Strategies to reduce nitrous oxide emissions from nitrogen fertiliser applied to dryland sorghum. Part 3. Residual impact of N applied in 2013–14 on sorghum grown in 2014–15

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Key findings

Very dry conditions during the 2013–14 summer meant that much of the nitrogen (N) fertiliser applied was not taken up by the sorghum crop, especially if it had been applied in-crop at booting. Between 46–65% of the applied N remained in the soil at harvest in 2013–14.

A following crop of unfertilised sorghum accessed the remaining N for crop growth and, at rates of 100 kg N/ha and above in the 2013–14 crop, increased grain yield and protein above the control. Late N application by topdressing in the 2013–14 crop gave similar crop production results to treatments where N was side-banded at sowing.

Two-year gross margins showed a significant benefit from N application as urea either at sowing or in-crop.

Introduction

This paper reports the biomass, grain production, and gross margin results from sorghum grown in 2014–15 on plots where nitrogen (N) fertiliser was applied in 2013–14 and no additional N was applied to the current crop. In 2013–14, we compared current practice (urea side-banded at sowing) with two alternative methods of delaying the availability of soil nitrate N from fertiliser N:

1. applying a nitrification inhibitor with the urea at sowing (Entec®)
2. applying urea post-sowing (at booting).

There were also three N rates of the urea and the Entec® at sowing treatments. While the 2013–14 crop showed a clear grain yield and protein response to N fertiliser compared with the nil-N control, there was no treatment difference between N rates of 80, 100 or 120 kg/ha applied as either urea or Entec® at sowing. Plots with urea applied post-sowing had grain yields no different from the nil-N control, and the post-sowing Entec® treatment was only marginally better. Grain protein from the two post-sowing N application treatments was also no different from the nil-N control treatment. These results reflected the limited rainfall between when these late N applications were made in December 2013 and grain harvest. Overall, the grain yields for the site were considerably lower than long-term average yields for the region.

A companion trial in 2013–14 using ^{15}N-labelled urea, Entec® and late-applied surface urea, showed that after accounting for N losses and grain N offtake, there was still 46%, 60% and 65% remaining of the N applied as urea-at-sowing, Entec-at-sowing, or post-sowing-urea, respectively. This remaining N was mostly located in the top 10–20 cm of the soil at harvest, with some also present on the surface as crop residues.

Since the poor rainfall in the 2013–14 summer prevented uptake of much of the applied N, we decided to grow unfertilised sorghum on the same trial plots during 2014–15 to assess the residual value of last season's N application treatments. The crop production and gaseous emissions results from the 2013–14 phase of the trial have been reported previously. This paper focuses on the agronomic results of the trial in the 2014–15 residual year and presents economic data for both years at the site. Gaseous emissions were not measured during this residual N trial.

Site details

2014–15

Location:	**Tamworth**
Co-operator:	**NSW Department of Primary Industries (Tamworth Agricultural Institute)**
Agronomy:	**MR Bazley sown on 75 cm rows on 28 October 2014, harvested 6 March 2015**
In-crop rain:	**422 mm**

Treatments

Name	2013–14 fertiliser treatment
Nil_0	no N applied
Urea_80	80 kg N/ha urea side-banded at sowing
Entec_80	80 kg N/ha Entec® side-banded at sowing
Urea_100	100 kg N/ha urea side-banded at sowing
Entec_100	100 kg N/ha Entec® side-banded at sowing
Urea_120	120 kg N/ha urea side-banded at sowing
Entec_120	120 kg N/ha Entec® side-banded at sowing
Urea_0+100	100 kg N/ha urea side-banded at sowing
Entec_0+100	100 kg N/ha Entec® side-banded at sowing
Entec® is urea coated with the nitrification inhibitor 3,4-dimethylpyrazole phosphate (DMPP) [Incitec Pivot Fertilisers Ltd]	

Results

- Biomass cuts at plant anthesis showed that, except for the urea_80 and Entec_80 treatments, all treatments were not significantly different in biomass from the nil-N control (Figure 1–left).
- Biomass N concentration showed a different pattern however, with the nil-N control and the two 80 kg N/ha treatments significantly lower in N content than all other treatments (Figure 1–right).
- Previous N treatment also affected the number of tillers per hectare, with the least number of tillers in the nil-N plots and the most in the two 80 kg N/ha treatments, with all others in between these extremes (data not shown).

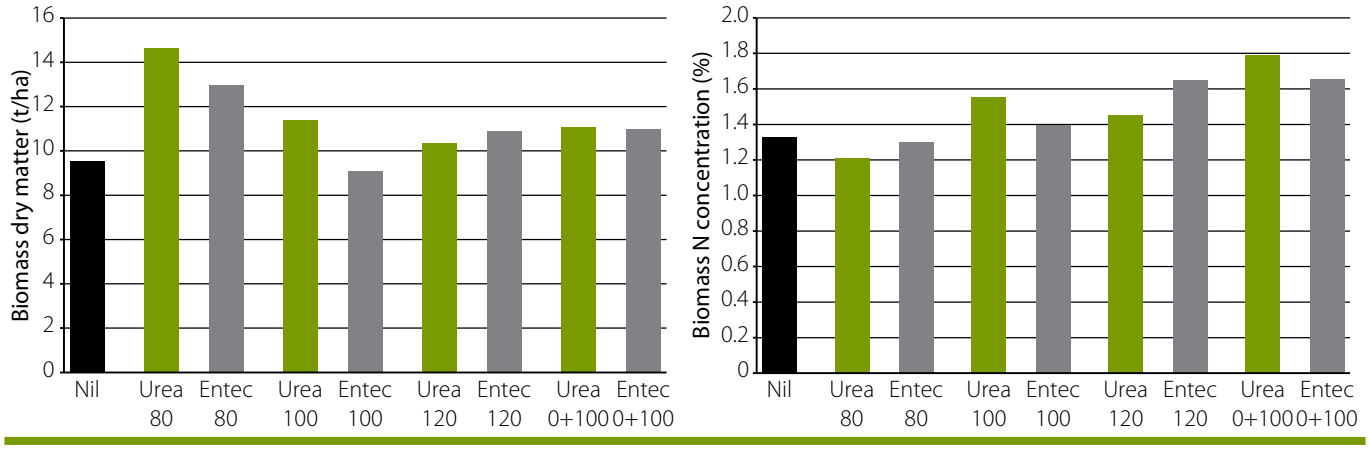

Figure 1. *Plant biomass (left) and biomass N concentration (right) in the Tamworth residual nitrogen trial at flowering*

- The grain yield and grain protein results indicate that any residual effect of the 80 kg N/ha urea or Entec® treatments had been used up in vegetative growth, thus not available to increase yield or protein levels (Figure 2).
- The higher N rate treatments of 100 kg N/ha and 120 kg N/ha left sufficient residual N in the soil to benefit both yield and protein more than 12 months after it was applied.
- The highest yield and protein was obtained where the N fertiliser was applied at booting in the previous crop and had not had sufficient rainfall to affect yield or protein last season. This appears to have higher residual N levels to benefit yield and grain protein levels in the subsequent sorghum crop.
- Gross margins for this trial covered both years of crop growth. For the second year of cropping in the trial area, there were no N fertiliser input costs as these were incurred in the first year, but all other inputs of sowing, harvesting, spraying, seed, P fertiliser, herbicides etc. were included as variable costs.

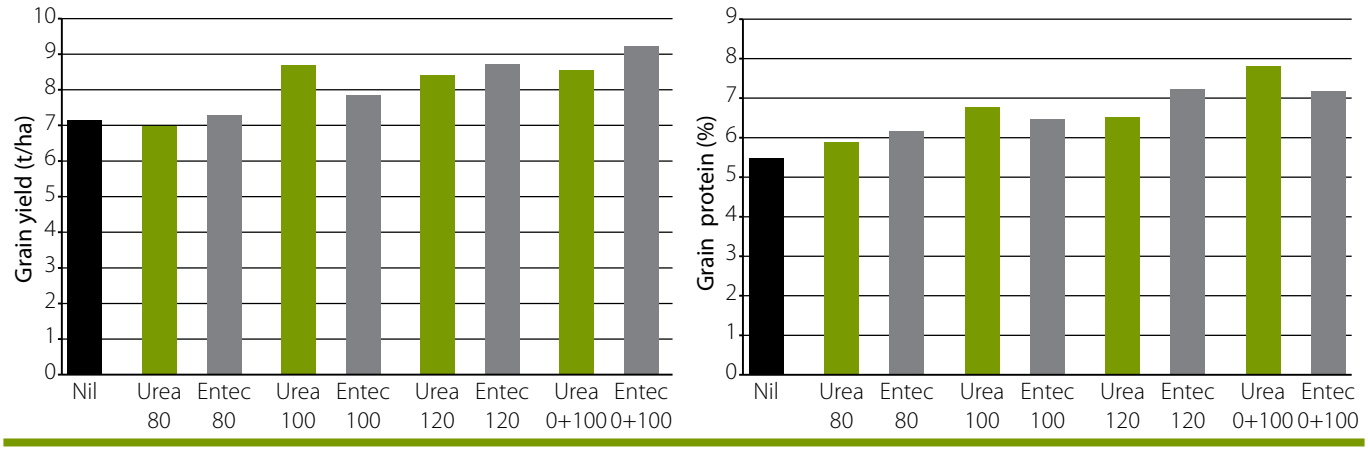

Figure 2. *Effects of nitrogen fertiliser applied in 2013 on the grain yield and protein of the following sorghum crop (2014–15)*

- The second year was clearly the dominant of the two years with good in-crop rainfall resulting in higher yields (hollow bars, Figure 3).
- Increasing the urea N rate gave better overall returns above the nil-N control, whereas the increase in overall returns with increasing Entec® was less than urea at 100 kg N/ha and least at the highest Entec® rate of 120 kg/ha as Entec® is more expensive than urea.
- The late-applied N treatments of urea and Entec, which returned less than the nil-N control treatment in the first year, returned the highest gross margins in the second year, and gave combined two-year returns equivalent to the urea_100 and urea_120 treatments (Figure 3).

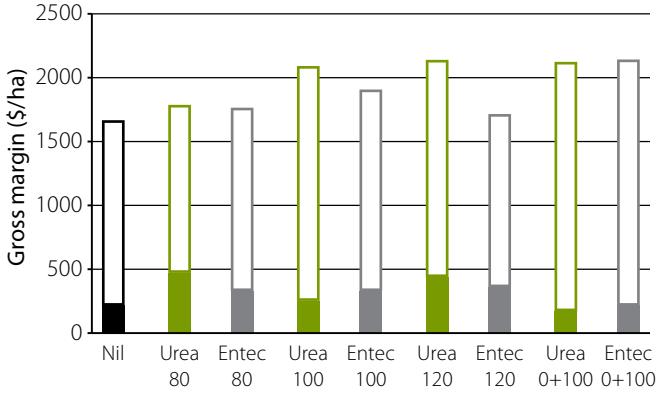

Figure 3. *Combined gross margins for two years of cropping after nitrogen fertiliser treatments applied in 2013. Solid bars show gross margins for the 2013–14 crop year, while hollow bars show the gross margins for the 2014–15 crop year*

Summary

These results clearly demonstrate the residual value of N fertiliser applied to a previous crop but not taken up because of prolonged dry conditions in the surface soil where the N is applied. It is also encouraging that much of the urea (and Entec®) that was topdressed on the soil surface in a hot, dry environment remained in place to benefit the following crop. This should provide greater confidence to farmers in increasing their use of in-crop fertiliser applications in this variable rainfall summer cropping system.

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