Efficient Grain Production compared with N_2O emissions

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Background

Nitrous oxide emissions – what do crops contribute? Over the last few years there has been increased talk about the role that agriculture plays in nitrous oxide (N_20) emissions however, limited research has been conducted around the grains industry's contribution to emissions.

Already farmers have begun to use nitrogen (N) more efficiently by including leguminous break crops in their rotations and taking a more prescribed approach to nitrogenous fertiliser applications that better match crop demand and the seasonal conditions. But how much N_20 is being emitted from soil remains unclear.

In 2012 BCG, in conjunction with DAFF, the Department of Primary Industries (DPI) and the Low Rainfall Collaboration Group (LRCG), managed two demonstrations that measured N_2O emissions from soils under varying cropping regimes.

The first compared the N_2O output when N was applied through synthetic fertiliser. The second measured the N contribution made by a vetch legume crop that was terminated at various times in the establishment year. The corresponding effect of N_2O emissions from a non-legume crop in 2013 was also measured. In 2013 UNFS established a site in the Booleroo Centre area to demonstrate N_2O emissions following N fertiliser application on a range of soil types.

In order to compare these management options on a greenhouse gas basis, N_20 emissions were measured from PVC cylinders of 30cm diameter which have been installed in between the crop row. N_20 gas was extracted via medical syringes into air evacuated vials at sampling intervals of one day prior, one day after and one week following a rainfall event. Collected samples were sent to Melbourne University for analysis.

If N_2O is released to the atmosphere N has not been used by the crop, which ultimately means that input dollars have been wasted.

The main aims of this demonstration are to:

- Increase farmer knowledge about the N_2O emissions made from fertiliser and legumes;
- Reveal options available to reduce N_20 emissions
- Provide information about nutrient use efficiency to maximise productivity.

Growers and advisors will also have a better understanding about how N application in the system can deliver the best result in terms of production per tonnes of carbon dioxide equivalents (CO_2e) emitted.

UNFS Demonstration Site

Farmer: Joe Koch, Booleroo Centre.
Crop: Hindmarsh barley sown back onto wheat stubble
Sowing date: 27th May with 60 kg/ha DAP

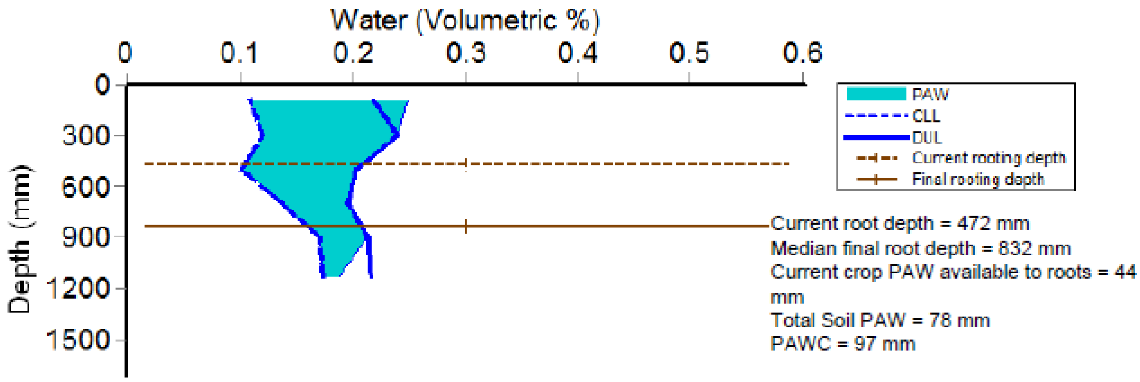

Figure 1: Plant Available Water at 14th July, 2013

Table 1: Water Budget at 14th July, 2013

Initial Plant Available Water (PAW status @ 17 May	10 mm
Rainfall since 17 May	148.5 mm
Evaporation since 17 May	40 mm
Transpiration since 17 May	5 mm
Deep drainage since 17 May	0 mm
Run-off since 17 May	9 mm
Current PAW status	78 mm

Nitrogen Application
Green seeker® N sensor (Table 2) was used on the 15th of July to assess the N status of the crop on the three distinct soil types within the paddock.

1. Sandy loam rise – low N status
2. Sandy clay loam mid-slope – moderate N status
3. Clay loam flat – high N status

Table 2: N sensor analysis and resulting N fertilser rates

Soil Type	**Green seeker 19th July**	**N rate kg/ha**	**Urea rate kg/ha**
Sandy loam	0.319	40	85
Sandy clay loam	0.24	25	55
Clay loam	0.4	18	40

Table 3: Activities at the site

Date	**Activity**	**Comments**
15th July	Nitrous oxideN_2O cylinders were setup at the site	
16th July	First N_2O measurements taken	
17th July	Variable rate urea applied to the site	20 mm of rain was received that night following application
18th July	Second N_2O measurement taken	
24th July	Third N_2O measurement	

Figure 2: N_2O sampling cylinder (right) with lid and syringe to extract samples from the cylinder (left)

Table 4: Soil Analysis of the site

Sandy loam	16/07/2013	18/07/2013	24/07/2013
Nitrogen kg/ha 0-10 cm	12.6	37.8	22.4
Organic carbon %	0.86		
pH $CaCl_2$	7.8		
PAW 0-10 cm	10 mm	15 mm	11 mm
Sandy clay loam			
Nitrogen kg/ha 0-10 cm	15.4	29.4	28
Organic carbon %	0.79		
pH $CaCl_2$	5.7		
PAW 0-10 cm	10.6 mm	12.5 mm	13.3 mm
Clay loam			
Nitrogen kg/ha 0-10 cm	16.8	14	37.8
Organic carbon %	0.91		
pH $CaCl_2$	6.4		
PAW 0-10 cm	12 mm	14 mm	11 mm

Despite the variation in soil type at the site the organic carbon levels were all very low (Table 4).

The moisture content of the soil before the N fertilizer application was high (Figure 1) with the soil being at the drained upper limit (DUL) on the 14th July. A further 20mm of rain was received on the 17th of July, only a few hours after application of the fertilizer, ensuring that the N was moved into the soil.

There was a response to rainfall at the site with increased N_2O emissions one day after N fertilizer application (Figure 3). Emissions were somewhat higher at this site compared to other dry-land cropping sites in other areas, although still not significant from a productivity perspective. Emissions did not appear to correlate with rate of N input during the sampling period. This was probably due to the variation in soil type and future work will be undertaken on a single soil type to remove this variation.

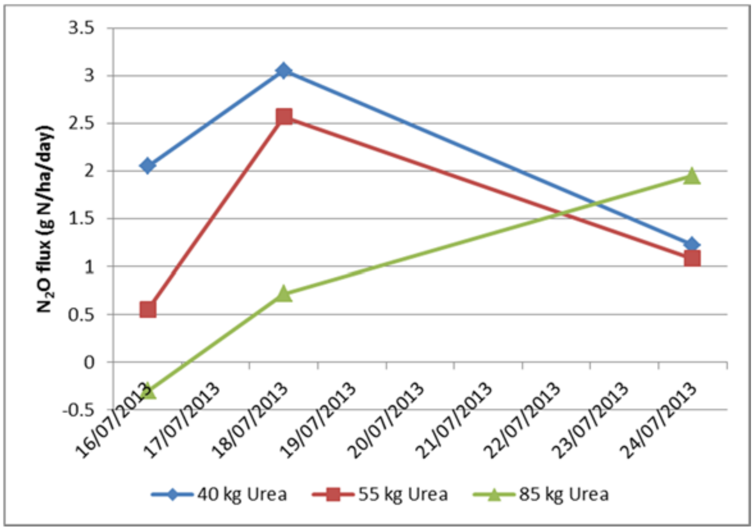

Figure 3: N_2O flux following various top-dressed rates of urea prior to, immediately following and one week after fertiliser application and rainfall occurring on the 17th of July, 2013**.**

Despite the higher rate of N fertilizer applied to the Sandy loam soil it was still not sufficient to lift the yield to that achieved in the heavier soil types (Figure 4). Given that this was a low rainfall site growers in this area would be unlikely to risk applying higher rates of N, even in well above average seasons.

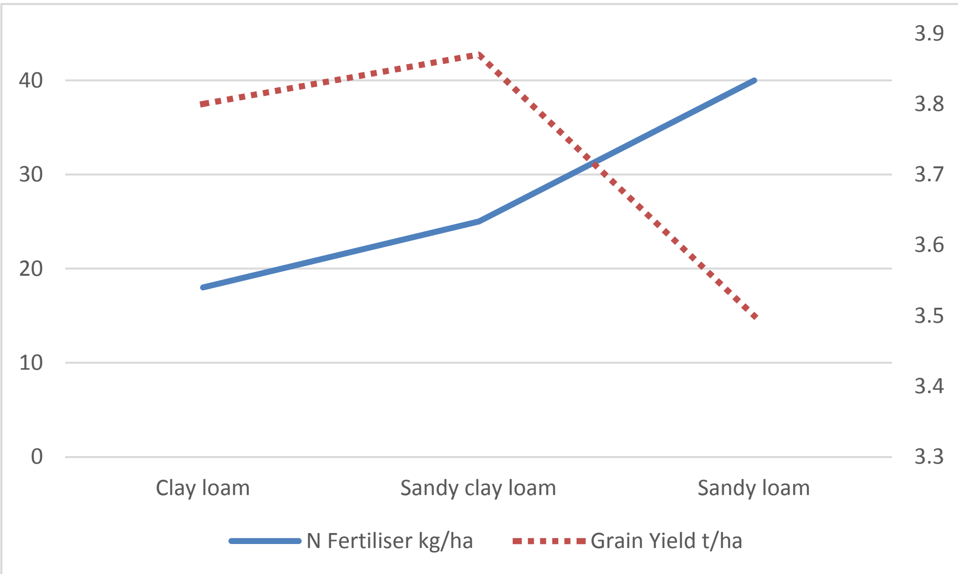

Figure 4: Impact of soil type and post sowing N fertiliser on grain yield of barley.

Summary

Although the N_2O emissions did not seem to correlate with the rate of N fertilizer applied the demonstration did clearly show that despite extremely wet conditions at and soon after application N_2O emissions are still relatively low (less than 10%) compared to irrigation sites. These emissions are likely to be well above average in this soil and rainfall indicating the emissions from N_2O in these cropping systems is relatively insignificant. The demonstration will be conducted again in 2014 using several rates of N on a single soil type to get a clearer picture of the variation in emissions.