EFFICIENT GRAIN PRODUCTION COMPARED WITH N_2O EMISSION.

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Take Home Messages

- *Nitrous oxide losses following rainfall from a wheat crop sown into vetch stubble that was terminated in various ways in the previous year were low: ~ 1.5 g N/ha/day or less.*

BACKGROUND

Most cropping farmers try to carefully match inputs of fertiliser application to crop demand. The major driver for this is economics because inapropriate nitrogen (N) fertiliser application equates to dollars lost; something that farmers can ill afford.

Nitrous oxide (N_2O) is a greenhouse gas which has worldwide agricultural, environmental and societal implications. Part of the reason for this is that it has a global warming potential (GWP) 298 times that of carbon dioxide. GWP is a measure of how much heat a greenhouse gas can trap in the atmosphere compared with carbon dioxide. N_2O is mainly produced by two chemical processes: nitrification and denitrification. The presence of favourable levels of nitrogen, soil carbon and moisture influences these processes (DAFF, 2011).

Previous work in low and medium rainfall environments has generally shown that N_2O losses tend to be small when compared with the amount of nitrogen (N) required to grow a crop. As a result, the focus of this work was to investigate options to improve nitrogen efficiency and ensure that grain productivity was maximimsed relative to N_2O emissions.

AIM

To measure N_2O losses from a wheat crop grown into vetch that was terminated via different end uses and to measure the effect on wheat yield and quality.

METHOD

Static chambers were placed in vetch treatments that were terminated 17 September 2012 (hay, brown manure, incorporated, grazed x 2 [8 June, 25 July] and harvested for grain on 13 November (Table 1). A complete randomised block design was used to compare 2013 grain yield and quality.

2012 Treatment	2012 End Use	Termination treatment
Hay	17 September	Mowed, residue removed from plots *
Brown Manure	17 September	2L/ha Roundup PowerMax, 300ml Lontrel
Incorporation by cultivation	17 September	Disced 2L/ha Roundup PowerMax, 300ml Lontrel
Grazed x2	8 June, 25 July 17 September	Simulated grazing by mowing 2L/ha Roundup PowerMax, 30
Harvest (control)	13 November	Header Harvest

Table 1. 2012 Vetch end uses

Demonstration scale measurements of N_2O emissions occurred in 2013 and were measured from sealed PVC static chambers of approximately 30cm diameter positioned between crop rows of 30.5cm (12 inch) spacing.

N_2O was drawn from airtight chambers via medical syringes into evacuated vials. N2O flux measurements were collected between 12pm to 3pm at intervals of 0, 30 and 60 minutes; one day prior to (11 July), one day after (15 July) and approximately seven days following a rain event (July 22 GS14,22). Ambient and soil temperatures were measured and soil (0-10cm) was collected to enable testing for moisture and nitrogen at each sampling. Samples were analysed at the Queensland University of Technology.

LOCATION	Birchip
REPLICATES	4
SOWING DATE	3 May
SOWING RATE	70kg/ha
CROP TYPE	CLF Elmore Plus wheat
FERTILISER	At sowing 30kg/ha Granulock Supreme Z + Impact
SEEDING EQUIPTMENT	BCG Gason parallelogram cone seeder (knife points, press wheels,30cm row spacing)
RAINFALL	GSR – 156mm; Annual 186mm. 16.2mm fell the evening before the second sampling (Table 1).

Date	11	12	13	14	15	16	17	18	19	20	21	22	Total
mm	0.0	0.2	9.6	6.6	0.2	0.2	0.0	1.6	1.8	2.0	0.2	0.0	22.4

Table 2. Horsham rainfall 11-22 July 2013.

RESULTS AND INTERPRETATION

2013 pre-sow soil nitrogen and pre-sow soil water.

2012 vetch termination treatment	2013 pre-sow soil water (mm) 0-120cm	2013 pre-sow soil nitrogen (kgN/ha) 0-120cm	2013 (11.7.13) In crop soil N (kgN/ha) 0-10cm	2013 (15.7.13) In crop soil N (kgN/ha) 0-10cm	2013 (22.7.13) In crop soil N (kgN/ha) 0-10cm
Cultivated	57	66b	63	38	29
Brown Manure	70	85a	90	64	56
Grazed	67	78ab	53	40	33
Harvest Control	54	71ab	86	47	44
Hay	51	44c	62	33	40
Sig. diff. LSD (P=0.05) CV%	NS 32	0.004 17 15			

Table 3. Vetch end use termination treatment effect on pre and post-harvest soil nitrogen and soil wa-ter (0-120cm) and in crop soil N sampled in July.

WHEAT YIELD AND QUALITY

Wheat yield ranged between 1.8 t/ha to 2.3 t/ha, and there was no significant difference between the 2012 vetch termination treatments (Table 4).

Protein was 13% or above for all treatments; the hay treatment had the lowest and brown manure the highest protein of all the termination treatments. These results corresponded to the amount of soil N at sowing for the wheat crop.

Brown manure vetch had a higher soil N and soil water than vetch taken through to harvest, but the fol-lowing wheat crop hayed off (low yield with high screenings) possibly due to low growing season rainfall (Decile 2 season). The least hayed off treatments occurred where biomass was removed; hay and grazed treatments.

2012 Treatment	Yield (t/ha)	Protein (%)	Test wt (kg/hL)	Screenings (%)	1000 grain weight
Cultivated	2.3	15.2ab	77ab	21a	21b
Brown Manure	2.1	16.0a	75bc	33a	19c
Grazed	2.1	14.1bc	80a	14b	24a
Control	1.9	15.4ab	74c	35a	19c
Hay	1.8	13.1c	80a	12b	25a
Sig. diff. LSD (P=0.05) CV%	NS 14.0	<0.001 1.6 7.2	<0.001 1 2	<0.001 6 36	<0.001 2 5

Table 4. Wheat yield and quality parameters.

N_2O FLUX

N_2O fluxes measured at this site were typical of much of the data collected during this project, with fluxes generally less than 1 g N/ha/day. Most treatments responded to rainfall with a corresponding increase in soil moisture and increased emissions at the second sampling day. However, clear differences between treatments did not appear to align with differences in soil N as the brown manure treatment exhibited the highest mineral N levels across the three sampling days, but it did not produce the highest emission except on day three. Spatial variability is a major factor when investigating data from static chambers (unreplicated).

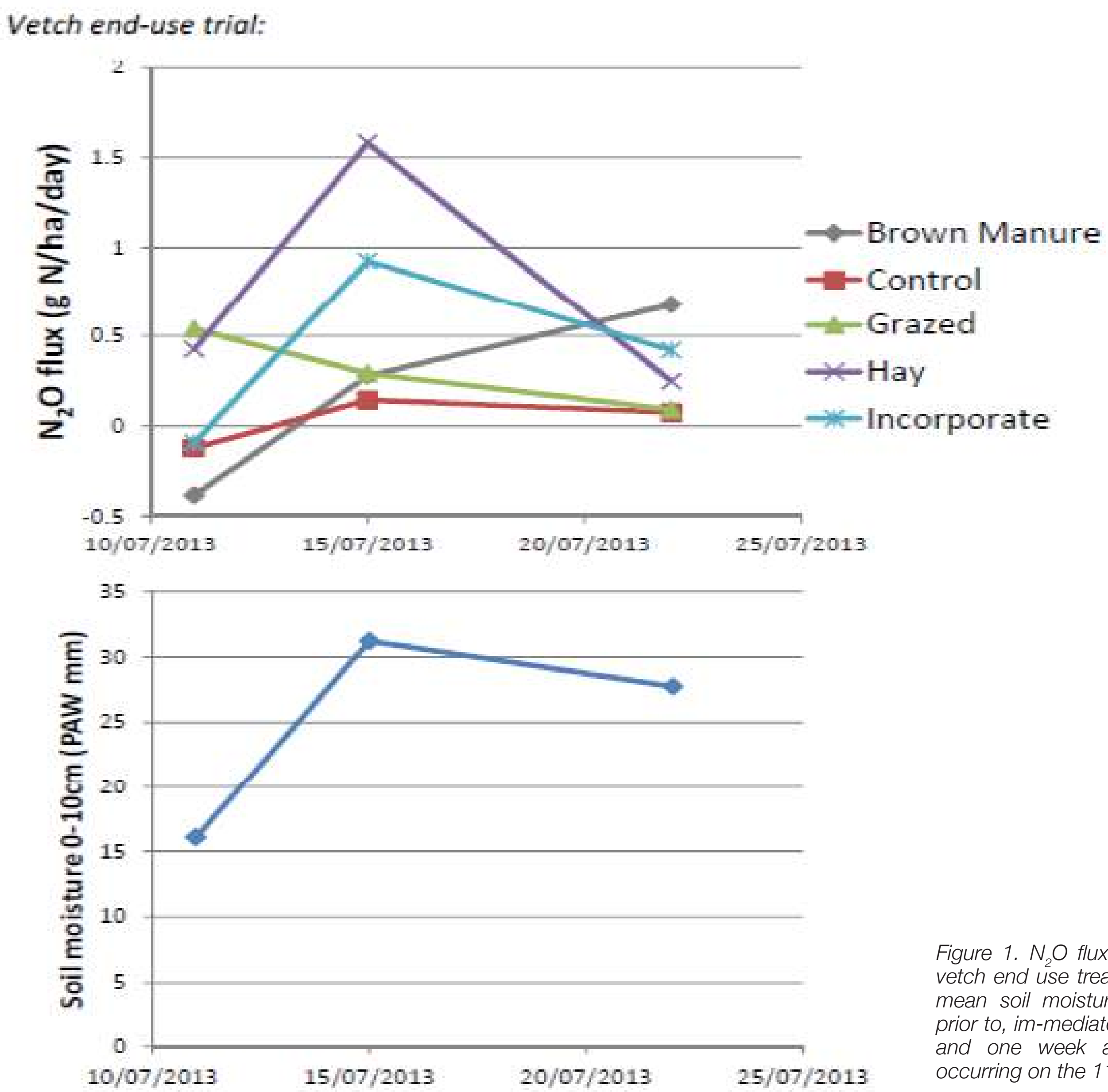

Figure 1. N_2O flux for various vetch end use treatments and mean soil moisture (0-10cm) prior to, im-mediately following and one week after rainfall occurring on the 11-22nd July.

COMMERCIAL PRACTICE

Findings of small N_2O losses align with previous work in low rainfall environments, indicating a relatively low loss of N as N_2O from the cropping system. Anecdotally, higher N_2O emissions may arise from legume stubbles following rainfall in the warmer summer/autumn months. More field based data may be needed to validate this.

This study also showed that 'haying off' can occur if wheat is grown in a low rainfall season following a vetch crop that was terminated later in the previous season, where spring and summer rainfall was also low.

Soil testing, paddock history, seasonal forecasts and/ or Yield Prophet® will continue to help growers improve nitrogen use efficiency per unit of N_2O emitted.

This project which includes the LRCC of which CWFS is a member along with SFS is continuing this year.

REFERENCES

Trenkel ME. (2010) Slow and controlled release and stabilized fertilizers: An option for enhancing nutri-ent use efficiency in agriculture. International Fertiliser Industry Association (IFA), Paris, France.

DAFF 'Reducing nitrous oxide emissions fact sheet' 2011 http://www.daff.gov.au/climatechange/australias-farming-future/climate-change-and-productivity-research/emissions_reduction2/nitrous_oxide_research_program/fact-sheet-reducing-nitrous_oxide_emissions

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