Cropping System Management Impacts on Greenhouse Gas Emissions in the Cool, Humid Northeastern U.S.

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Introduction

Estimation of greenhouse gas emissions from agriculture requires assessment from different climatic regions and cropping systems. Research was conducted to evaluate cropping system impacts on greenhouse gas emissions in the cool, humid Northeast. This research contributes to the national research project conducted by USDA-ARS termed the Greenhouse Gas Reduction and Carbon Enhancement Network (GRACENet).

Materials and Methods

Field Experiment

A long-term potato cropping system experiment established in 2004 in Presque Isle, ME, on a Caribou gravelly loam soil. The climate in Presque Isle is ***Cool*** (MAT=4.4ºC, seasonal 15ºC) and ***humid*** (MAP=100 cm). The field experiment contains three systems that contribute to the USDA-ARS GRACENet Project:

Business as Usual =2-yr barley-potato rotation with Fall tillage each year

3-yr Rotation = 3-yr barley-timothy sod-potato rotation with Spring tillage before potato .

3-yr + Compost = 3-yr barley-timothy sod-potato rotation with compost application (56 Mg ha^{-1}) and Spring tillage before potato.

Barley receives 80 kg N ha^{-1}

2006 GHG Monitoring

Sampling in 2006 occurred in the barley phase of each system. There were two chambers per plot, across 3 field replicates. These were sampled on 14 dates (June 6 to September 21), using 0-30-60 minute sampling intervals early in season, and 0-20-40 minute intervals when temperature increased. Samples were analyzed for CO_2, N_2O, and CH_4 according to the GRACENet protocol. Soil samples taken prior to 2006 season were analyzed using methods of Griffin and Porter (2004), Weil et al (2004) and Cambradella and Elliott (1992).

Analysis

Flux of CO_2 and N_2O at each sampling date were compared with Analysis of Variance. Cumulative flux data were calculated by interpolation of sampling data and assuming constant environmental conditions between sampling dates. Estimates of cumulative flux were compared using Repeated Measures analysis.

Results

- *Soil temperature* differences between systems were small, generally 1-1.5ºC (Fig. 1).
- *CO_2 flux* increased in all systems until mid-July (30-40 kg C ha^{-1}d^{-1}) and decreased in August-September to less than 20 kg C ha^{-1}d^{-1} (Fig. 2). Significant differences (P = 0.10) existed between systems on every sampling date except 1 and 18 August.
- *N_2O flux* was greatest between 1 June and 15 July (Fig. 3), with greater emission from 3-yr Rotation + Compost. Flux in August and September was near zero for all systems. Rainfall (Fig. 4) appeared to influence the N_2O flux peak recorded on July 6.
- *Cumulative CO_2 flux* (Fig. 5) was not different for the 3-yr Rotations (with and without compost). The 2-yr Business as Usual treatment had lower cumulative CO_2 flux. Most of this difference was evident in the first month and may be related to lower soil water content (Fig. 4).
- *Cumulative N_2O flux* was higher in the 3-yr Rotation + Compost, compared to the same rotation with fertilizer or the 2-yr Business as Usual rotation (Fig. 6).
- *Total and labile C and N* were higher in the compost-amended system after two years of amendment (Table 2).
- *Methane (CH_4)* was detected, but did not accumulate during sampling. Consequently, CH_4 flux was not estimated.

Table 1. Selected soil properties, May 2006.

System	Soil pH	Total C	Total N	POM-C	POM-N	Active C
	1:1, v/v	---------------- %	-------------------	% of Total C	% of Total N	mg kg^{-1} soil
Business As Usual	5.31	2.75	0.23	21.4	19.8	428
3-yr Rotation No Compost	5.42	2.77	0.24	23.5	20.7	426
3-yr Rotation + Compost	5.59	3.26	0.29	35.7	28.6	496
Prob. > F	0.03	0.04	0.03	0.06	0.03	0.03

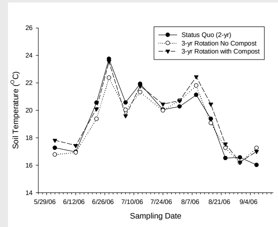

Fig. 1 Season soil temperature in Presque Isle, Maine

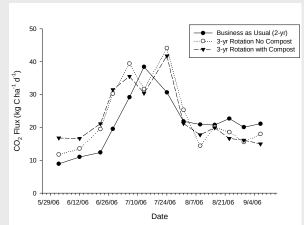

Fig. 2 CO_2 flux estimates for three cropping systems in Maine

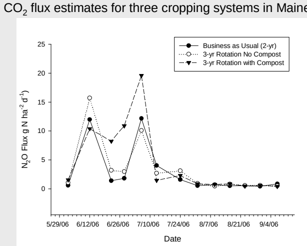

Fig. 3 N_2O flux estimates for three cropping systems in Maine

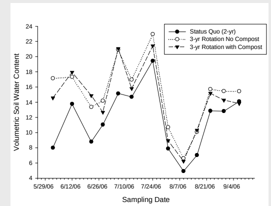

Fig. 4 Season soil water concentration in Presque Isle, Maine

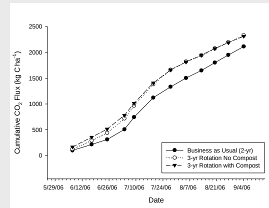

Fig. 5 Estimated cumulative CO_2 flux for three cropping systems in Maine

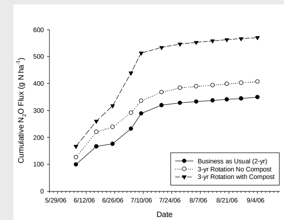

Fig. 6 Estimated cumulative N_2O flux for three cropping systems in Maine

Discussion

- CO_2 and N_2O flux were affected by cropping system on individual dates. The Business as Usual system had lower CO_2 flux during the first half of these season, but was higher during the second half of the season.
- Cumulative CO_2 flux from 2-Yr Business as Usual was slightly lower than the 3-yr Rotations.
- Cumulative N_2O flux was higher in the compost amended system.
- Significantly greater soil organic C and N including active C in the compost-amended treatment did not result in greater CO_2 flux compared to the same rotation with fertilizer. These results suggest sequestering of C with compost.
- Moisture and temperature measurements were made outside the chambers and the chambers did not contain growing plants. These conditions may have affected both temperature and moisture conditions within the chamber. Sensors inside chambers are planned for 2007, as well as flux determinations in potato.

Reference:

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Acknowledgement:

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