GOA Site Report

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

Trial Code: GONU00417-1

Season/years: Summer 2016/17

Location: 'Old Gwandalan', Peak Hill

Collaborators: Paul Bell

Keywords

GONU004, wheat nutrition, nitrogen rates, fallow nitrogen, Nitrogen, Peak Hill

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 additional grain quality or yield compared to applying at sowing. However, neither did it result in penalties compared to conventional application timings.

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.

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

Aims

Main aims:

- Determine effect of N application at the start of fallowing and if it would facilitate movement of N deeper into the profile (as moisture moved deeper).
- Determine if deeper movement of N into the soil 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⦹ and Lancer⦹	**Seeding rate**	55 kg/ha
Sowing date	16/5/2017	**Harvest Date**	21/11/2017
Seedling equipment	Double Boot Tyne	**Row Spacing**	27.5 cm
Crop Nutrition (kg/ha)	150 Triphos	**Soil type**	Clay Loam
Previous Crop	Wheat	**Pre-Sowing stubble management**	Direct Drilled
Soil test results (at sowing)	Colwell P ~ 14 ppm, Sulphur ~ 8 ppm	**Nitrogen**	0-10cm ~16 kg/ha 10-90cm ~ 12 kg/ha

T Following treatments were used:

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

Table 2. Nitrogen application timings

Fallow	12/1/2017
Mid Fallow	29/3/2017
Sowing	16/5/2017
Topdressing	6/10/2017

Table 3. Rainfall: 2016

Month	Rainfall (mm)[2]
Jan	19.4
Feb	0
Mar	117.2
Apr	21.2
May	51.6
Jun	1.2
Jul	10.2
Aug	13.8
Sep	5
Oct	61.8
Nov	3.6

Rainfall comments:

- 132 mm fell between the early and mid-fallow timing
- 30 mm fell between mid-fallow and sowing time
- 77 mm fell between sowing and topdressing timings
- 142 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 '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 little N moved below 30 cm.

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

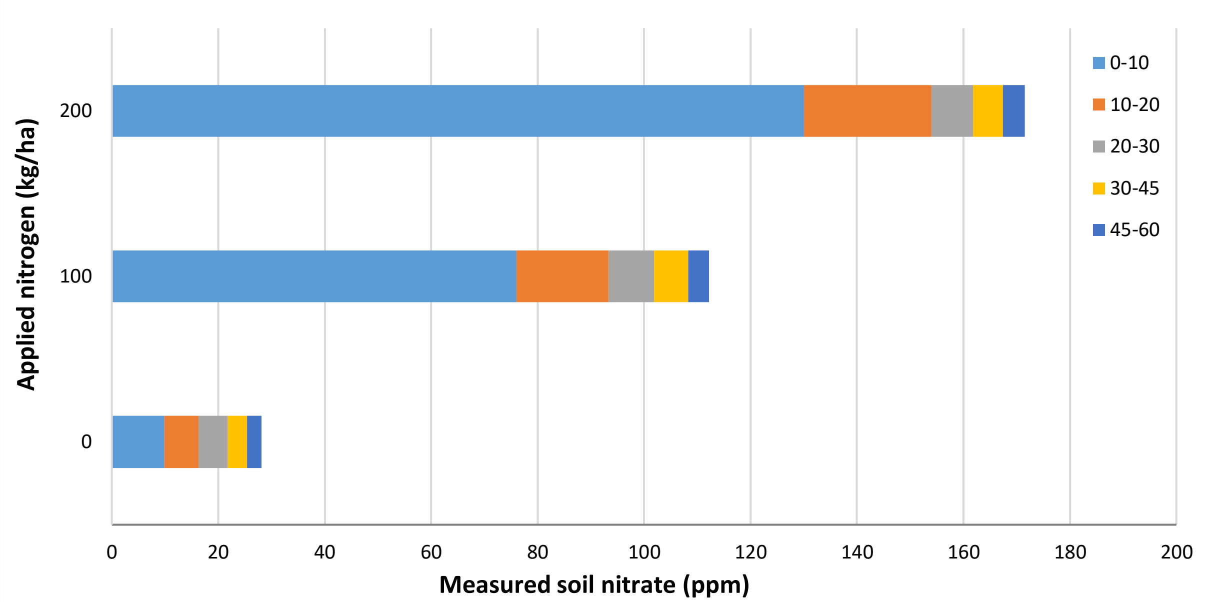

Figure 1. Soil nitrate (ppm) tested at planting for different N rates applied during the fallow for 5 soil profile segments (measured in cm from the soil surface).

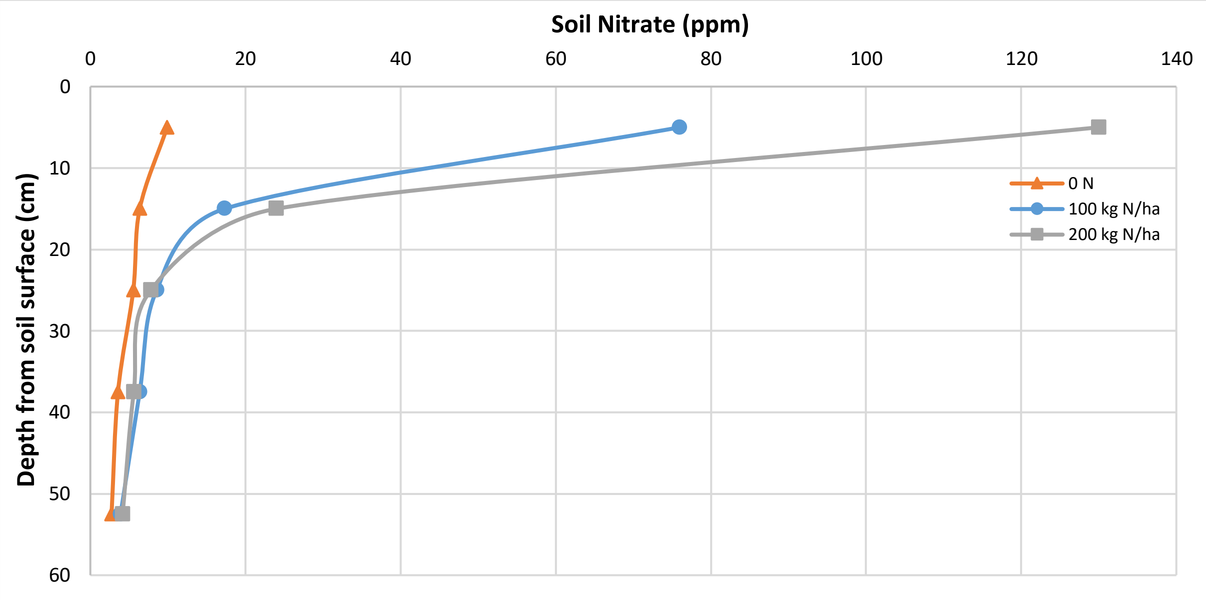

Figure 2. Soil nitrate (ppm) levels at planting for different N rates applied during the fallow for 4 soil profile segments (measured in cm from the soil surface).

Crop vegetation was measured using a 'GreenSeeker' NDVI at 111 days after sowing (DAS). There was a response to both timing and rate but not variety. Where nitrogen was applied in the fallow and at sowing greater NDVI readings than where N was applied as topdressing or where no N was applied were recorded. The NDVI readings increased with increasing rates of applied N (**Figure 3**) and all treatments where N was applied had higher vegetation index than the 0 N treatments.

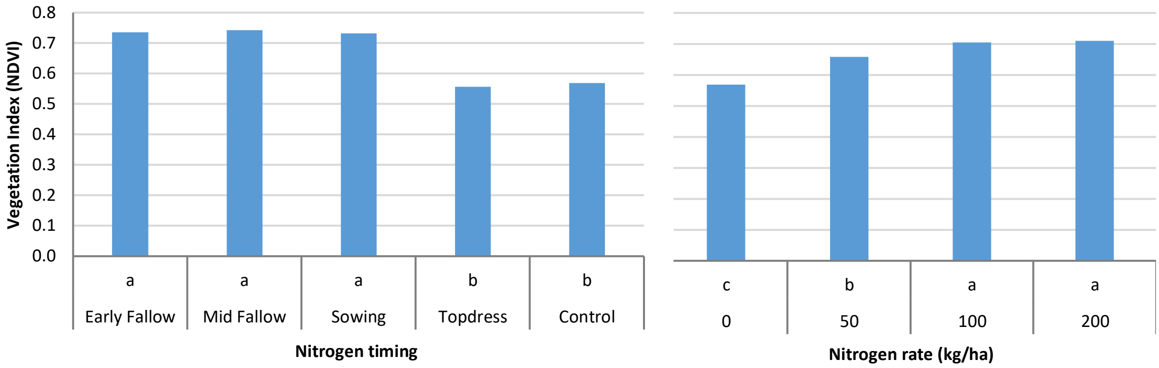

Figure 3. Vegetation Index (NDVI) 111 days after sowing for the various nitrogen timings and application rates

Yields

Harvest yields showed a yield response to nitrogen. Regardless of rate or timing increased yields were from an average of 2.9 (no applied N) to 3.9 t/ha. There was no difference in yield between high and low biomass lines.

Timing of N application: The timing of nitrogen application (in isolation from rate and variety) resulted in no difference between the fallow and sowing timing treatments. Both fallow treatments and the sowing treatment out yielded the topdress and UTC.

Nitrogen rates: Yields increased with increasing applied nitrogen up to 100 kg/ha (Figure 4), after which yields plateaued. Difference in yield between no nitrogen and 100 kg/ha was approximately 0.8 t/ha

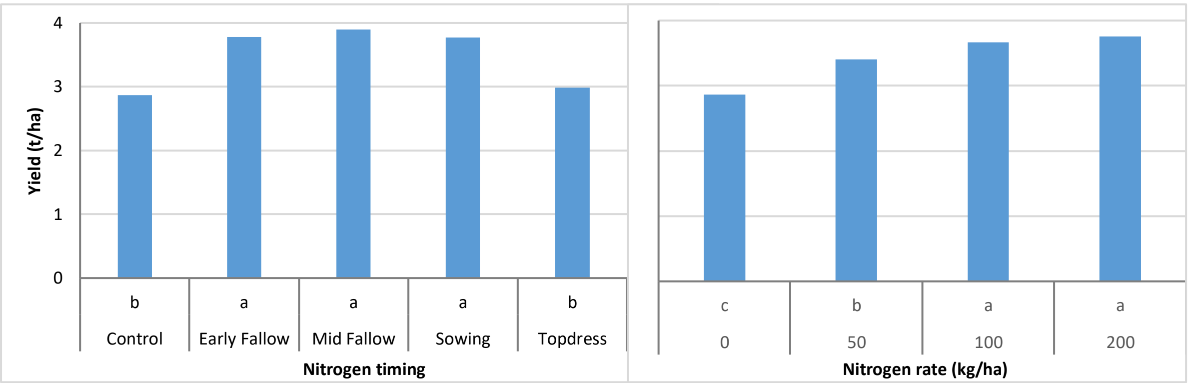

Figure 4. Average yield (by variety and timing of N application) (t/ha) for different nitrogen application rates (kg/ha) regardless of timing or variety. Treatments with the same letter are not significantly different.

There was no interaction between timing and rate.

Protein and screenings

Protein increased as N rate increased while screenings decreased (Table 2). Both grain quality parameters would result in significant grade upgrades. The 0 N treatments would have been graded as AGP1 grade while the 200 N treatment would have made Prime Hard (APH).

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

Applied N	Protein		Screenings	
200	13.8	a	4.5	c
100	12.9	b	5.0	bc
50	11.6	c	5.2	b
0	9.3	d	6.5	a

There was a protein response to timing, the Topdress treatment (**Figure 5**) had a higher protein than other timings. Sowing timing also had higher protein than Early Fallow Timing. These levels would result in improved quality grades.

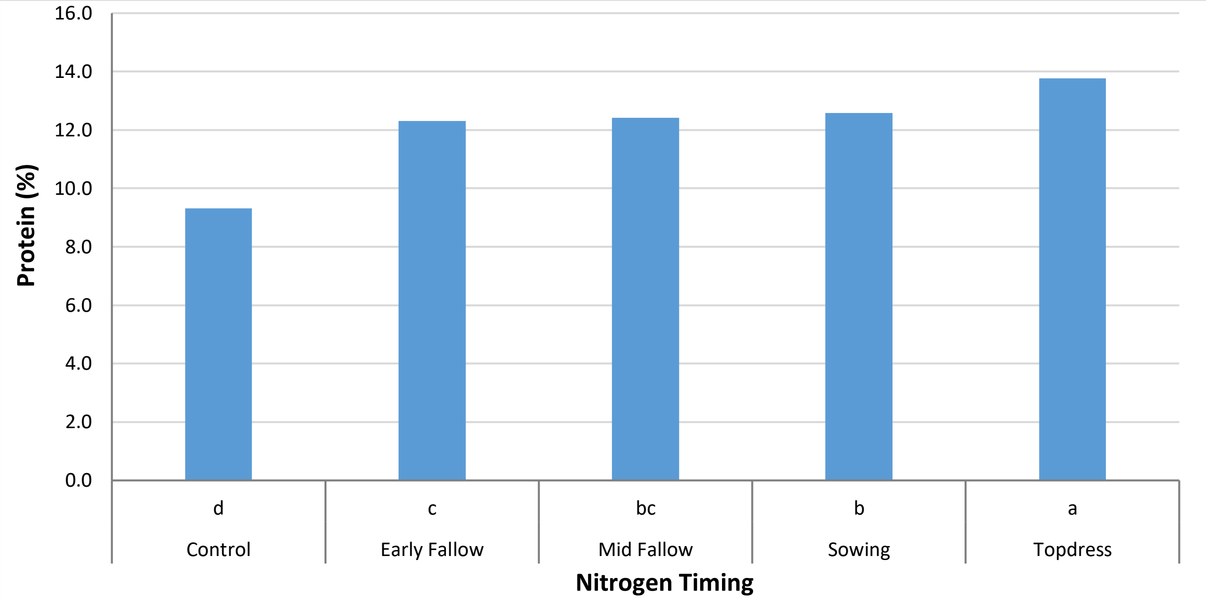

Figure 5. Average Protein (%) by time of application. Treatments with the same letter are not significantly different.

Discussion

Soil nitrogen

Movement of nitrogen deeper into the soil profile when it was applied at early fallow was limited to about 20 cm depth, even though there was close to 160 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). The 2017 fallow did not receive enough rainfall to wet up the subsoil (or facilitate moving nitrogen deep into the profile).

Yield

There was a positive N yield response that tended to increase with increasing N rate, though this depended on application timing. Yield response tended to peak at about 100 kg/ha for fallow and sowing timings. There was no yield response to topdressing treatments. The crop did not 'hay' off at the higher nitrogen rates.

Protein and screenings

Protein levels increased with increasing N rates while screenings decreased. Topdressing N application had higher protein than other timings however timing had no influence on screenings. There is some anecdotal evidence that screenings increase at high nitrogen rates, however this did not occur in the trial.

Increasing protein proved to be challenging, and in this trial it took 200 kg N/ha to improve protein enough to make ‘prime hard’ grade . This tends to follow the general rule for nitrogen response, where in a highly responsive situation large yield response commonly is associated with little change in protein[3].

Conclusion

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

Application of N in the fallow did not adversely affect yields, although it did not necessarily provide any benefits in increased protein (nor reduced screenings). There was, however, very strong yield and protein response to applied nitrogen.

There tended to be a plateau in N yield response between 100 and 200 kg N/ha. There was no observed ‘haying off’ that might have been expected with such high N rates, nor did screenings increase.

There was an advantage by topdressing N to drive protein, however, loading all N at this timing was at the expense of yield gain.

Some caution should be taken when applying N in the fallow 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

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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	LSD (yield)	Protein	LSD (protein)	Screenings	LSD (screenings)
Gregory	Control	0	2.9	klm	8.8	k	7.7	a
	Early Fallow	50	3.4	fghijk	10.4	i	6.5	abcde
		100	3.8	bcdef	11.7	fg	8.0	ab
		200	3.9	bcdef	13.1	cd	5.8	de
	Mid Fallow	50	3.6	defgh	10.8	hi	6.9	abcd
		100	4.0	abcde	12.3	ef	6.4	abcde
		200	3.7	bcdefg	13.0	d	6.4	abcde
	Sowing	50	3.5	defghi	10.9	hi	5.6	def
		100	3.8	bcdef	12.3	e	5.9	cde
		200	3.5	defghi	13.1	cd	5.9	cde
	Topdress	50	3.0	ijklm	12.2	ef	7.6	abc
		100	3.2	ghijkl	12.3	ef	7.0	abcd
		200	3.2	hijklm	13.7	bc	6.2	bcde
Lancer	Control	0	2.8	m	9.8	j	5.3	e
	Early Fallow	50	3.5	efghij	11.4	gh	3.9	fgh
		100	3.9	bcdef	13.2	cd	3.2	gh
		200	4.2	abc	14.0	b	2.8	h
	Mid Fallow	50	3.7	cdefgh	11.0	h	4.9	efg
		100	4.0	abcd	13.3	cd	3.3	gh
		200	4.3	ab	14.1	b	2.9	h
	Sowing	50	3.6	defghi	11.9	efg	3.5	gh
		100	3.7	bcdefg	13.2	cd	3.2	h
		200	4.5	a	14.1	b	2.8	h
	Topdress	50	3.0	jklm	14.2	b	3.0	h
		100	2.8	lm	14.9	a	3.4	gh
		200	2.7	lm	15.2	a	3.0	h