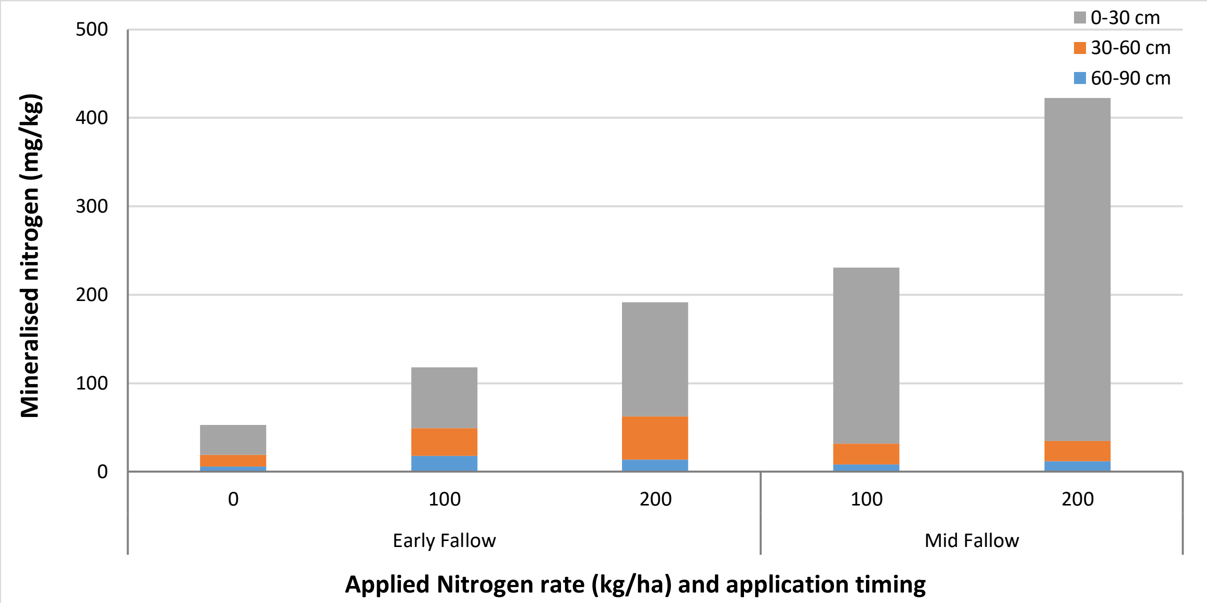

Figure 1. Mineralised nitrogen (nitrate plus ammonium) (kg/ha) at planting for different rates of nitrogen applied during the fallow for 3 soil profile segments (measured in cm from the soil surface) for three nitrogen application rates (kg/ha) and 2 application timings.

Yield, N response: Yield showed clear response to nitrogen. N application regardless of rate or timing increased yields by an average of 6.1 (no applied N) to 7.7 t/ha (200 kg N/ha),

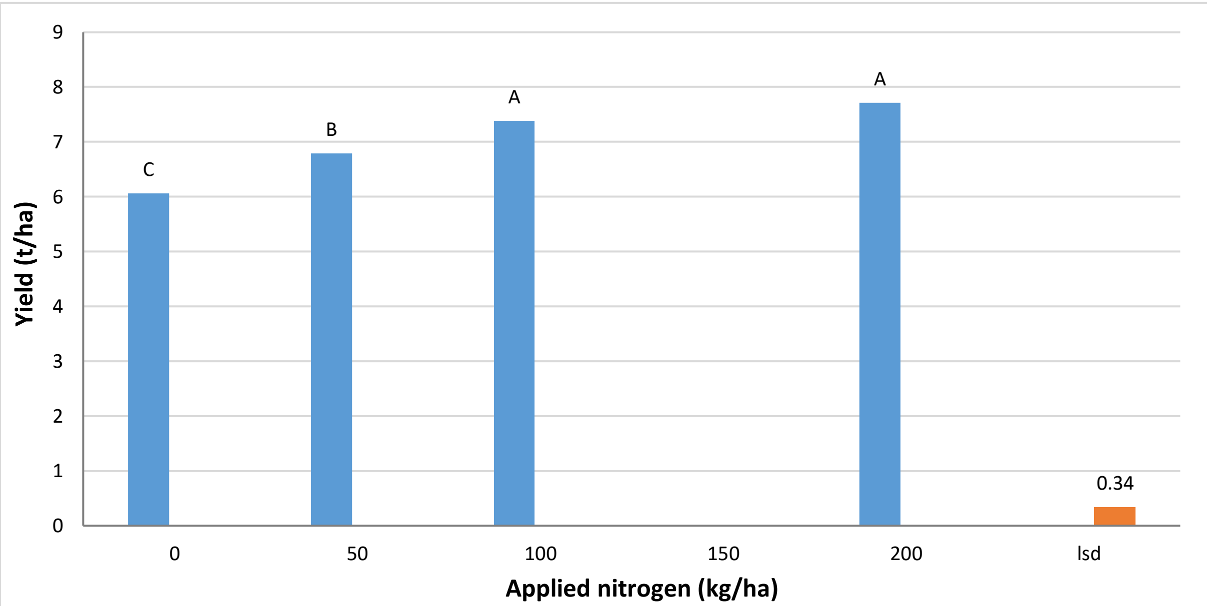

Figure 2.

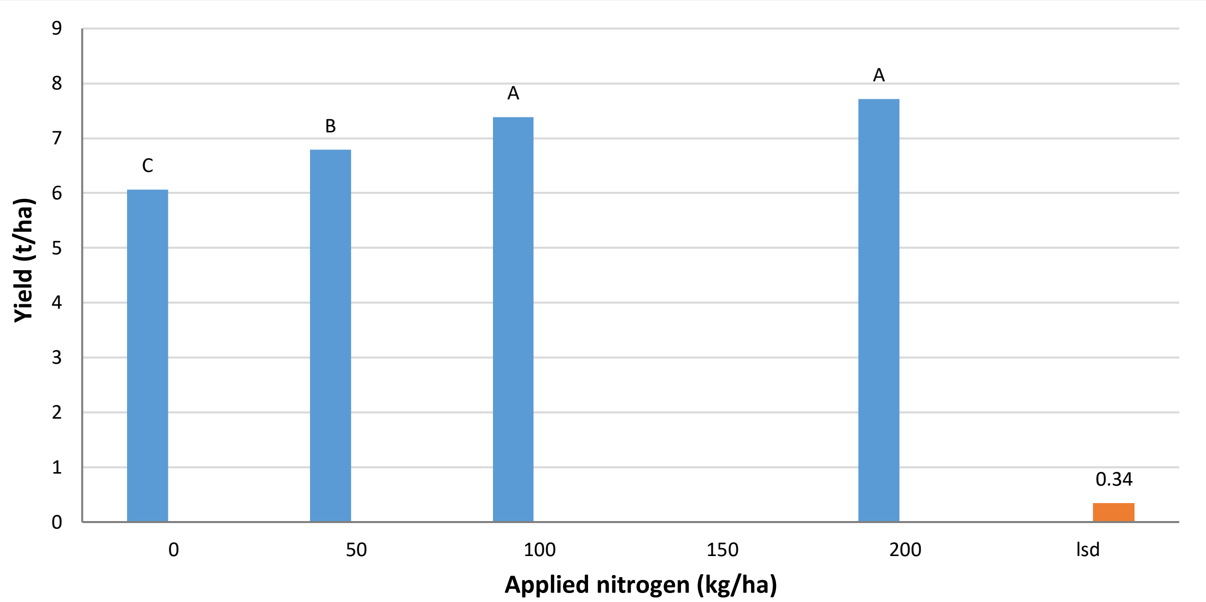

Figure 2. Yields (t/ha) (averaged for application timing and variety) for different Nitrogen application rates (kg/ha). Treatments with the same letter are not significantly different.

Yield, variety response: Gregory⦸ (higher biomass line) out yielded Lancer⦸ (lower biomass line) by an average of close to 400 kg/ha.

Yield, timing of N application response: There was very little influence of N application timing on yields (Figure 3). Sowing N treatment yielded about 500 kg/ha less than topdressing timing.

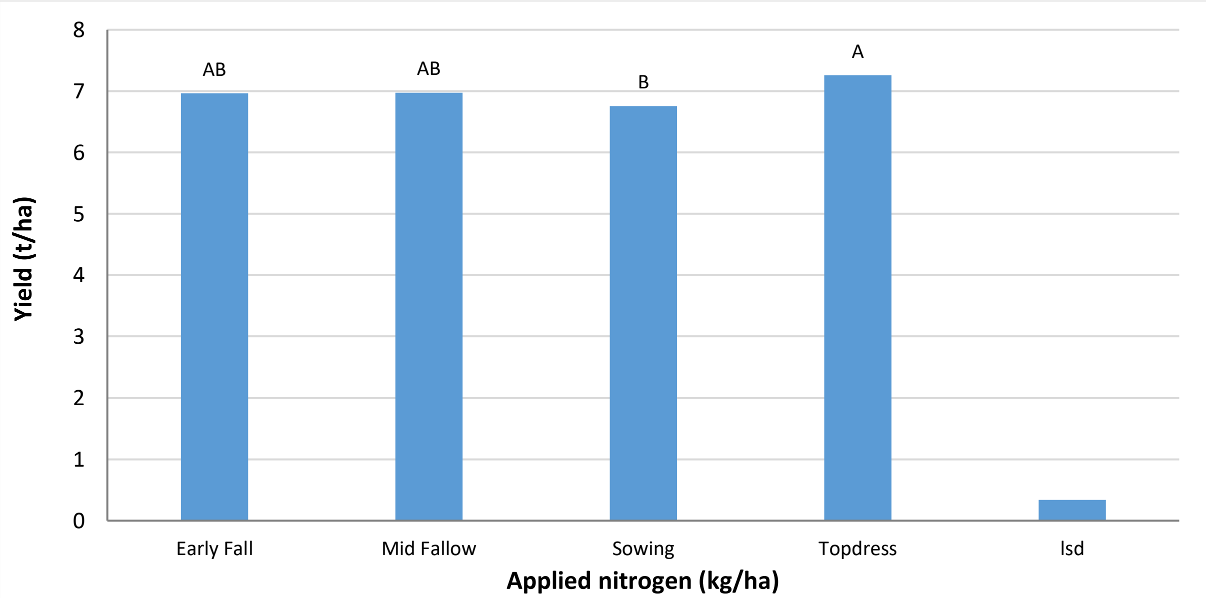

Figure 3. Yields (t/ha) (averaged for rate and variety) for the different Nitrogen application timings (kg/ha). Treatments with the same letter are not significantly different.

Yield, interaction between variety, nitrogen rate and timing: there were no significant interactions between timing, N rate and variety.

Grain quality Protein; There was varietal difference in both protein and screenings, with high biomass line Gregory⦸ having higher screenings and lower protein than Lancer. Protein levels increased with increasing nitrogen rates and later application timings. Screenings tended to decrease as N rate increased (Table).

Table 3. Grain protein and screenings (%) for the different rates of Nitrogen (kg/ha). Values with the same letter are not significantly different.

Variety	Protein	Screenings
Gregory⑴	10.3 A	1.9 A
Lancer⑴	10.8 B	1.6 B
L.S.D	0.3	0.1
Timing	**Protein**	**Screenings**
Early Fallow	10.4 A	1.8 AB
Mid Fallow	10.4 A	1.8 AB
Sowing	10.2 A	1.9 A
Topdress	11.0 B	1.7 B
L.S.D	0.4	0.2
N rate	**Protein**	**Screenings**
0	9.1 A	2.0 A
50	9.8 B	1.8 B
100	11.0 C	1.7 BC
200	12.2 D	1.6 C
L.S.D	0.4	0.2

Discussion

Soil nitrogen: Very high rates of soil N were recorded in the mid-fallow application treatment when assessed at sowing. Most likely explanation is resulting from testing directly over the drill line. It is highly likely that urea had not sufficient time to move laterally or vertically into surrounding soil. Implications of this is that amounts of measured nitrogen are likely to be an overestimation of available soil N across the whole profile, as it is highly possible soil between the bands has much lower N. In addition, soil testing at planting (~50mg/kg) appeared to provide a poor indication of starting soil nitrogen status, when taking into account high yields (6 t/ha) where no N was applied.

What is consistent is low levels of nitrate deeper in the soil, likely indicating that virtually none of the urea applied in the fallow had moved deep into the profile. There were some differences in nitrate levels detected in the 30-60 cm layer, particularly at the highest N rate.

While N measured in the 60-90 cm depth was negligible, more was detected where N had been applied than where it had not. Fallow N application did allow some N to move deeper into the soil (30-60 cm zone), however, this did not have any beneficial influence on yield or grain quality. It is feasible that the extremely wet conditions and soft finish in 2016 allowed for optimal utilisation of nitrogen regardless of where it was available in the profile.

Yields: Very high yields were achieved, with an average of over 6 t/ha even where no N was applied. Highest yields, 7.7 t/ha, were achieved at the highest rate of nitrogen (200 kg N/ha). However, this was not statistically different to 100 kg N/ha and it appears the response had plateaued. 100 kg N/ha resulted in a yield increase of approximately 1.3 t/ha over where no additional N was applied.

There was no yield or quality advantage or disadvantage to application of urea in the fallow compared to sowing time. There was however a small protein advantage from topdressing urea (in line with other research[3]).

Results from this site suggest that fallow application of N can be as efficient as sowing or in-crop applications. While small amounts of N did move down the profile, this had no influence on yields or grain quality (in a very wet season).

Conclusions

Increasing rates of N increased yields and grain quality.

In a very wet season delaying N (until Z30) improved grain quality.

Early and mid-fallow nitrogen application did not significantly improve yield or quality, compared to a sowing application at this site.

Acknowledgements

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[3] https://grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Nitrogen-decision-Guidelines-and-rules-of-thumb

Appendix

Variety	N Timing	N rate (kg/ha)	YIELD (t/ha)	Screenings (%)	Protein (%)
0	Early Fallow	Gregory	5.9 JKL	2.4 A	8.0 S
50	Early Fallow	Gregory	6.5 FGHIJKL	1.8 CDEFGHIJ	9.4 MNOPQR
100	Early Fallow	Gregory	7.8 ABCDE	1.7 EFGHIJ	10.8 FGHIJ
200	Early Fallow	Gregory	7.9 ABCD	1.5 IJK	12.4 ABC
0	Sowing	Gregory	6.7 FGHIJ	2.0 ABCDEFGH	9.7 KLMNOPQ
50	Sowing	Gregory	6.8 EFGHI	2.1 ABCDEF	10.0 IJKLMNOP
100	Sowing	Gregory	7.1 CDEFGH	2.0 BCDEFGHI	9.9 JKLMNOPQ
200	Sowing	Gregory	7.2 CDEFG	2.1 ABCDE	10.9 EFGHI
0	Topdress	Gregory	6.5 GHIJKL	2.4 AB	9.0 OPQRS
50	Topdress	Gregory	7.4 ABCDEF	1.7 EFGHIJK	10.5 FGHIJKL
100	Topdress	Gregory	8.2 AB	1.8 DEFGHIJ	11.1 DEFGH
200	Topdress	Gregory	8.3 A	1.4 JK	12.7 AB
0	Mid Fallow	Gregory	6.1 IJKL	2.2 ABC	8.7 RS
50	Mid Fallow	Gregory	7.3 BCDEFG	2.0 ABCDEFG	8.9 QRS
100	Mid Fallow	Gregory	7.4 ABCDEFG	2.0 BCDEFGHI	10.7 FGHIJK
200	Mid Fallow	Gregory	7.8 ABCD	1.7 EFGHIJK	12.0 ABCD
0	Early Fallow	Lancer	5.8 JKL	2.2 ABCD	9.0 PQRS
50	Early Fallow	Lancer	6.7 FGHIJ	1.6 GHIJK	10.0 IJKLMNO
100	Early Fallow	Lancer	7.2 CDEFG	1.7 EFGHIJK	11.1 DEFGH
200	Early Fallow	Lancer	7.9 ABC	1.4 JK	12.8 AB
0	Sowing	Lancer	5.7 L	1.6 GHIJK	9.3 NOPQR
50	Sowing	Lancer	6.2 HIJKL	1.6 FGHIJK	9.2 NOPQR
100	Sowing	Lancer	7.0 DEFGHI	1.6 FGHIJK	11.4 CDEF
200	Sowing	Lancer	7.3 BCDEFG	1.8 CDEFGHIJ	11.2 DEFG
0	Topdress	Lancer	5.7 KL	1.7 EFGHIJK	9.6 LMNOPQR
50	Topdress	Lancer	6.6 FGHIJKL	1.8 DEFGHIJ	10.3 GHIJKLM
100	Topdress	Lancer	7.4 ABCDEFG	1.5 JK	11.9 BCDE
200	Topdress	Lancer	7.8 ABCDE	1.3 K	13.0 A
0	Mid Fallow	Lancer	6.2 HIJKL	1.8 CDEFGHIJ	9.2 NOPQR
50	Mid Fallow	Lancer	6.7 FGHIJK	1.6 HIJK	10.2 HIJKLMN
100	Mid Fallow	Lancer	7.0 CDEFGHI	1.5 IJK	11.1 DEFGH
200	Mid Fallow	Lancer	7.4 ABCDEFG	1.5 JK	12.6 AB
lsd			1.0	0.5	1.0