Efficient Grain Production compared with N_2O emissions

DAFF project AOTGR1-956996-222
Upper North Farming Systems Component

Background

Nitrous oxide emissions – what do crops contribute? (Article from BCG Newsletter)

Over the last few years there has been increased talk about the role that agriculture plays in nitrous oxide (N20) emissions however, limited research has been conducted around the grains industry's contribution to emissions.

Already farmers have begun to use nitrogen 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 N20 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 nitrogen 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 and the corresponding effect of N_2O emissions from a non-legume crop in 2013 was also measured. In 2013 the Upper North Farming systems group established a site in the Booleroo Centre area to demonstrate N_2O emissions following nitrogen fertilser 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 will be sent to Melbourne University for analysis.

If N_2O is released to the atmosphere; nitrogen 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 N2O emissions made from fertiliser and legumes; reveal options available to reduce N20 emissions; and to provide information about nutrient use efficiency that maximises productivity.

Additionally, growers and advisors will have a better understanding about how nitrogen application in the system can deliver the best result in terms of production per tonnes of carbon dioxide equivalents (CO2e) emitted.

UNFS Demonstration Site

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

Yield Prophet Outputs as at 14th July

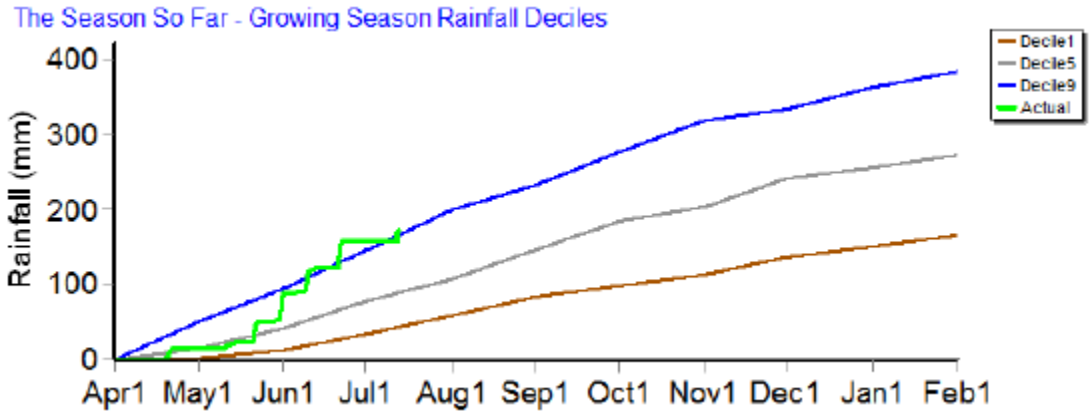

Figure 1: Growing Season rainfall to 14th July

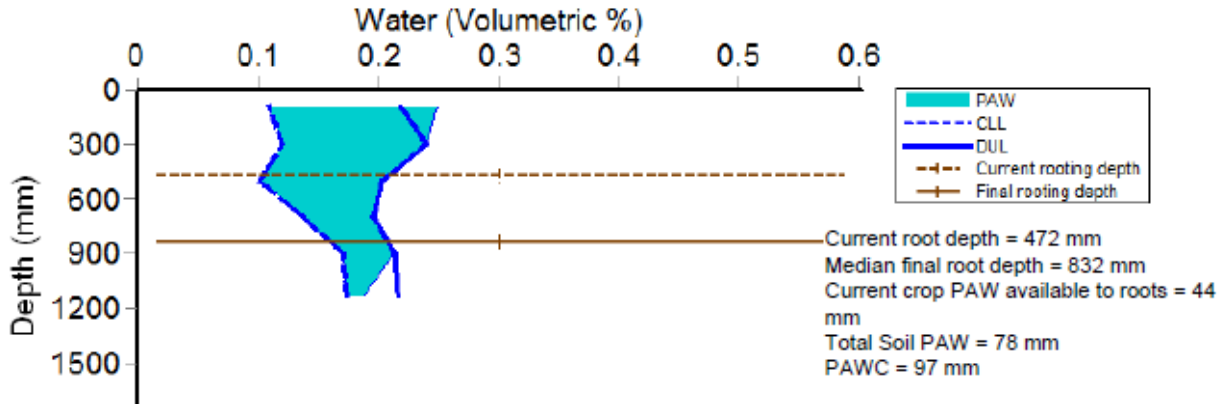

Figure 2: PAW at 14th July

Table 1: Water Budget at 14th July

Initial PAW status @ 17-May	10 mm
Rainfall since 17-May	148.5 mm
Irrigations	: mm
	: mm
	: mm
	: mm
	: mm
	: mm
	: mm
	: mm
	: mm
	: 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**

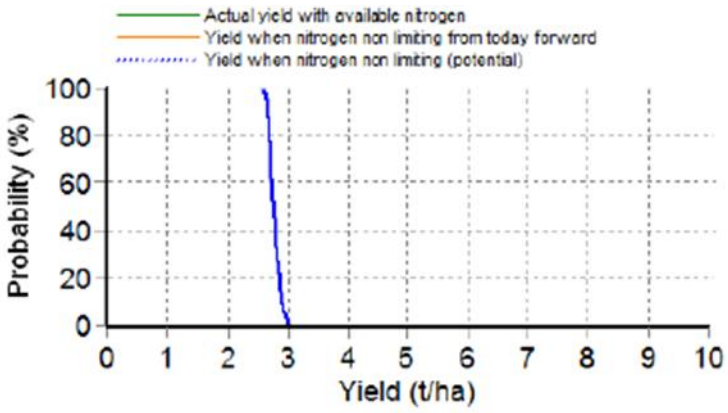

Figure 3: Grain Yield Outcome as at 8th October

Nitrogen Application

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

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

From the N sensor analysis the following nitrogen fertilser rates were determined:

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

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 4 N2O sampling cylinder (right) with lid and syringe to extract samples from the cylinder (left)

Soil Analysis of the site

Sandy loam	16th July	18th July	24th July
Nitrogen kg/ha 0-10 cm	12.6	37.8	22.4
Organic carbon %	0.86		
pH CaCl2	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 CaCl2	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 CaCl2	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.

The moisture content of the soil before the N fertilizer application was high, with rain being received within several hours of application ensuring that fertilizer N was moved into the soil. The extremely wet conditions during this period (decile 9 rainfall) ensured that the soil remained wet for an extended period. This should have resulted in the maximum release of N_2O, compared to more normal seasonal conditions.

There was a response to rainfall at the site with increased N2O emissions after monitoring day one. Emissions were somewhat higher at this site, although still not significant from a productivity perspective potentially indicating a slightly different soil type with higher background levels of mineral N and labile carbon although this will need to be confirmed. Emissions did not appear to correlate with rate of N input during the sampling period.

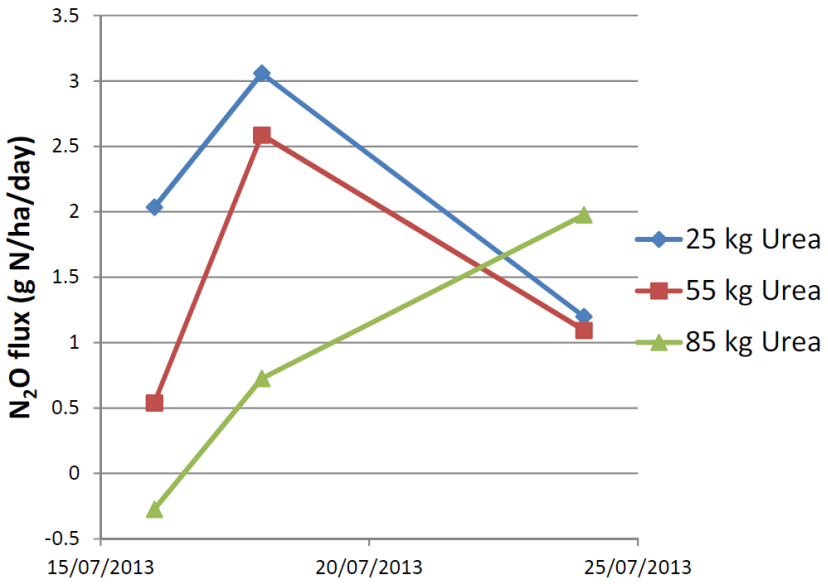

Figure 5: N_2O flux following various topdressed rates of urea prior to, immediately following and one week after fertiliser application and rainfall occurring on the 17th of July.

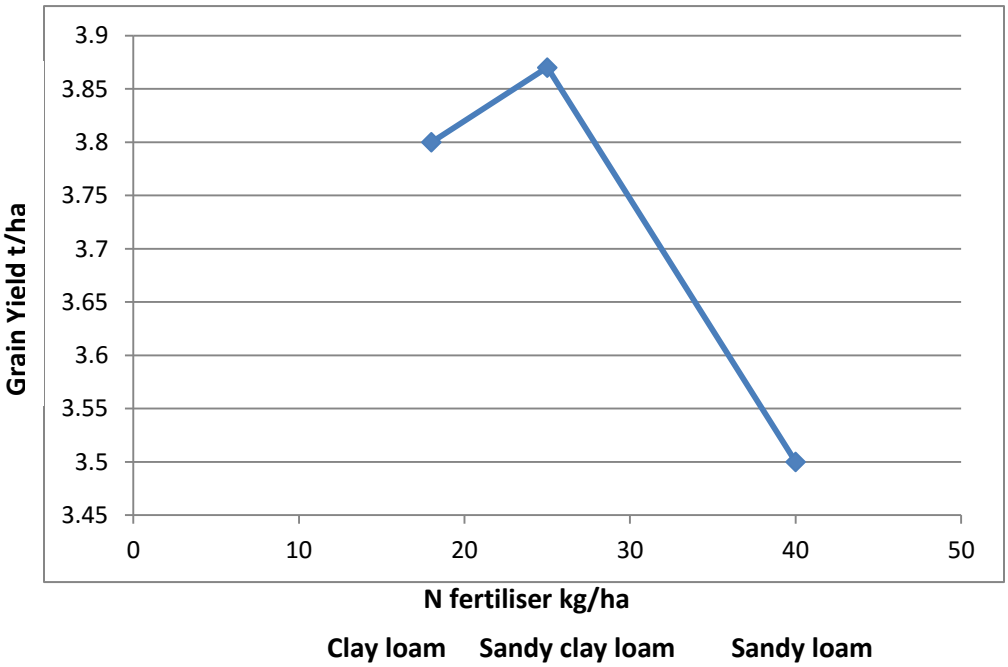

Figure 6: Impact of Soil Type and Post Sowing N fertiliser on Grain Yield of barley

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. Given that this was a low rainfall site growers in this area would not be prepared to risk applying higher rates of N, even in well above average seasons.