Agronomic response of sorghum varieties to nitrogen management – Terry Hie Hie 2014–15

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Introduction

The Northern Grains Region of NSW, with its typical black/grey cracking clays (vertosols), relies heavily on stored moisture and subsoil nutrient reserves for crop production. Although plant available water (PAW) is the principal driver of yield potential, nitrogen (N) is considered one of the most important limitations of yield. The optimum N requirement of a crop is dependent on yield potential, which in turn depends on total PAW in the soil profile. Declining soil organic matter and/or N reserves has also resulted in an increased reliance on N fertilisers. Subsequently, as yield potential rises and soil fertility declines, nitrogen fertiliser management becomes more important. While there are N response guidelines for crops such as wheat, information for sorghum is more limited.

Critical grain protein values can be used to help monitor the effectiveness of N management decisions in crops such as sorghum. Optimum sorghum grain yields are generally achieved when grain protein concentration (GPC) levels of 9–10% are attained, with yield affected at levels below 9%. Conversely, at levels >10% grain protein, higher rates of N might only increase grain protein.

The aim of this research was to determine the agronomic response of sorghum to N management, to help develop more robust soil test/crop response guidelines. Results from a dryland N response sorghum trial conducted at Terry Hie Hie in the 2014–15 season are outlined in this report.

Site details

Location:	**"East Grattai", Terry Hie Hie**
Co-operator:	**Michael Ledingham**
Soil type:	**Grey vertosol**
Starting nutrition:	**Starting soil nutrition is outlined in Table 1. The available soil nitrate N was calculated as ~50 kg N/ha (0–120 cm)**
Planter:	**Monosem double disc precision planter with single skip row configuration**
Target population:	**30,000 plants/ha**
Fertiliser:	**42 kg/ha Granulock Z extra applied at planting**
Sowing date:	**2 October 2014**
PAW (sowing):	**~47 mm (0–120 cm)**
In-crop rainfall:	**257.5 mm**
Harvest date:	**4 March 2015**

Table 1. *Starting soil nutrition*

Depth (cm)	Nitrate (mg/kg)	Colwell P (mg/kg)	Colwell K (mg/kg)	Sulfur (mg/kg)	Organic carbon (%)	Conductivity (dS/m)	pH ($CaCl_2$)	BSES P (mg/kg)
0–10	3	21	194	2.4	0.53	0.018	5.5	37.94
10–30	3	4	94	2.2	0.32	0.027	6.0	10.22
30–60	4	3	66	3.9	0.42	0.066	7.1	5.57
60–90	2	< 0.2	106	9.0	0.30	0.137	7.6	–
90–120	1	< 0.2	123	35.1	0.06	0.234	7.7	–

Key findings

Although plant available water (PAW) at sowing was ~47 mm (0–120 cm), timely in-crop rainfall of 257 mm improved yield potential.

If yield and subsequently fertiliser decisions were made on PAW at sowing and a low input approach to nitrogen (N) application was taken, as per the nil treatment in this experiment (42 kg/ha of Granulock Z), 0.9 t/ha or 20% of yield potential would have been lost, compared with the optimum N response rate (120 kg N/ha).

Significantly, even at modest levels of N application (e.g. 40–80 kg N/ha), grain yield was increased by 0.56 t/ha or 13% over the nil N treatment.

Although maximum yield was achieved at 11.1% grain protein content (GPC), the rate of grain yield increase per unit of additional N declined at GPC >10%. Importantly, results from this experiment did show that yield was compromised by N deficiency when GPC was <9%.

Results from this experiment highlight the need to consider yield potential in terms of targeted yields and hence N requirements. Importantly, if N inputs are limited then yield potential can be negatively affected.

Treatments

Varieties: Three hybrids, Pacific MR 43, MR Bazley and MR Buster.

Nitrogen (N) rate: 0, 40, 80, 120, and 180 kg N/ha applied as urea (46% N) upfront at sowing, with six replicates per treatment.

Results

Although PAW at sowing was only ~47 mm, good December/January rainfall of 200 mm resulted in 257 mm of in-crop rainfall being received. The starting soil nitrate N at ~50 kg N/ha (0–120 cm) was very low and would be considered likely to be responsive to N application.

Grain yield

There was a significant (P<0.001) variety and grain yield response to applied N, but no variety by N interaction. Adding 40 kg N/ha (~87 kg/ha of urea), resulted in a 0.56 t/ha or 13% increase in grain yield over the nil applied N treatment (4.96 t/ha vs 4.40 t/ha), with no significant difference between the 40 kg N/ha or 80 kg N/ha treatments (Figure 1). Optimum yield was achieved by adding 120 kg N/ha (~260 kg/ha urea) resulting in a 0.9 t/ha or 20% increase in grain yield over the nil N treatment and a 7% yield increase over the 40 kg N/ha treatment. Increasing the N rate to 180 kg N/ha resulted in no significant yield increase over the 120 kg N/ha application rate, with the N response curve plateauing (Figure 1).

In terms of variety response, averaged across all treatments Pacific MR 43 and MR Buster both out yielded MR Bazley (5.05 t/ha and 5.10 t/ha vs 4.82 t/ha, respectively), possibly reflecting maturity differences. There was no significant difference in yield between Pacific MR 43 and MR Buster.

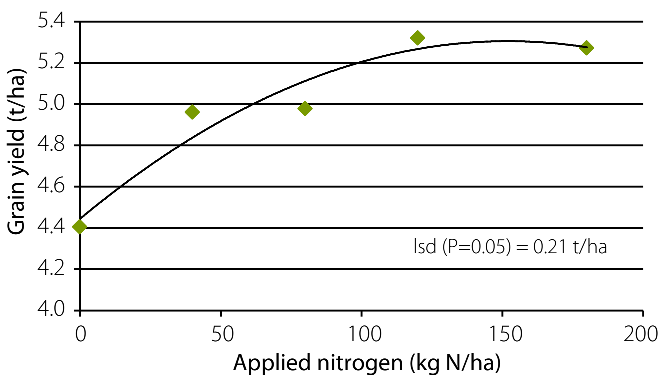

***Figure 1.** Grain yield response to varying rates of applied nitrogen at Terry Hie Hie in the 2014–15 season*

Grain protein concentration

Increasing rates of N application resulted in higher levels of grain protein with significant increases observed in GPC up to 120 kg N/ha (Figure 2). The GPC achieved with no addition of N in this experiment was only 8.6%, an indication that the available N compromised grain yield achievement, supporting previous findings that yield will increase with additional N when GPC is <9%. Grain yield in this experiment was maximised at around 11% GPC with the 120 kg N/ha rate, which is slightly above the critical 10% GPC. Importantly however, the grain yield response per unit of additional N did decline above 10% GPC (>40 kg N/ha). The rate of yield gain associated with each kg of N applied declined from 14 kg/unit of N at 40 kg N/ha (10.0% GPC), to ~7.6 kg/unit N at 120 kg N/ha (11.1% GPC) and only ~4.8 kg/unit of additional N at the 180 kg N/ha rate (11.2% GPC).

In terms of variety responses, there was an inverse relationship between grain yield and GPC, with the lowest yielding variety (MR Bazley) achieving the highest GPC (data not shown).

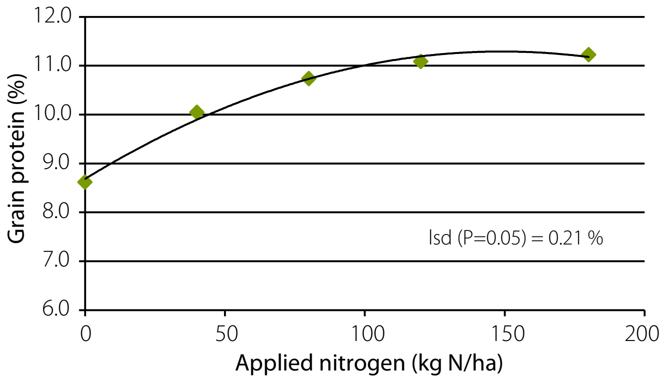

Figure 2. *Grain protein concentration response to applied nitrogen at Terry Hie Hie 2014–15 in the season*

Summary

In the water-limited environments of the northern grains region, yield potential tends to decline as you move to the north and west of the region and is associated with increasing temperature and decreasing rainfall. As a consequence, lower target plant populations and wider row configurations are often used to improve reliability, but this can decrease yield potential under more favourable conditions. The difficulty in predicting yield responses in these dryland environments centres principally on the fact that estimates are heavily reliant on PAW levels at sowing which are traditionally considered the main determinant of yield potential. In this instance, with only ~47 mm (0–120 cm) of PAW at sowing, yield potential was considered low and was further compounded by low starting soil N. However, as was the case in the 2014–15 season with early sowing and timely in-crop rainfall (200 mm December/January and 52 mm February), yield potential can improve substantially. In these incidences, N can become an important factor that limits grain yield potential.

If yield and subsequently fertiliser decisions were made on PAW at sowing, and a conservative approach or low input approach to N application was taken (i.e. only 42 kg/ha of Granulock Z applied i.e. ~5 kg N/ha) as per this experiment, 0.9 t/ha or 20% of grain yield potential would have been lost compared with the optimum N response rate (120 kg N/ha). Significantly, even at modest levels of N application (e.g. 40–80 kg N/ha) grain yield was increased by 0.56 t/ha or 13% over the nil N treatment. Although maximum yield was achieved at 11.1% GPC, the rate of grain yield increase per unit of additional N declined at GPC >10%, bringing into question the economic return per unit of additional N applied. These results did, however, show yield potential was compromised when GPC was <10%.

Results from this experiment highlight the need to consider yield potential in terms of targeted yields and N requirements. Under conditions of low starting soil N reserves and or potentially good PAW (starting plus in-crop rainfall), then grain yield responses to applied N are considered more likely. Importantly, if N inputs are limited then yield potential likewise is potentially negatively affected.

Acknowledgements

This research was co-funded by the GRDC and NSW DPI as part of the collaborative GRDC, University of Queensland/NSW DPI project UQ00063: MPCNII – Regional soil testing for the Northern Grains Region. We thank Dr Neroli Graham (NSW DPI) for statistical analyses. Technical assistance provided by Nicole Carrigan, Peter Perfrement and Michael Dal Santo (all NSW DPI), is gratefully acknowledged. Thanks to the Ledingham family for hosting the site and to Gavin McDouall, HMAg for his assistance.