Microplot Study with the Portable Flow through System and Soil Core Incubation for N_2O Emissions Measurements

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INTRODUCTION

Soil moisture and N fertilization are major factors affecting emissions of highly potent greenhouse gas nitrous oxide, which is the major contributor to climate change from agricultural land. A well-known substrate acetylene is commonly used in soil incubation studies for preventing nitrification and therefore eliminating respective pool of nitrous oxide by deactivating ammonia monoohygenase enzyme, which catalyzes ammonia oxidation process.

The inhibition reaction happens at 0.1-10Pa (0.01%) concentrations of acetylene. The current study was designed to evaluate the effects N fertilization and repeat water additions on N_2O and CO_2 emissions and to assess the nitrification and denitrification pools of N_2O-N in no-till winter wheat system in Pacific Northwest.

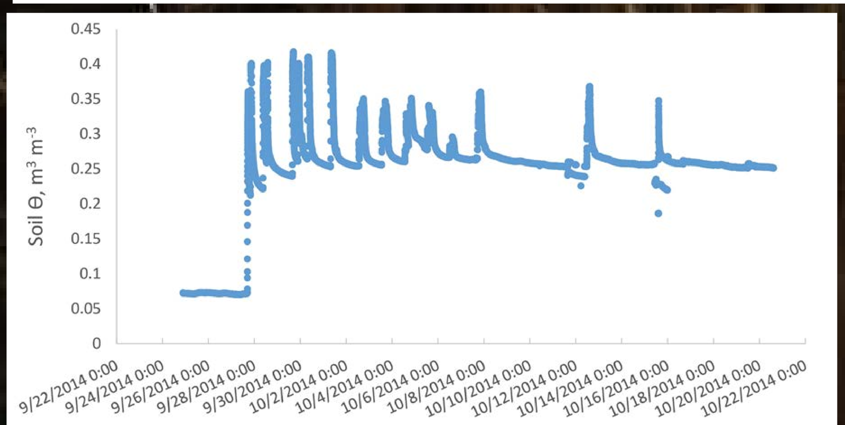
MATERIALS AND METHODS

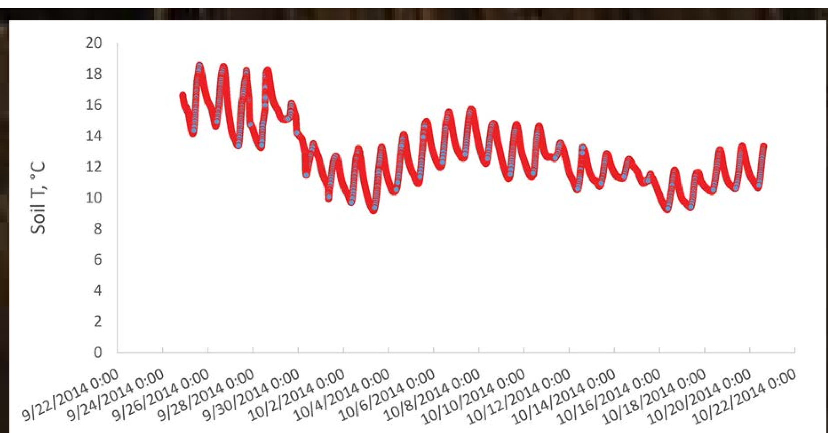
We implemented two Li-Cors 8100A and the total of 30 Li-Cor chambers coupled with one LGR 23r N_2O analyzer via a series of solenoid valves and a CR1000 datalogger (Kostyanovsky K.I., et al, submitted) in continuous flow through chamber system for monitoring of CO_2 and N_2O emissions in the short term microplot study between October 1 and October 12, 2014. The following treatments were repeated seven times, preceded by abundant water additions:

- 150 kg KNO_3-N ha^{-1}+35g glucose
- 150 kg aqua-N ha^{-1}+35g glucose
- No fertilizer+35g glucose
- 150kg KNO_3-N ha^{-1}
- 150kg aqua-N ha^{-1}
- No fertilizer

Fertilized treatments resulted in the effective application rate of 1050 kg N ha^{-1} in order to avoid limiting N due to repeat water additions for maximum treatment effects of N_2O emissions. Glucose additions each time were added to increase soil microbial activity.

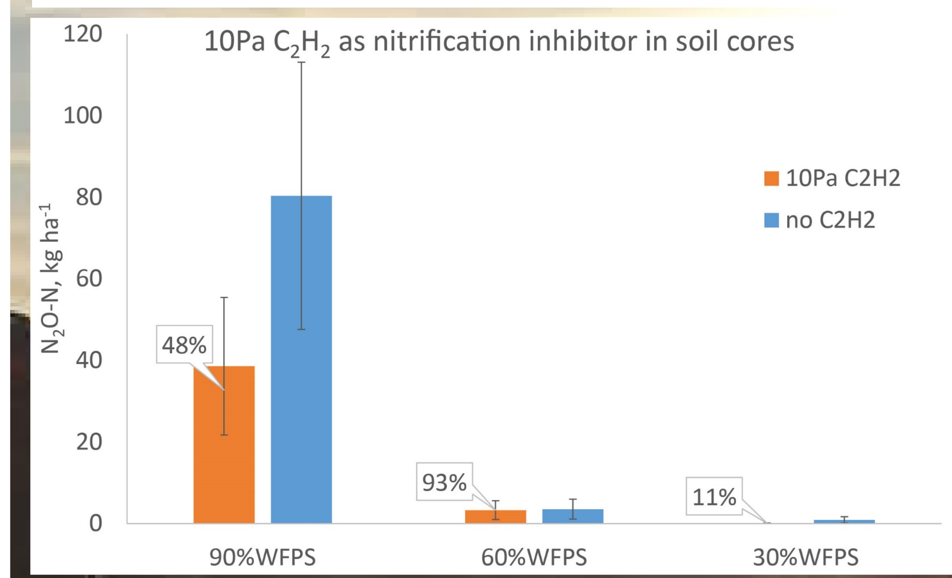
RESULTS AND DISCUSSION





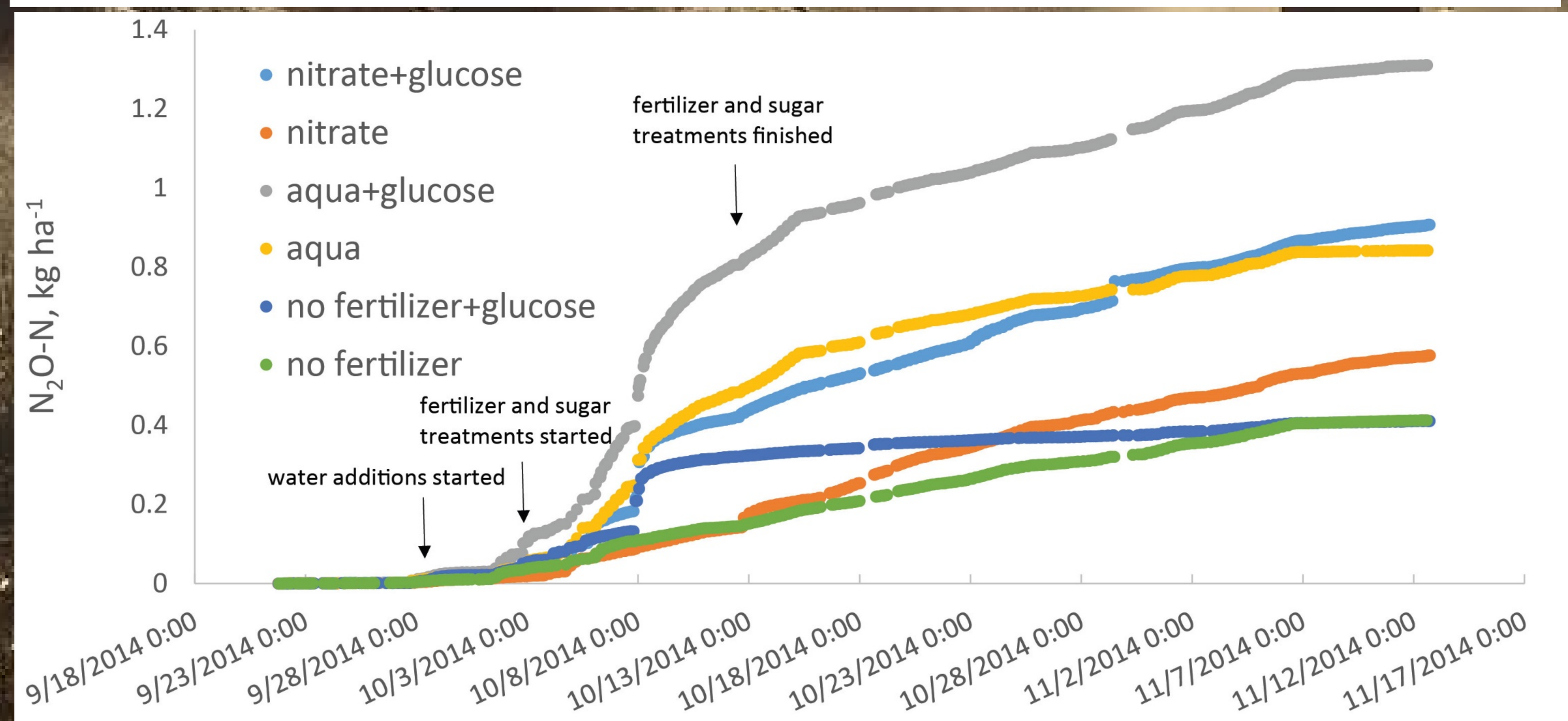
Soil moisture and temperature measured at 15cm for the duration of the study

Soil incubation study previously conducted on 24 cores from 0-20cm at 10Pa and 0Pa of C_2H_2 in order to obtain values for nitrification and denitrification pools of N_2O (Kostyanovsky K.I. et al., 2014) showed highest emissions occur at 90%WFPS. Due to inability of achieving 90%WFPS moisture level on the permanent basis in unsaturated soils (see soil moisture plot), results of the incubation study at semi saturated conditions produce higher fluxes of N_2O than in situ measurements.

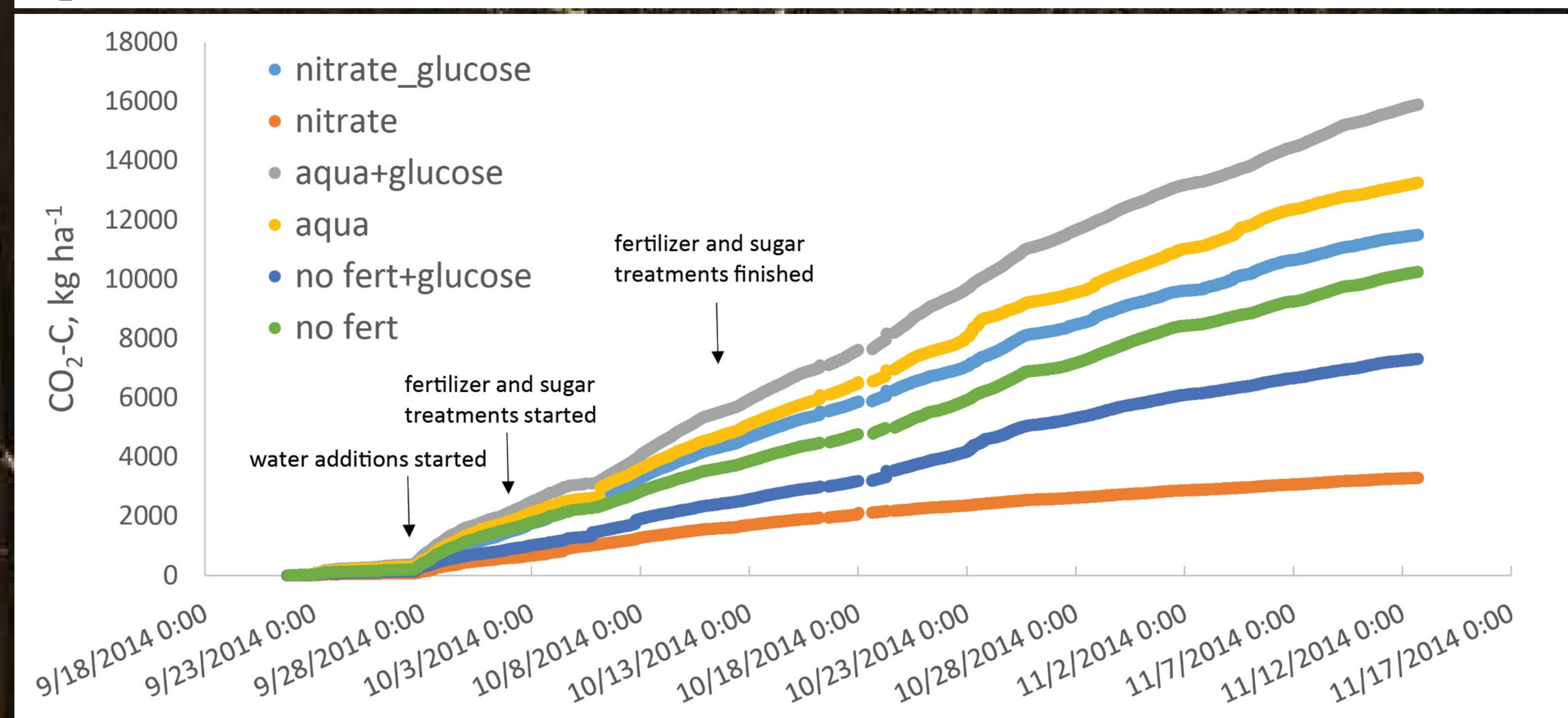


The fraction of N_2O originating from denitrification is 0.48 at 90%WFPS, 0.93 at 60%WFPS, and 0.11 at 30% WFPS. As majority of the time soil is within 60%WFPS range in the in situ study, most of the N_2O produced from denitrification.

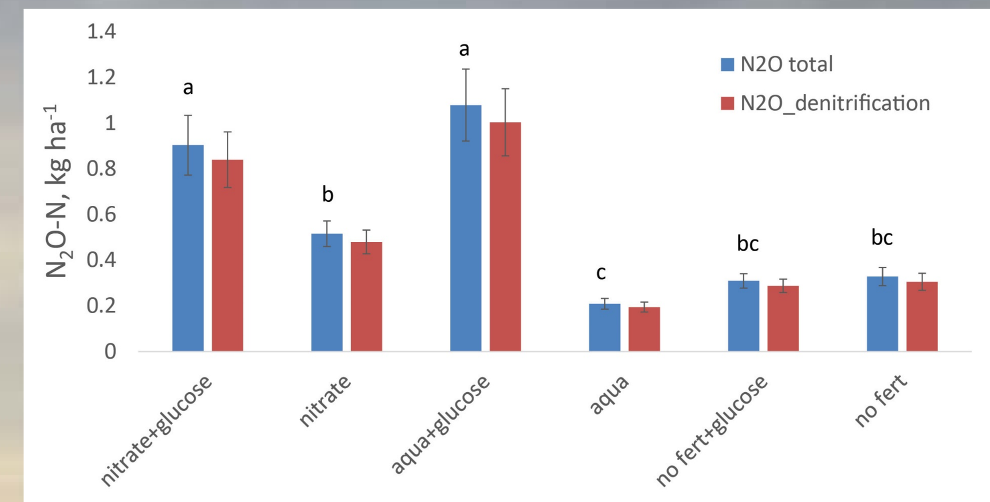
Automatic static chamber study conducted in 5 replications per treatment and set up to conduct 4 N_2O measurements and 8 CO_2 measurements per chamber per 24h period demonstrated higher fluxes of N_2O produced by aqua fertilizer than KNO_3 or no fertilizer treatments. Application of glucose also increased N_2O emissions.



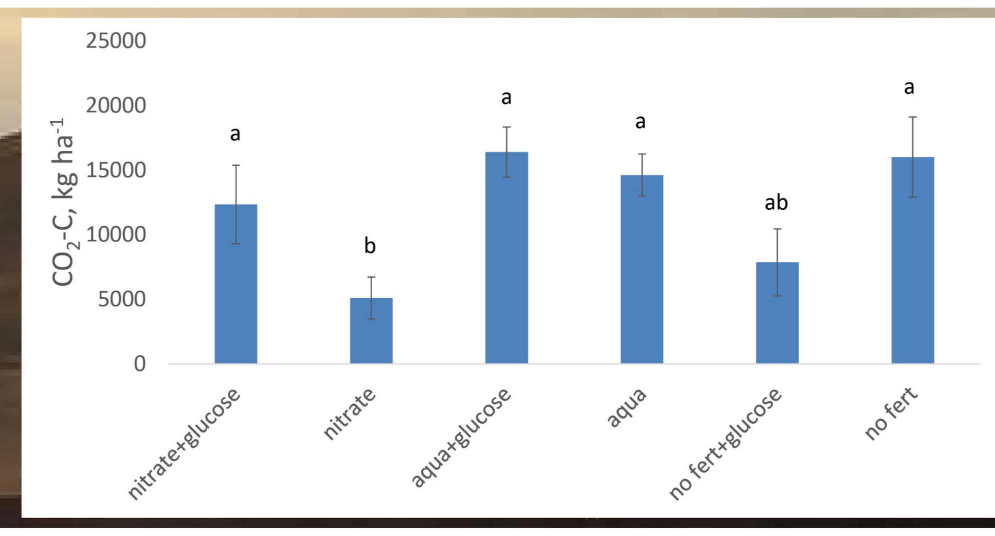
Emissions of N_2O were highest from aqua+glucose treatment, likely due to nitrification of NH_4^+ from N source and denitrification both contributing to N_2O production.



Treatment effects on CO_2 emissions were less pronounced. Linear increase in cumulative CO_2 indicates that moisture and soluble carbon likely affect mineralization less than nitrification and denitrification processes.



Denitrification was the major predicted part of N_2O flux based on soil core incubation results applied to in situ chamber data.



Net CO_2 emissions over 1.5 month period were comparable to annual emissions likely due to multiple drying and wetting.

CONCLUSIONS

- Denitrification is the major source of N_2O in semi saturated soils;
- Repeat water additions establish moisture levels at approximately 60%WFPS following drainage;
- Exponential increase in N_2O emissions occurs following fertilizer N and water additions;
- Nitrate+glucose and aqua+glucose treatments produced highest N_2O flux likely due to increased microbial activity in non-limiting N environment;
- N_2O emissions from aqua+glucose treatment were exponential in the initial days of the study likely due to nitrification and denitrification combined resulting in high N_2O flux;
- Despite application of N exceeding agronomic rates by 7 times over a short period, the net N_2O loss was 0.1% of N applied, possibly due to leaching of N to groundwater.

References:

Kostyanovsky, K.I., Huggins, D.R., Stockle, C.O., Karimi, T., Waldo, S.R. Effects of N Fertilization and Irrigation on Nitrification and Denitrification Pools of N_2O: Acetylene Inhibition Microplot Study. Proceedings of the 2014 ASA-CSA-SSSA International Annual Meetings. Long Beach, CA. November 2-6.

Kostyanovsky, K.I., Huggins, D.R., Stockle, C. O., Waldo, S., Lamb, B., Smith, J.L. **Flow through Chamber System for Automated Measurements of Soil N_2O and CO2 Emissions. Journal of Environmental Quality (Submitted).**

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