GOA Site Report

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

Trial Code: GONU00417-5

Season/years: Summer 2016/17

Location: 'Wallah', Forbes

Collaborators: David Rogers

Keywords

GONU004, wheat nutrition, nitrogen rates, fallow nitrogen, nitrogen, Forbes

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 improvements compared to at sowing application.

No yield or quality penalties occurred when comparing in fallow to at sowing N timing application.

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

Research aims include:

- Determine effect of N application at the start of fallowing and how it might facilitate movement of N deeper into the profile as the moisture moves deeper.

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[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 if deeper N movement offers any improvement in crop yield or protein.
- Assess any impact of N movement on higher and lower biomass varieties.

Methods

This 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⟨PBR⟩ and Lancer⟨PBR⟩	**Seeding rate**	55 kg/ha
Sowing date	8/5/2017	**Harvest Date**	15/11/2017
Seedling equipment	Double Boot Tyne	**Row Spacing**	27.5 cm
Crop Nutrition (kg/ha)	150 Triphos	**Soil type**	Clay Loam
Previous Crop	Canola	**Pre-Sowing stubble management**	Cultivated
Soil test results (at sowing)	Colwell P ~ 32 ppm, Sulphur ~ 7.3 ppm	**Nitrogen**	0-10cm ~ 83 kg/ha 10-60cm ~ 112 kg/ha

The trial included the following treatments:

- **Variety**: high and low biomass, EGA Gregory⟨PBR⟩ and Lancer⟨PBR⟩ 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	19/1/2017
Mid Fallow	17/3/2017
Sowing	8/5/2017
Topdressing	2/8/2017

Table 3. Rainfall 2016

Month	Rainfall (mm)[2]
Feb	2
Mar	160
Apr	13.2
May	47.8
Jun	5.6
Jul	24.2
Aug	23.6
Sep	6.2
Oct	73.2
Nov	9.4

Rainfall comments:

- 40 mm fell between early and mid-fallow timings
- 135 mm fell between mid-fallow and sowing timings
- 77 mm fell between sowing and topdressing timings
- 189 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

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

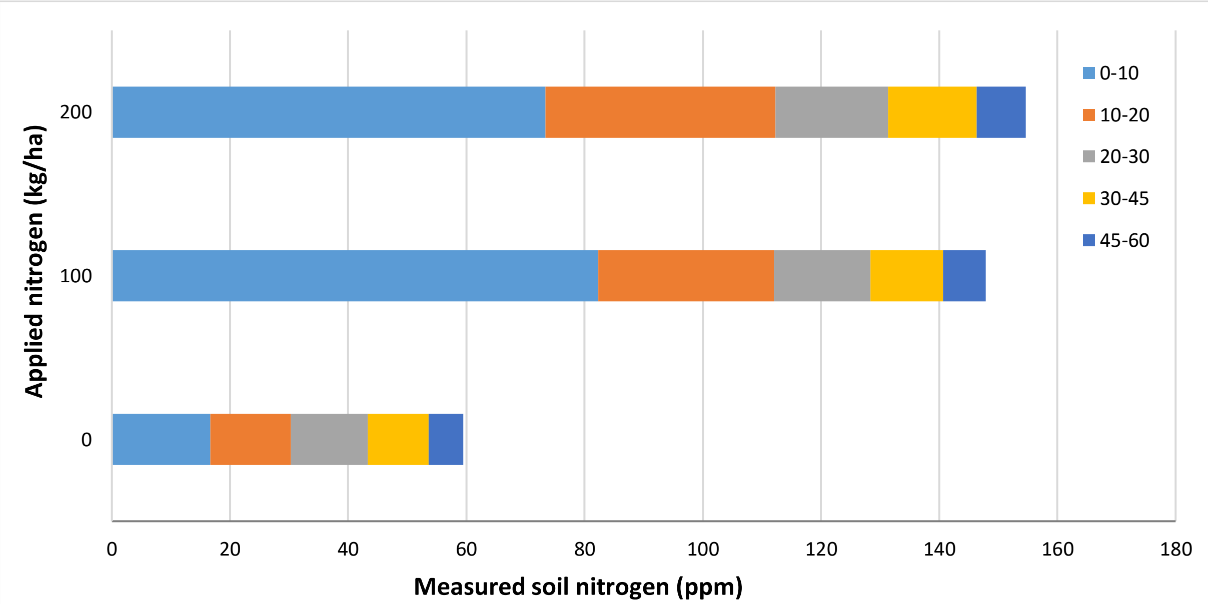

Figure 1. Soil nitrate (ppm) tested at planting for different rates of nitrogen applied during the fallow for 5 soil profile segments (measured in cm from the soil surface).

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

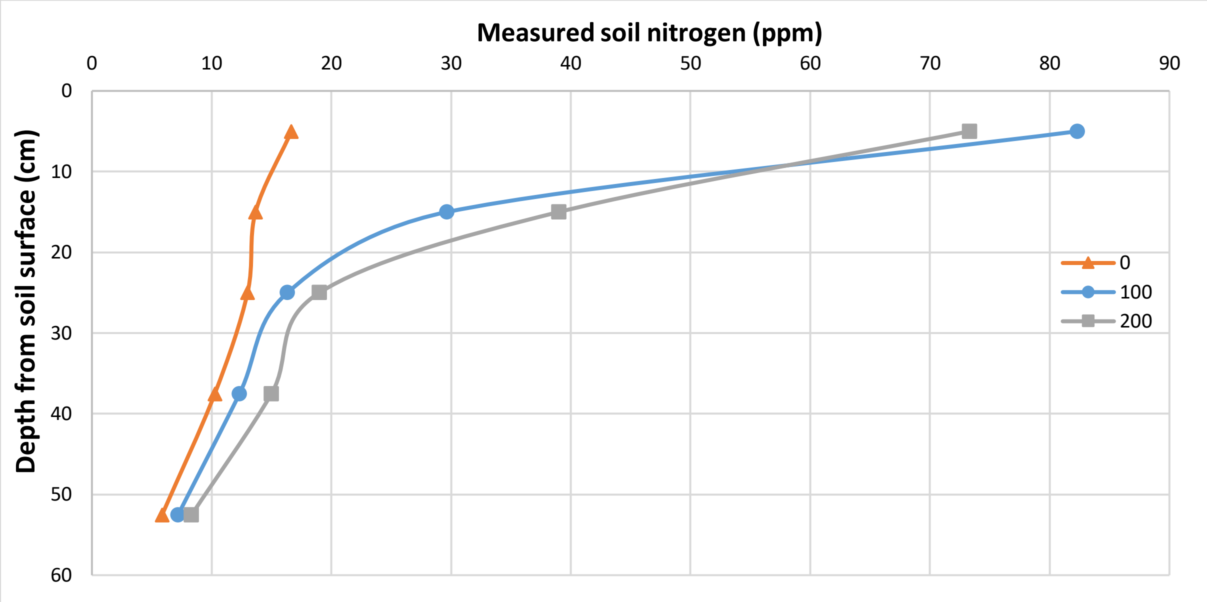

Figure 2. Soil nitrate (ppm) tested at planting for different rates of nitrogen applied during the fallow for 5 soil profile segments (measured in cm from the soil surface).

Vegetation Index

Crop vegetation was measured using a 'GreenSeeker' NDVI at 86 days after sowing (DAS). There was no significant difference between the various treatments.

Yields

Yields showed a yield response to nitrogen, regardless of variety, rate or timing. On average yields increased from 4.1 (no applied N) to 4.7 t/ha.

Timing of N application

In isolation from rate and variety, there was no difference between either of the fallow and sowing N treatments (approx. 4.6 t/ha), however topdressing treatment produced additional yield, and averaged 5.0 t/ha.

Nitrogen rates

The maximum yield was achieved at the lowest applied rate (50 kg/ha), yields plateaued at the higher rates (**Figure 3**). Difference in yield between 0 and 50 kg/ha N was approximately 0.6 t/ha

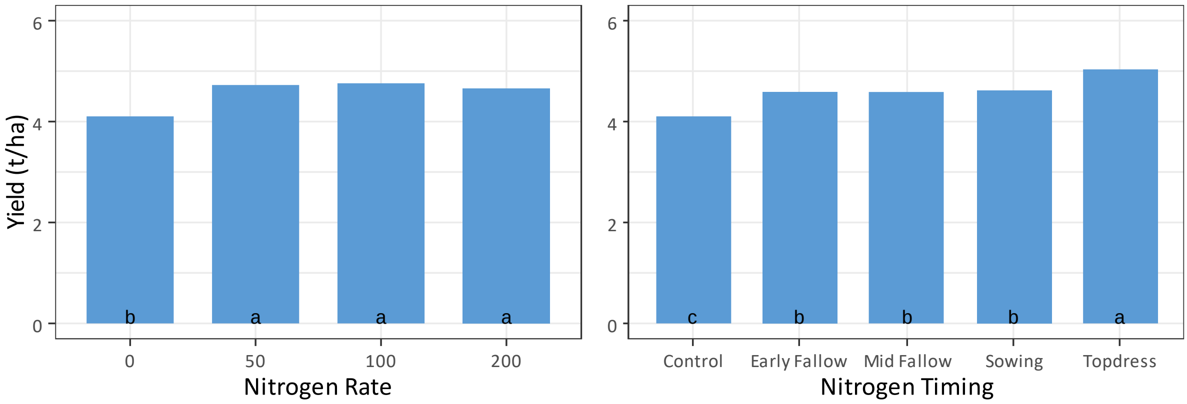

Figure 3. Average yield (by variety and timing of N application) (t/ha) for different nitrogen application rates (kg/ha) regardless of timing or variety. Treatments with the same letter are not significantly different.

There was no yield difference between the high and low biomass lines nor was there a significant interaction between timing and rate.

Protein and screenings: Protein increased as rate of N increased while screenings decreased (Table **2**). The protein was sufficient to result in a bin upgrade. Where no nitrogen was applied, based on the protein levels, grade would be APW1, and where 50 kg N/ha was applied the grade would be H2. The remaining treatments (100N, 200 N) would have made APH grade.

Time of N application had no influence on protein levels. There was only a small increase in screenings for the sowing timing N application, neither of which would cause any changes in grades.

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	13.7	a	3.7	b	**Early Fallow**	13.0	a	3.6	c
100	13.0	b	4.0	b	**Mid Fallow**	13.1	a	3.8	bc
50	12.4	c	3.7	b	**Sowing**	13.0	a	4.1	ab
0	11.3	d	4.4	a	**Topdress**	13.1	a	3.6	c
					Control	11.3	b	4.4	a

Discussion

Soil nitrogen: The site had a relatively high starting soil nitrogen level and was assessed as having a full moisture profile (using a push probe) at the time of the early fallow application. However, the movement of nitrogen deeper into the soil profile was much less than expected. Application of N at early fallow timing did not result in significant amounts of N moving deeper than 20 cm, even though there was close to 175 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 fallow of 2017 there was not enough rainfall to move nitrogen deeper into the already moist subsoil.

Yields: There was modest yield response to applied nitrogen, limited to the application of the first 50 kg/ha of N. It is likely that the high starting N levels limited likely yield response. There was a higher yield response to topdressing N than other timings. Compared to a number of other similar trials conducted by GOA, this is considered unusual. One possible explanation might be linked to a rainfall event in May where 44 mm fell over 3 days, this may have caused some waterlogging and subsequent denitrification. It was thought that the crop would 'hay' off at higher nitrogen rates, however, this was not evident.

Protein and screenings: Protein levels increased with increasing N application rates however timing had no effect. Screenings were relatively low. Addition of nitrogen (regardless of rate or timing) tended to reduce screenings. There is some anecdotal evidence that screenings tend to increase at high nitrogen rates, however this was not the case in this trial, and probably reflects the observation that the crop did not 'hay off'.

Increasing protein levels proves to be challenging. In this trial where starting soil nitrogen was relatively high (close to 200 kg N/ha) it still took the addition of a further 100 kg N/ha to improve the protein levels enough to make the 'Australian Prime Hard' grade . This result tends to follow the general rule 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 the desired outcome of improving yields and grain quality when compared to application at sowing. It is likely that there was not enough time or rainfall in the period between application and sowing. However, the trial has shown that application of N in the fallow can be as efficient as at sowing. While the supposition of the trial has not necessarily been achieved, valuable trial results include that movement of N in the soil is perhaps less and slower than current understandings suggest.

Conclusion

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

Fallow applied N 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 yield response to N somewhere between 50 and 100 kg N/ha. There was no observed 'haying off' that might have been expected with such high N rates, nor did screenings elevate with higher N.

Some caution needs be taken when applying N in the fallow at higher rates, as the potential for losses can be considerable, particularly, if conditions are hot and wet, although this likely to be limited to very high (most likely non-commercial) rates (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 (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