GOA Site Report

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

Trial Code: GONU00417-2

Season/years: Summer 2016/17

Location: 'Glenaroo', Fifield

Collaborators: Gordon Larkins

Keywords

GONU004, wheat nutrition, nitrogen rates, fallow nitrogen, nitrogen, Fifield

Take home message

Applying nitrogen in the fallow did not result in movement of N deeper into the profile

Applying nitrogen in the fallow did not provide anticipated grain quality or yield benefits, however, neither did it result in penalties when compared to conventional application timings (all timings much the same yield).

Yield gains from N application were significant and profitable.

Background

In recent years, there has been anecdotal reports of lower than expected grain protein and yields despite application of adequate levels of nitrogen in winter crops grown in the GOA region. A general view is that this has tended to occur in seasons with a relatively dry finish, and likely to be as a result of depletion of nitrogen (N) from the sub-soil combined with a possible history of under-fertilising crops and the gradual move away from lucerne and legume-grass pasture rotations. Another aspect is that although sufficient N was applied through later topdressings, it was generally only available higher in the soil profile and therefore not readily available where the plants were extracting moisture, i.e. from depth.

It is also possible that the poorer performances are due to nitrogen being lost from the system. South Australian[1] research found that under conducive climatic conditions losses from volatilisation alone can be as high as 1% per day (this doesn't include losses from denitrification or leaching).

If it is the case that topdressed nitrogen becomes 'perched', it might be expected that this N should be available for subsequent crops, and with the advantage of time, possibly lower in the profile.

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

Aims

Project main aims:

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

- Determine effect of N application at the start of the fallow period and would it facilitate N movement deeper into the profile as fallow moisture moved deeper in the profile.
- Determine if deeper N movement into the profile offered any improvement in crop yield or protein.
- Assess impact of N movement on higher and lower biomass varieties.

Methods

The trial used a full factorial randomised completed block design, with 3 replications. Small plots were used approximately 2 x 10 m in size.

Table 1. Trial site details

Trial Establishment Date	Summer 2016/17		
Crop and Variety	Wheat - Gregory$^{(D}$ and Lancer$^{(D}$	**Seeding rate**	55 kg/ha
Sowing date	5/5/2017	**Harvest Date**	15/11/2017
Seedling equipment	Double Boot Tyne	**Row Spacing**	27.5 cm
Crop Nutrition (kg/ha)	160 Triphos	**Soil type**	Clay Loam
Previous Crop	Wheat	**Pre-Sowing stubble management**	Direct Drilled
Soil test results (at sowing)	Colwell P ~ ppm, Sulphur ~ ppm	**Nitrogen**	0-10cm ~ kg/ha 10-90cm ~ kg/ha

Treatments included:

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

Table 2. Nitrogen application timings

Fallow	12/1/2017
Mid Fallow	28/3/2017
Sowing	5/5/2017
Topdressing	2/8/2017

Table 3. Rainfall 2016

Month	Rainfall (mm)[2]
Jan	21.8
Feb	0.4
Mar	145.6
Apr	13.8
May	7.8
Jun	3.8
Jul	24.6
Aug	20
Sep	3.8
Oct	63.8
Nov	1.8

Rainfall comments:

- 155 mm fell between early and mid-fallow timings
- 26 mm fell between mid-fallow and sowing timings
- 36 mm fell between sowing and topdressing timings
- 124 mm in-crop rainfall

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

Soil cores to 60 cm were collected at sowing from where 0, 100 and 200 kg/ha N was applied at the 'Early Fallow' timing. Cores were collected from directly over the fertiliser band. These cores were split into 5 depths (0-10, 10-20, 20-30, 30-45 and 45-60 cm from the soil surface) and tested for two forms of nitrogen, nitrate and ammonium.

Results

Soil testing

Testing revealed that most of the nitrogen remained in the top 10 cm (**Figure 1**), while **Figure 2** clearly shows that very little N moved below 30 cm.

[2] Data from SILO: Mumblepeg (Station number 051005)

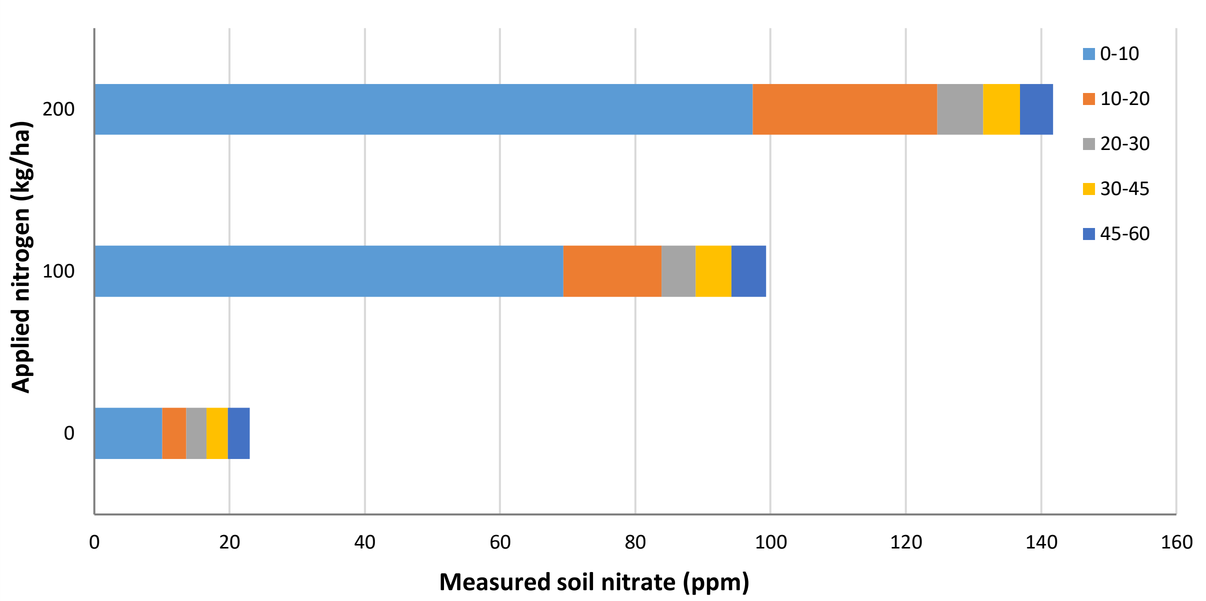

Figure 1. Soil nitrate (ppm) tested at planting for different rates of nitrogen applied during the fallow for 5 soil profile segments (measured in cm from the soil surface).

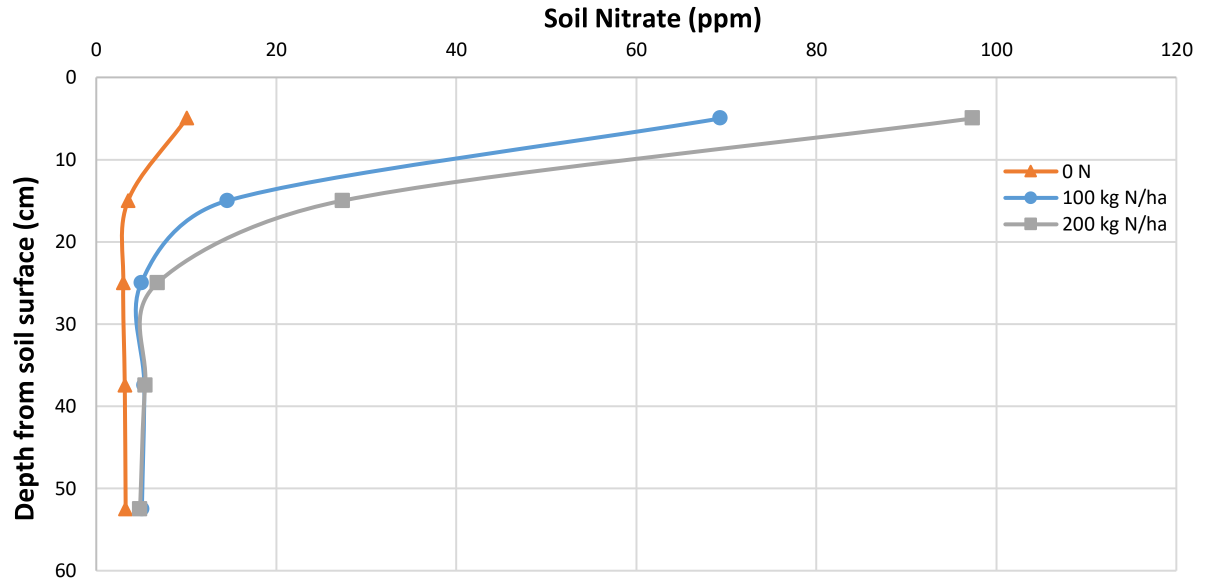

Figure 2. Soil nitrate (ppm) tested at planting for different rates of nitrogen applied during the fallow for 4 soil profile segments (measured in cm from the soil surface).

Vegetation Index

Crop vegetation was measured using a 'GreenSeeker' NDVI at 110 days after sowing (DAS). There was a response to both timing and rate but not variety. NDVI readings increased with increasing rates of applied N (**Figure 3**) and all treatments where N was applied had a higher vegetation index than 0 N treatments. Where nitrogen was applied in both fallow timings they had a greater NDVI reading than where N was applied at sowing. Vegetation index of the control was not different to the Topdressing treatment.

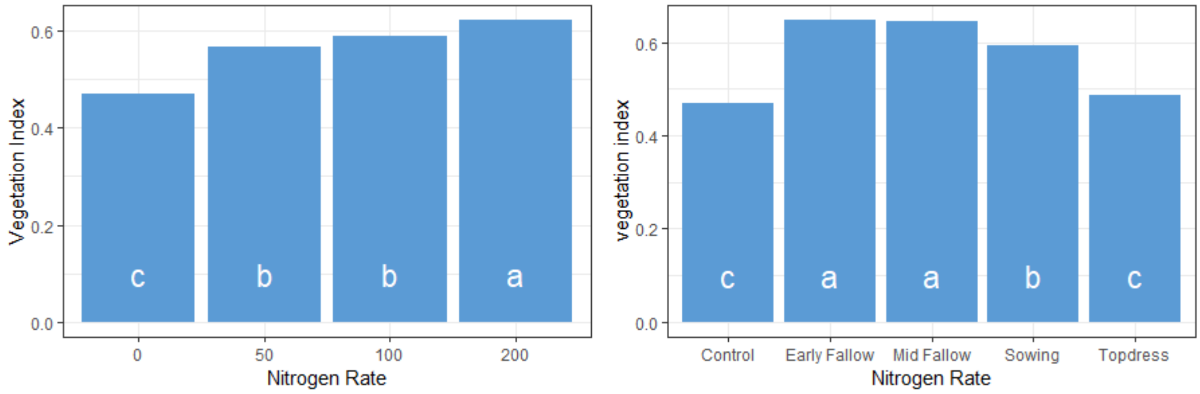

Figure 3. Vegetation Index (NDVI) 110 days after sowing for the various nitrogen timings and application rates (*Treatments with the same letter are not significantly different.)

Yield

Harvest yields showed a yield response to nitrogen. Application of N regardless of rate or timing increased yields from an average of 2.1 (no applied N) to 3.0 t/ha

Timing of N application: There was no difference between fallow and sowing N treatments (when assessed in isolation from rate and variety), with all out yielding the UTC.

Nitrogen rates: Yields increase with increasing applied nitrogen up to 100 kg/ha, (Figure 4) after which yields plateaued. Yield difference between no nitrogen and 100 kg/ha N was approximately 0.8 t/ha

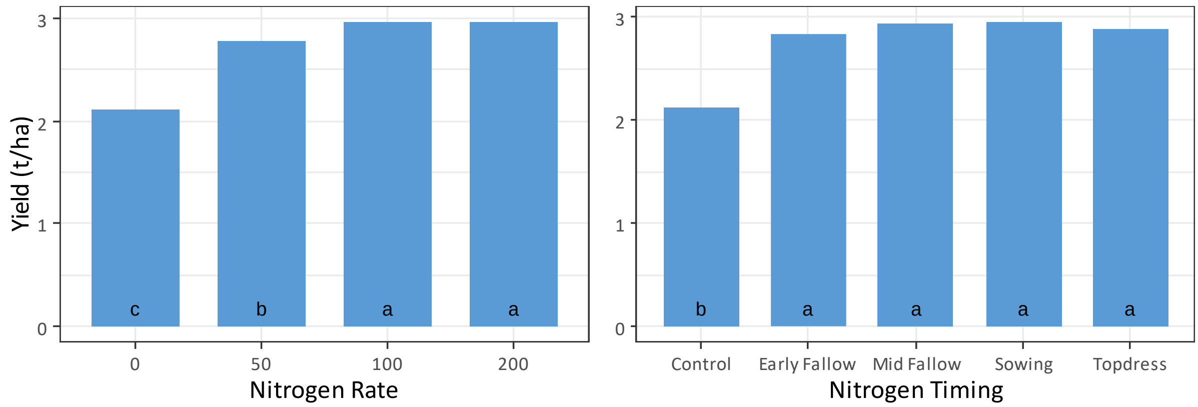

Figure 4. Average yield (by variety and timing of N application) (t/ha) for different nitrogen application rates (kg/ha) regardless of timing or variety.
*Treatments with the same letter are not significantly different.

There was no difference in yield of the high and low biomass lines nor was there any interaction between timing and rate. There was a tendency for yields to increase with rate for the mid and sowing timings, while for topdressing treatment there was no statistical difference in yields between lowest and highest rates (

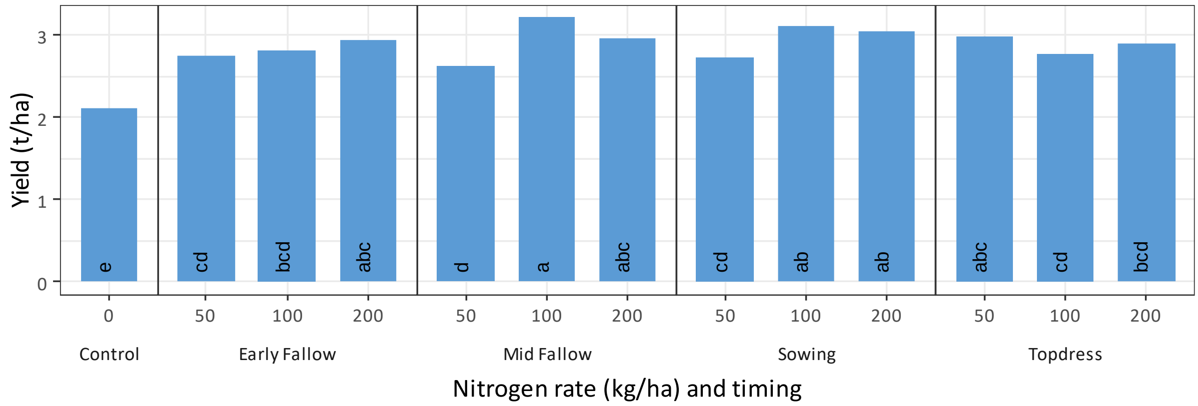

Figure 5).

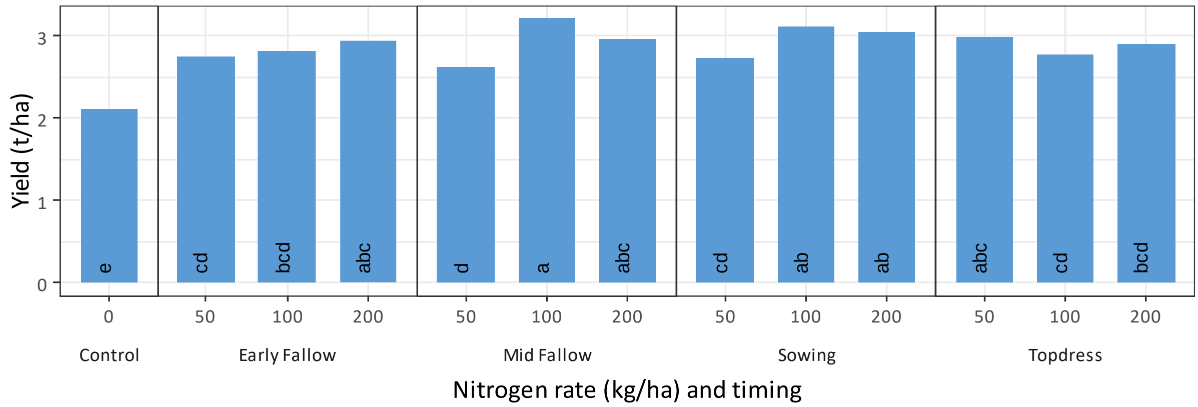

Figure 5. Average yield (by nitrogen rate and timing, t/ha) regardless of variety.
*Treatments with the same letter are not significantly different.

Protein and screenings

Protein increased as rate of N increased while screenings decreased (Table **2**), and the protein increases were enough to improve the bin grades. The 0 N treatments would have been graded ASW compared to the 200 N treatments that would have been graded as Australian Prime Hard. There was a Protein response to N timing, where fallow treatments having higher protein levels than either sowing or topdressing treatments (Table **2**). However, only the mid-fallow treatment would have made APH, and all other treatments would be placed into the same grade (H2). There were small differences in screenings with topdressing N tending to be higher than early fallow treatment.

Table 2. Grain protein and screenings (%) for the different rates of nitrogen (kg/ha) and timings. Treatments with the same letter are not significantly different.

Applied N	Protein		Screenings		Timing	Protein		Screenings	
200	13.8	a	3.6	a	**Topdress**	11.9	c	2.4	b
100	12.4	b	2.5	b	**Sowing**	12.3	b	2.2	bc
50	11.2	c	2.1	c	**Mid Fallow**	13.1	a	2.1	bc
0	9.3	d	1.9	c	**Early Fallow**	12.7	a	1.9	c
					Control	9.3	d	3.6	a

Discussion

Soil nitrogen: Movement of nitrogen deeper into the soil profile was much less than expected. N application at early fallow timing did not result in significant amounts of N moving deeper than 20 cm into the profile, even though there was close to 180 mm of rain between application and soil testing.

Movement of nitrogen deeper in the soil is likely to be a function of time and rainfall (amount and pattern) and in the 2017 fallow there was not enough rainfall to wet up the subsoil, and without a pathway neither did the N mover deeper into the profile)

Yields: There was a positive yield response that tended to increase with increasing N rate, though this depended to some degree on application timing. Yield response tended to peak at about 50 kg/ha, however, there was no yield differences between various timings. The crop did not 'hay' off at higher nitrogen rates, despite what is normally expected to occur in a relatively dry spring finish.

Protein and screenings: Protein levels increased with increasing N rates while screenings decreased. Topdressing N application had lower protein than other timings, however timing had no influence on screenings. There is some anecdotal evidence that screenings tend to increase at high nitrogen rates, but this was not the case in this trial, and probably reflects the observation that the crop did not 'hay off'.

Applying fertilizer to increase protein levels proved to be a challenge. It took the addition of 200 kg N/ha lift the protein levels enough to make 'Australian Prime Hard'. This tends to follow general rule of thumb views for nitrogen response, where in a highly responsive situation a large yield response may be associated with little change in protein[3].

Application of nitrogen in the fallow did not achieve any improved outcomes (improved yields and grain quality) compared to a sowing application. It is likely that there was not enough time or rainfall between application and sowing to move nitrogen deeper into the profile. On the other hand this (and other GOA trials) have provided excellent insight into understanding the speed (or lack of it) of movement of nitrogen deeper into our profiles in the Central West environment.

Conclusion

Applying N in the fallow did not result in nitrogen moving deeper than about 20 cm into the soil profile.

Fallow N application did not adversely affect yields nor it did not necessarily provide any benefits in increased protein (nor reduced screenings). Overall there was, a strong yield and a moderate protein response to applied nitrogen.

There tended to be a plateau in yield response to N somewhere between 50 and 100 kg N/ha. There was no observed 'haying off' that might have been expected with high N rates, nor did screenings increase.

Some caution needs to be taken when applying N in fallows at higher rates, as potential losses can be considerable, particularly, if conditions are hot and wet, especially where very high (most likely non-commercial) rates are applied (i.e. 200 and or more kg N/ha)

Acknowledgements

Research undertaken as part of this project is made possible by significant contributions of growers through both trial cooperation and support of GRDC. The authors thank them for their continued support. Special thanks to Gordon Larkins for hosting this trial.

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[3]http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2013/02/Nitrogen-decision-Guidelines-and-rules-of-thumb#sthash.7wBkwMIc.dpuf

Appendix

Variety	Nitrogen timing	Nitrogen rate (kg/ha)	Yield (t/ha)	LSD (yield)	Protein (%)	LSD (protein)	Screenings (%)	LSD (screenings)
Gregory	Control	0	2.2	ij	8.7	n	4.6	a
	Early Fallow	50	2.7	efgh	10.1	lm	2.3	cdefgh
		100	2.8	cdefgh	12.3	fghi	2.3	cdefgh
		200	2.9	bcdefgh	13.8	bc	1.6	fghi
	Mid Fallow	50	2.7	efgh	11.2	jk	2.8	bcde
		100	3.2	abcd	11.9	fghij	2.1	defghi
		200	2.5	ghi	14.6	ab	1.8	efghi
	Sowing	50	2.6	fgh	10.8	kl	2.9	bcd
		100	3.2	abcd	11.5	ijk	3.5	b
		200	3.0	abcdef	12.4	fgh	2.5	bcdefg
	Topdress	50	3.2	ab	10.2	lm	3.2	bc
		100	2.8	defgh	10.9	jkl	2.6	bcdef
		200	2.9	bcdefgh	11.5	ijk	3.2	bc
Lancer	Control	0	2.1	j	9.9	m	2.7	bcd
	Early Fallow	50	2.8	defgh	11.6	hijk	2.2	defghi
		100	2.8	cdefgh	13.5	cd	1.6	fghi
		200	3.0	abcdef	15.0	a	1.3	hi
	Mid Fallow	50	2.5	h	11.5	ijk	2.9	bcd
		100	3.2	abc	14.1	bc	1.5	ghi
		200	3.4	a	15.1	a	1.8	efghi
	Sowing	50	2.8	defgh	11.7	ghij	1.8	efghi
		100	3.0	abcdef	12.6	efg	1.3	hi
		200	3.1	abcde	14.6	ab	1.3	i
	Topdress	50	2.7	efgh	12.4	fgh	1.9	efghi
		100	2.7	efgh	12.7	def	1.9	defghi
		200	2.9	bcdefg	13.4	cde	1.3	hi