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Published by NSW Department of Primary Industries,
a part of the Department of Regional New South Wales.

Strategic nitrogen management for western no–till farming systems on Vertosols

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Introduction

In the past Walgett growers have been able to sow AH or APH wheat without the addition of fertiliser in their grey Vertosols and achieve the required protein (>11%). The sole reliance on soil N over time has depleted soil fertility, which has been compounded with three flood events alone over the past four years that would have resulted in significant denitrification losses. EGA Gregory⊕ is an example of a variety that is APH and has struggled to reach this grade without the addition of N-fertiliser at Walgett. Livingston⊕ is another common variety sown in the Walgett district that has also struggled to reach it's AH grade.

Considering the episodic nature of rainfall in the Walgett district, it can be costly if a crop fails and especially if nitrogen has been applied up-front. Walgett rainfall is summer dominant (60:40 split) with an annual rainfall of 478 mm. Therefore it is suggested that nitrogen might be better applied during the growing season after rainfall events when there is more confidence of the crop reaching maturity.

Common techniques to apply nitrogen that have been used in the Walgett district have included water run Urea, broadcast Urea or direct drilled Urea at sowing. The fertiliser rates have varied from 20 to 80 kg N/ha and applied anywhere from pre-plant to grain fill. The purpose of this trial was to compare the use of a Rodgers root zone injector (Plate 1) to apply in-crop nitrogen following rain with the traditional methods used in the district.

Plate 1. *Root zone Injector at 'Bridgewater'*

Key findings

80 units N/ha drilled at sowing had the highest response (P<0.001) in protein 12.6% at 'Eulengo' and 11.2% at 'Bridgewater' compared to the control 8.5% and 8.7%, respectively.

Liquid run Urea (4.3 t/ha), pre drilled Urea (4.6 t/ha), root zone injection (4.2 t/ha) and broadcast Urea (4.5 t/ha) at 80 units N/ha produced the highest yields (P <0.001) at 'Bridgewater' when compared to the control (3.9 t/ha).

Pre drilled Urea (3.3 t/ha) 40 and 80 units N/ha produced the highest yield (P < 0.001) at 'Eulengo' when compared to all other treatments. (Control 2.5 t/ha).

There were no N-response differences in protein or yield between EGA Gregory⊕ and Livingston⊕ at either 'Bridgewater' or 'Eulengo'.

NUTRITION & SOILS

Site details

Location Site 1: **Walgett 'Bridgewater'**

Co-operator: **Greg Weber**

Previous crop: **Wheat**

Soil Type: **Grey Vertosol**

Location Site 2: **Cryon 'Eulengo'**

Co-operator: **Priscilla Radford**

Previous crop: **Wheat**

Soil Type: **Grey Vertosol**

Soil nitrate-N results are shown in Table 1.

Table 1: *Soil analysis of both sites for starting nitrate-N (depth in cm).*

Bridgewater	**0–10**	**10–30**	**30–60**	**60–90**	**90–120**
Ammonium Nitrogen mg/kg	5	7	7	7	9
Nitrate Nitrogen mg/kg	4	2	2	3	2
Eulengo	**0–10**	**10–30**	**30–60**	**60–90**	**90–120**
Ammonium Nitrogen mg/kg	10	5	5	3	9
Nitrate Nitrogen mg/kg	5	7	5	4	6

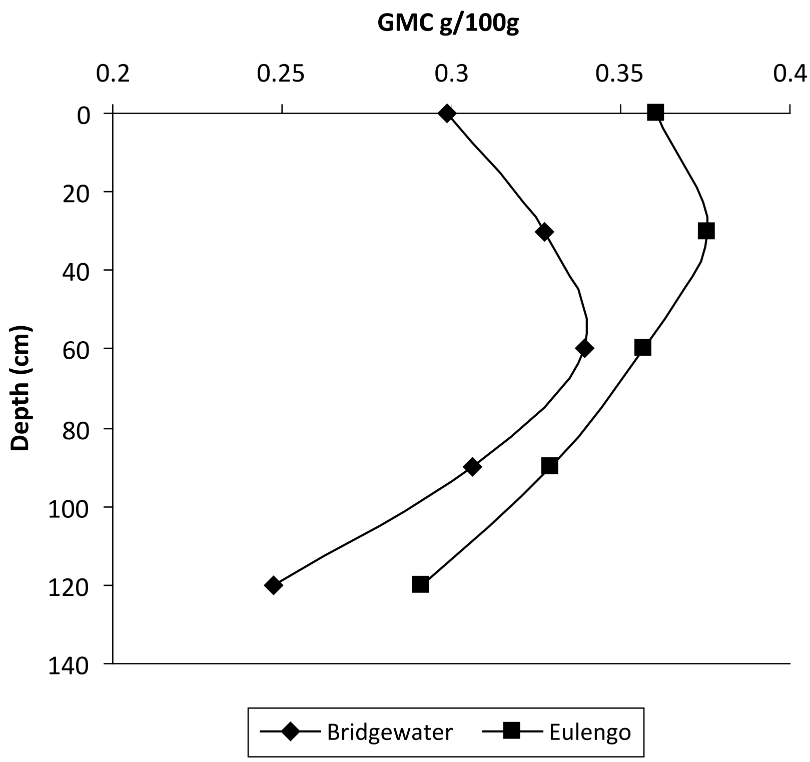

Figure 1: *Gravimetric moisture content of soil profile for 'Bridgewater' and 'Eulengo' at sowing.*

Treatments

The Bridgewater and Eulengo sites were sown on the 16th May and the15th June, respectively. Livingston⁽ᵈ⁾ and EGA Gregory⁽ᵈ⁾ were sown at 30 kg/ha for both sites. Treatments were applied according to rainfall events and their dates are listed in Table 2. Both sites were harvested on the 12th November.

Table 2: *Treatments and dates they were applied at the Walgett and Cryon N-response sites.*

Treatment/Site	Bridgewater	Eulengo
Control		
Urea 80 kg/ha at sowing	16/05/12	15/06/12
Urea 40 kg/ha at sowing	16/05/12	15/06/12
Urea 40 kg/ha pre rain	20/08/12	
Urea 80 kg/ha pre rain	20/08/12	
Liquid Spray 40 kg/ha event 1	1/08/12	9/08/12
Liquid Spray 80 kg/ha event 1	1/08/12	9/08/12
RZI 40 kg/ha post rain	3/08/12	10/08/12
RZI 80 kg/ha post rain	3/08/12	10/08/12
Liquid Spray 40 kg/ha event 2	17/09/12	
Liquid Spray 80 kg/ha event 2	17/09/12	

Telemetry rain gauges were installed on the 9th July and EnviroPro LE 160 cm soil moisture probes on the 13th August.

Table 3: *Rainfall (mm) for 'Bridgewater' and 'Eulengo'.*

	Bridgewater	Eulengo
May	19.5	
June	18.5	1
July	42	58
August	4.5	11.5
September	1.5	5.5
October	0	2.5
November	0	4
Total	86	82.5

Results

Soil Water

The output of the EnviroPro LE probes showing rainfall, soil moisture and soil temperature for both sites are shown in Figures 2 and 3. The 'Eulengo' soil moisture depleted in a linear pattern when compared to the 'Bridgewater' site that appears to have depleted steeply initially and then more gradual. The approximate starting plant available water content (PAWC) estimated from the gravimetric moisture content and bulk densities from CSIRO's SoilMapp App was 260 mm for the 'Bridgewater' site and 293 mm for 'Eulengo'.

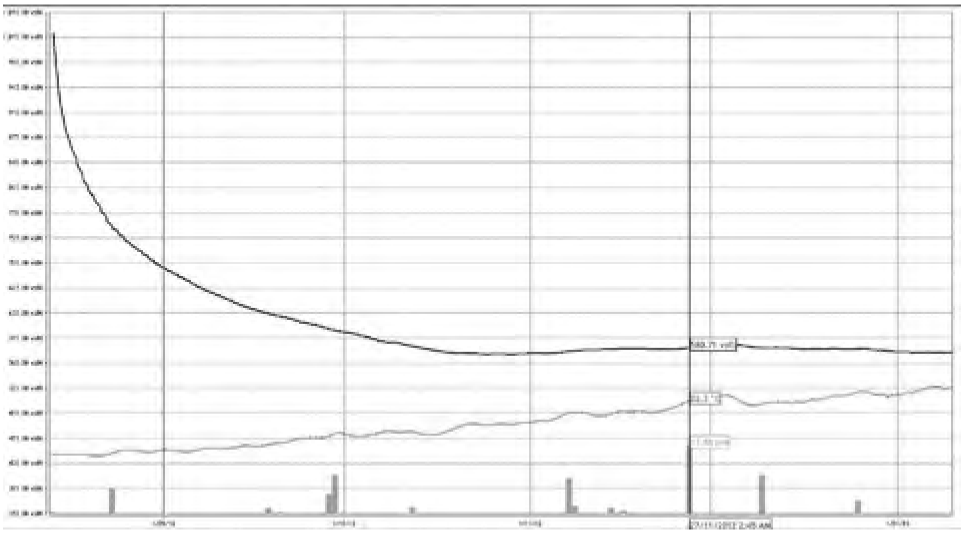

Figure 2: *EnviroPro LE soil moisture, soil temperature and rainfall for 'Bridgewater'.*

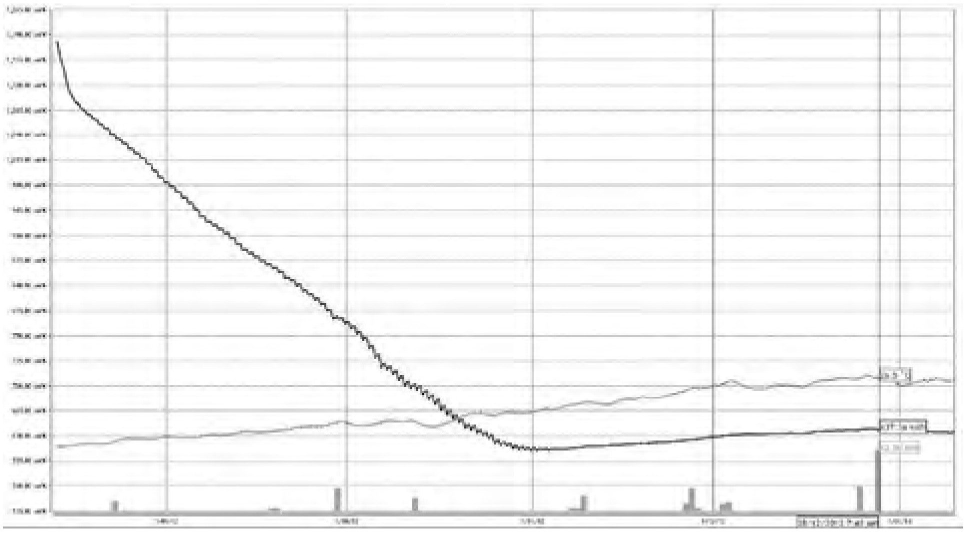

Figure 3: *EnviroPro soil moisture temperature and rainfall for 'Eulengo'.*

Protein

The results of the protein for both sites and varieties are shown in Figures 4 and 5. The direct drilled Urea at 80 units N/ha at sowing produced the highest protein at 'Eulengo' 12.6% and 'Bridgewater' 11.2% for both varieties and was significantly different to the other treatments (P<0.001). There was no statistical difference between EGA Gregory⁽ᵈ⁾ and Livingston⁽ᵈ⁾ at both sites. There were no significant differences between the other treatments.

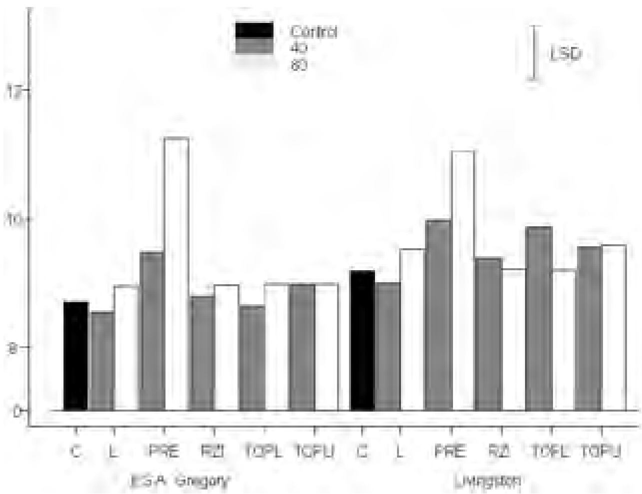

Figure 4: *'Bridgewater' protein (%) for EGA Gregory⁽ᵈ⁾ and Livingston⁽ᵈ⁾. LSD bar indicates significant differences between treatments (P=0.05). (C=control, L=Liquid run event 2, PRE=direct drill at sowing, RZI=Root zone Injector, TOPL=Liquid run event 1, TOPU=Urea Broadcast)*

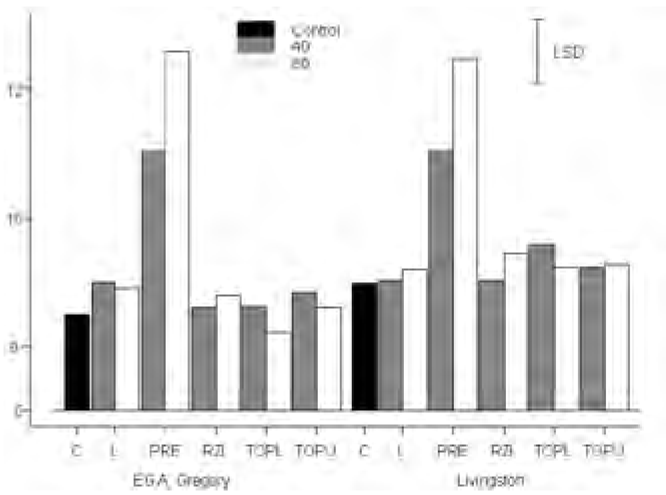

Figure 5: *'Eulengo' protein (%) for EGA Gregory⁽ᵈ⁾ and Livingston⁽ᵈ⁾. LSD bar indicates significant differences between treatments (P=0.05) (C=control, L=Liquid run event 2, PRE=direct drill at sowing, RZI=Root zone Injector, TOPL=Liquid run event 1, TOPU=Urea Broadcast)*

Yield

The yield results for both sites and varieties are shown in Figures 6 and 7.

The Liquid run Urea (4.3 t/ha), pre drilled Urea (4.6 t/ha), root zone injection (4.2 t/ha) and broadcast Urea (4.5 t/ha) at 80 units N/ha produced the highest yields and were significantly higher then the other treatments (P <0.001) at 'Bridgewater' when compared to the control (3.9 t/ha). Pre drilled Urea 40 (3.3 t/ha) and 80 (3.1 t/ha) units N/ha produced the highest yield (P < 0.001) at 'Eulengo' when compared to the other treatments (Control 2.5t/ha). There was no statistical difference between EGA Gregory and Livingston at both sites. There were no significant differences between the other treatments.

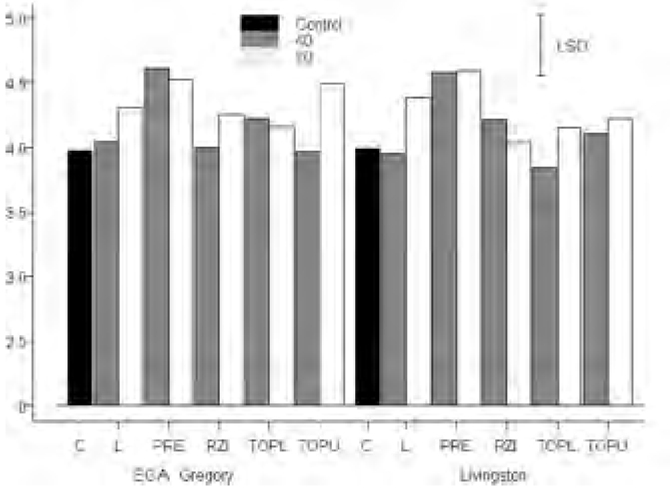

Figure 6: *'Bridgewater' Yield (t/ha) for EGA Gregoryɸ and Livingstonɸ. LSD bar indicates significant differences between treatments (P=0.05)(C=control, L=Liquid run event 2, PRE=direct drill at sowing, RZI=Root zone Injector, TOPL=Liquid run event 1, TOPU=Urea Broadcast).*

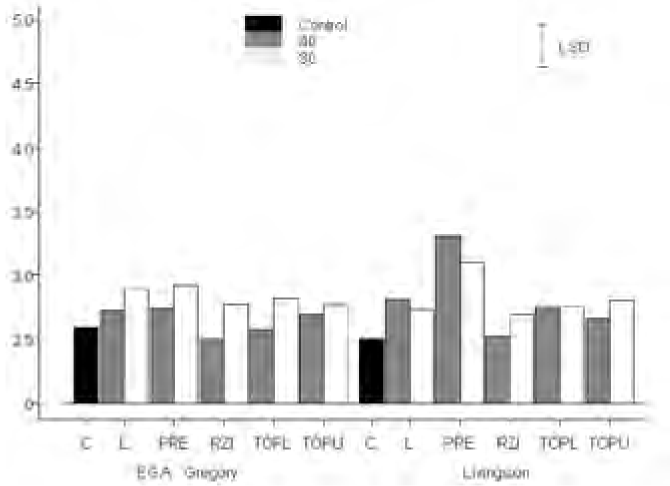

Figure 7: *'Eulengo' Yield (t/ha) for EGA Gregoryɸ and Livingstonɸ. LSD bar indicates significant differences between treatments (P=0.05). (C=control, L=Liquid run event 2, PRE=direct drill at sowing, RZI=Root zone Injector, TOPL=Liquid run event 1, TOPU=Urea Broadcast)*

Discussion

The starting soil nitrate-N for both sites was very low with an approximately 17 kg/ha for 'Bridgewater' and 35 kg/ha for 'Eulengo' to 1.2 metres (Table 1). The low starting nitrate-N concentrations were ideal to investigate protein and yield response using traditional methods for applying nitrogen and compare them with the root zone injector.

Rainfall (Table 3) at both sites was limited in the later part of the growing season (Aug. Sept., Oct., Nov.). Therefore rainfall that did eventuate was very low and could explain the lack of response in protein and yield following liquid applications or broadcast Urea applications.

Considering the episodic rainfall patterns in the Walgett region and the results of this report it would seem a logical conclusion to direct drill Urea at sowing. Nitrate-N is then available to the crop and there is no risk of missing liquid run or broadcast applications of nitrogen in-crop due to paddock accessibility after rainfall. This method also conceals the product in the soil and reduces the potential for ammonia volatilisation losses. However, this is costly if you are planting on half a profile of moisture and risk losing your crop. In-crop application of nitrogen is an important management tool for many farmers to capitalise on boosting their protein and yield if good rainfall eventuates. In-crop applications of nitrogen allow for the careful management of supplying the crop at strategic growth stages as well. However, this can be very difficult to achieve if there is no rain at the targeted growth stage. This is where a root zone injector may be better utilised. Injecting liquid Urea at 5000 PSI it has the potential to inject nitrogen into the soil and reach the shallow roots of the crop. Injecting would allow the liquid to penetrate the soil and minimise the risk of ammonia volatilisation losses. The root zone injector application of nitrogen in this study did not produce a response to yield and protein; however neither did any other in crop N application treatments, which is more a reflection of the in crop rainfall rather then the methods of application. The root zone injector has potential to be another management tool for applying nitrogen in crop and needs further investigation under varying seasonal conditions. The root zone injector also has the benefit of minimal disturbance when applying nitrogen in crop and therefore less soil moisture loss after rainfall.

Summary

- 80 units N/ha drilled at sowing had the highest response ($P<0.001$) in protein 12.6% at 'Eulengo' and 11.2% at 'Bridgewater' compared to the control 8.5% and 8.7% respectively.
- Liquid run Urea (4.3 t/ha), pre drilled Urea (4.6 t/ha), root zone injection (4.2 t/ha) and broadcast Urea (4.5 t/ha) at 80 units N/ha produced the highest yields ($P<0.001$) at 'Bridgewater' when compared to the control (3.9 t/ha).
- Pre drilled Urea (3.3 t/ha) 40 and 80 units N/ha produced the highest yield ($P < 0.001$) at 'Eulengo' when compared to all other treatments (Control 2.5t/ha).
- There were no differences in protein or yield responses between EGA Gregory⍉ and Livingston⍉ at either 'Bridgewater' or 'Eulengo'.

Acknowledgements

Thank you to GRDC for the Agribusiness grant (Tender 7.2.3.01C). Thanks to Priscilla Radford 'Eulengo' and Greg Weber 'Bridgewater' for allowing us to conduct the trials on their properties. Thanks also to Steven Harden for statistical analysis of the data. Thanks to GrainCorp at Walgett for grain analysis.