IMPACTS OF AGRICULTURE ON GREENHOUSE GASES AND NITROGEN CYCLING

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INTRODUCTION

Agricultural management practices significantly alter emissions of greenhouse gases (GHGs) to our atmosphere and nutrient cycling in fields[1]. Fertilizers (manure) applied to agricultural fields can increase GHG flux rates and the amount of nitrogen (N) and phosphorus (P) in soils. Fertilization can lead to leaching, volatilization, denitrification and water runoff of nutrients[2]. Excess N and P can cause eutrophication in water bodies, which is a major issue in the Lake Champlain watershed in Vermont. While P has been widely studied throughout the Lake Champlain Basin, less is known about N. Yet, understanding N cycling is important for controlling and managing eutrophication[3]. Best Management practices (BMPs), such as the incorporation of manure via aeration tillage, have been adopted in an attempt to minimize nutrient runoff, but little is known about the effects of such BMPs on GHG emissions. This study focused on comparing soil NO_3^- and NH_4^+concentrations, and GHG fluxes of carbon dioxide (CO_2) and nitrous oxide (N_2O). While CO_2 emissions are the result of plant and microbial respiration[4], N_2O emissions result primarily from denitrification, a process that relies on low oxygen soils and high nitrate availability[5].

Fig. 1. Example of greenhouse gas sampling setup in Field 1 (BMP).

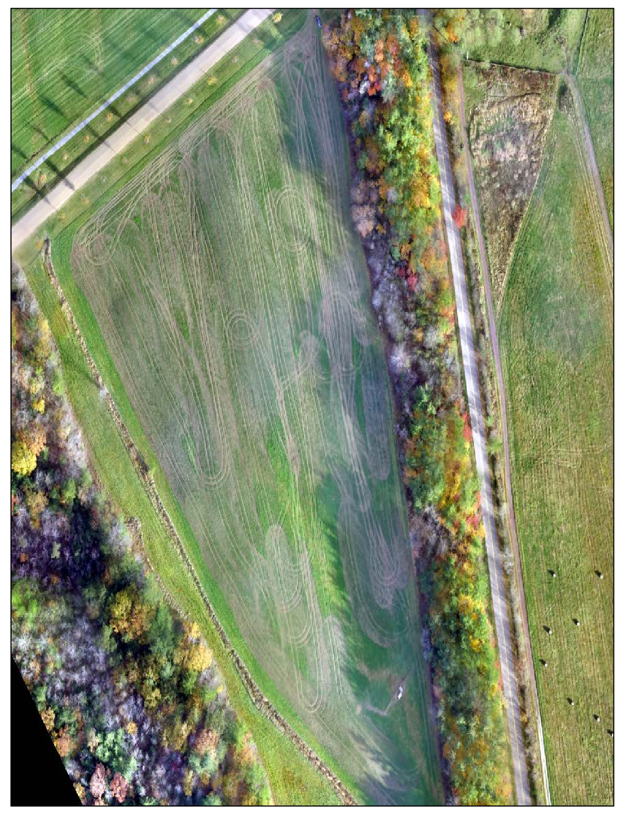

Fig. 2. Aerial photo of Field 2 taken by a drone. Field 2 is the conventional field where manure was broadcasted.

Fig. 3. Aerial photo of Field 1 taken by a drone. Field 1 is the BMP where the field is aerated before manure was spread.

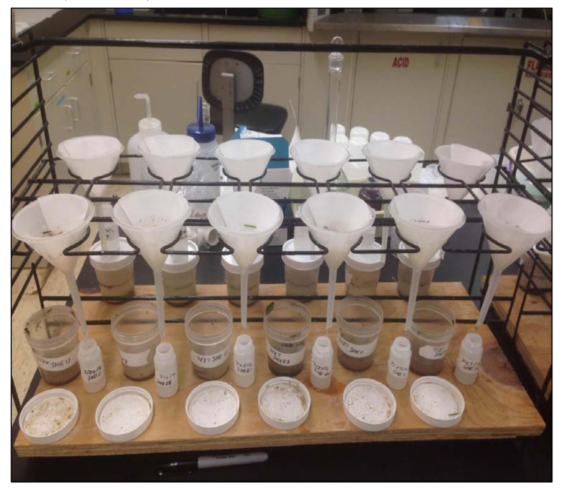

Fig. 4. Soils collected from each field were taken back to the lab for a KCL extraction to determine available soil N.

METHODS

Two pasture fields, adjacent to Lake Champlain, were selected for this four-year study in Shelburne, Vermont.

Field 2 is a conventional field where manure is spread directly across the field (broadcast; Fig. 2).

Field 1 is a best management practice (BMP) where soil is aerated before manure is spread (Fig. 3).

A comprehensive assessment of soil health was completed by Cornell Soil Health Laboratory in April of 2016.

Using static flux chambers and an Infrared Photoacoustic Spectroscopy gas analyzer, CO_2 and N_2O fluxes were measured on site. Gas fluxes were analyzed using R and JMP software.

At each time of sampling soil temperature, air temperature, and soil moisture were recorded and soil samples were taken (0-10 cm) and analyzed in the lab for NO_3^- and NH_4^+.

Soil moisture was determined gravimetrically in the lab.

Soil nitrate and ammonium concentrations were determined using a Flow Injection Analyzer after KCL extractions were completed.

RESULTS

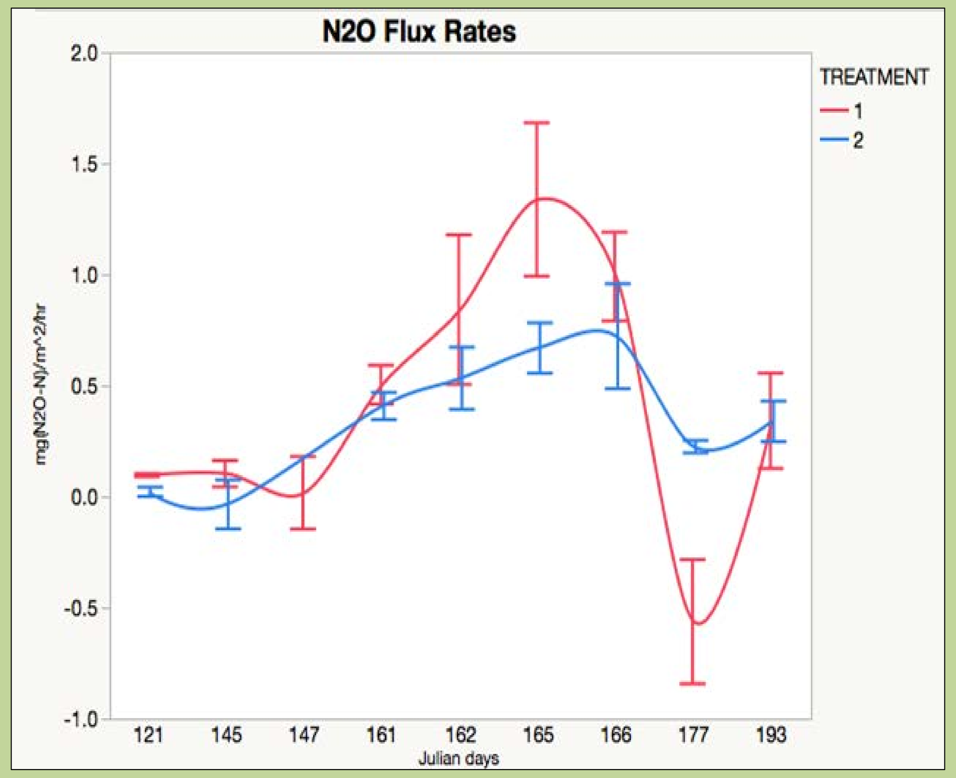

Fig. 5. Manure application on Day 161 shows an increase in N_2O flux rates in both treatments. Immediately after manure application, the aerated field (1; red line) shows higher N_2O flux rates than the non-aerated field (2; blue line).

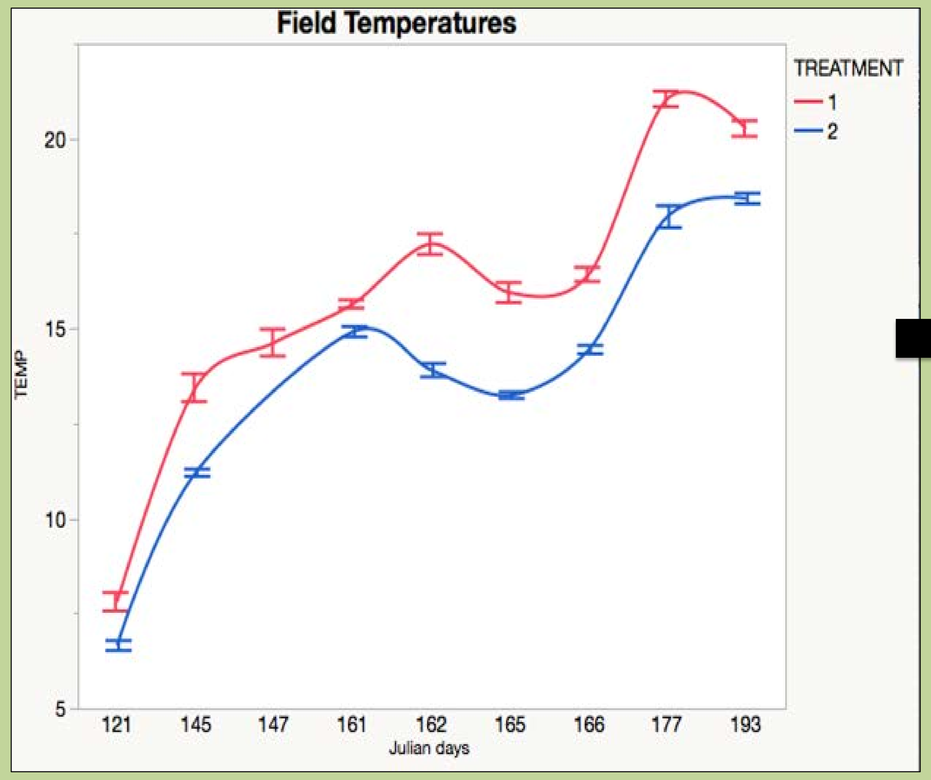

Fig. 6. The aerated field (1; red line) had higher soil temperatures than the conventional field (2; blue line) due to times of sampling.

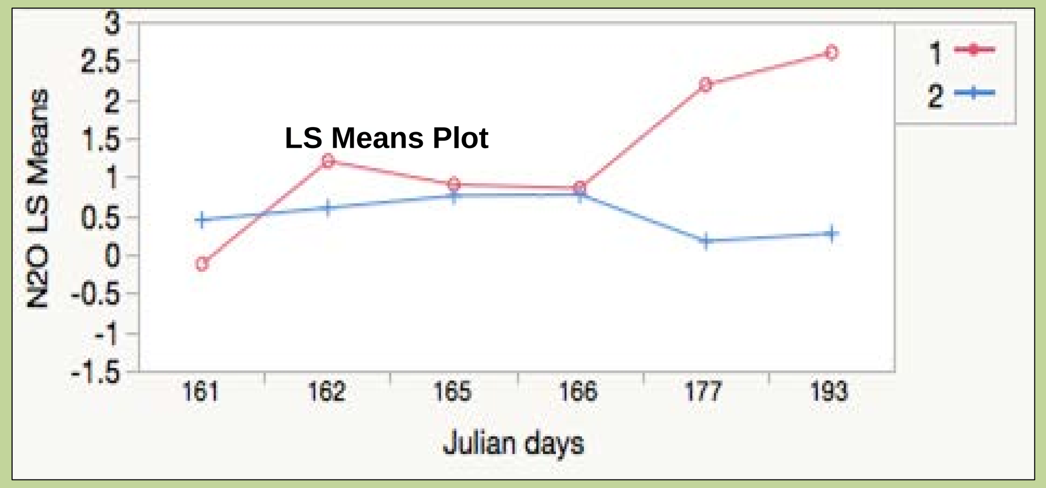

Fig. 7. A model was fit with a correction for soil temperature and produced an LS means plot. The plot shows the N_2O flux rates after temperature differences are accounted for. The aerated field (1; red line) still shows higher N_2O flux rates.

Effect Tests

Source	Nparm	DF	Sum of Squares	F Ratio	Prob > F
TREATMENT	1	1	0.8640624	4.9897	0.0304*
julian days	5	5	3.4305106	3.9621	0.0045*
TREATMENT*julian days	5	5	2.0937715	2.4182	0.0499*
TEMP	1	1	0.7398347	4.2724	0.0444*
TEMP*TREATMENT	1	1	0.9002039	5.1985	0.0273*

Fig. 8. The effects test shows Julian days, treatment, and temperature all had significant effects on N2O emissions.

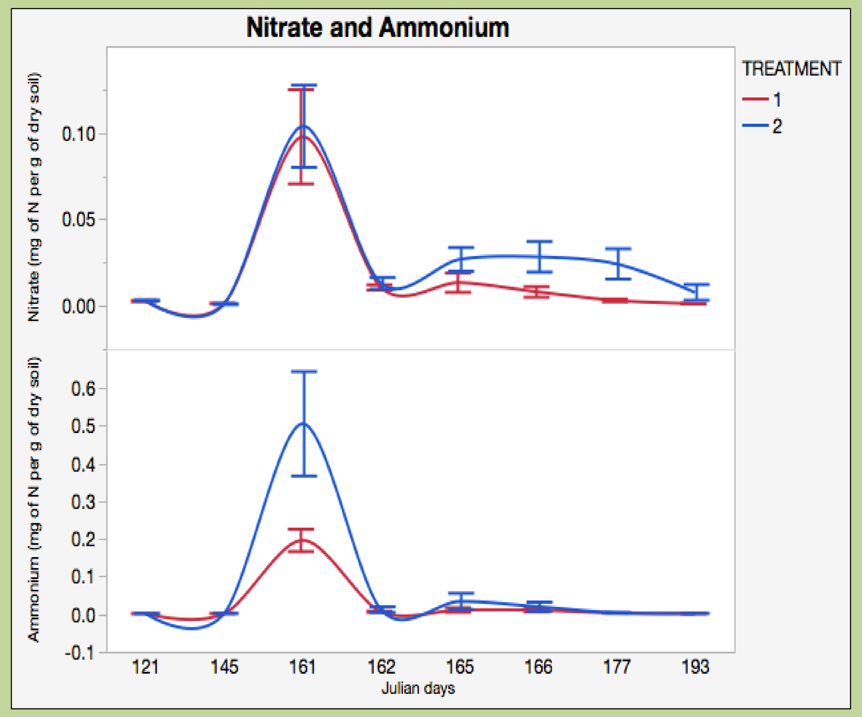

Fig. 9. Nitrate and ammonium concentrations were affected by the spread of manure. Nitrate followed similar trends in both fields. Ammonium was higher in the conventional field (2; blue lines).

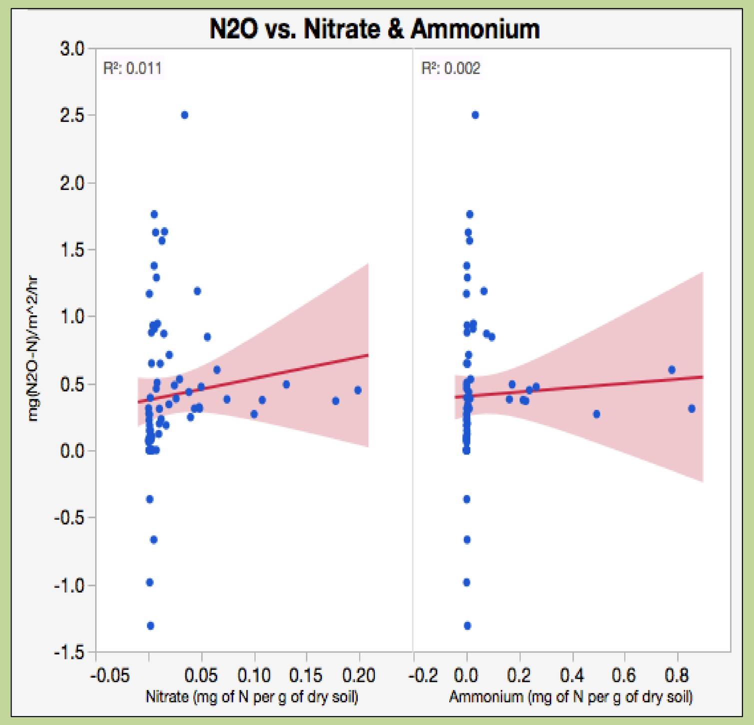

Fig. 10. Nitrate and ammonium concentrations show no significant correlation with N_2O flux rates.

Important Julian Days:

Day 121= April 30th 2016
Sampling started
Day 161 = June 9th 2016
Manure was spread on this day.
Day 193= July 11th 2016
End of sampling

Field 2 Conventional (broadcast)	Field 1 Aerated (BMP)
Silty clay loam	Clay loam
Sand: 9%	Sand: 42%
Silt: 52%	Silt: 28%
Clay: 38%	Clay: 29%
Quality Score: 85/Optimal	Quality Score: 77/Excellent

CONCLUSIONS

- N_2O emissions were on a delayed release: 5-16 days after manure spreading.
- N_2O emissions were temperature influenced, but even accounting for that, N_2O differed by field treatment.
- N_2O emissions were higher in the Aerated field (field 1, red line), especially 5 days after manure was spread and continuing for 30+ days after manure was spread.
- N_2O emissions were significantly effected by: Julian days, treatment, and temperature.
- Nitrates - no significant difference between treatments.
- Ammonium – non-aerated field treatment (field 2, blue line) had more ammonium.
- Nitrate / Ammonium had no significant effect on N_2O flux rates, regardless of treatment.
- Future work will be necessary to draw more conclusions.

for Future Work, follow Adair Lab: adairlab.weebly.com

REFERENCES

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