Response of Greenhouse Gas Emissions to Varying Compost Rates and Soil Moisture under Laboratory Conditions

Mavis Badu [1], Urszula Norton [1], Jay Norton [2]

[1] Plant Sciences Department, [2] Department of Ecosystem Sciences and Management

UNIVERSITY of WYOMING

Introduction

There is a growing interest amongst dryland winter wheat (*Triticum aestivum*, L.) farmers in the US Northern High Plains (NHP) in transitioning to organically certified practices. This requires an active program of soil fertility improvement.

Past experiences and anecdotal evidence suggest that application of small amounts of composted manure every 3-4 years does not warrant desirable effects on soil health and instead, contributes to increased soil salinity.

The solution may be a one-time fall application of very high rate of compost. It is unclear however, how such practice will affect potential carbon (C) and nitrogen (N) loses. Monitoring greenhouse gas (GHG) fluxes during laboratory incubations may help better understand the drivers of soil organic matter (SOM) mineralization and potential losses between winter and summer.

Objectives

Investigate GHG fluxes from soils amended with different rates of composted feedlot manure and inorganic fertilizer and incubated at varying levels of soil moisture during an 8-week period of gradually increased temperatures that mimic transitioning from winter to early summer.

Materials and Methods

- Study duration: 8 weeks
- Main treatment: composted manure applied at four rates: 0, 15, 30 and 45 Mg ha^{-1}, or inorganic fertilizer (IF) (89 kg ha^{-1} ammonium phosphate + 119 kg ha^{-1} ammonium sulphate)
- Sub-treatment: soil moisture applied at three rates: 5%, 7% and 14% Water Filled Pore Space (WFPS)
- Each combination of treatments exposed increasing temperature (5ºC, 10ºC, 15ºC and 25ºC) changed every two weeks
- Experimental set up: 27 g of sieved soil in a plastic specimen cup placed in a 946 cm^3 glass jar sealed with lid with silicone septum.
- Measurements: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) concentrations from the jar headspace at 1, 4, 7 and 14 days of every temperature-time period.

Table 1. Initial soil and compost properties

	Compost	Soil
pH (1:1 soil: water ratio)	8.46	7.80
Bulk density (gcm$^{3-1}$)	0.98	1.37
Total N (g kg^{-1})	9. 08	1.72
Total C (g kg^{-1})	85.7	18.40
TOC (g kg^{-1})	76.33	13.45
IC (g kg^{-1})	9.38	4.96
Available P (mg kg^{-1})	36.20	23.50

Results and Discussion

Soil and compost mixing likely resulted in the highest GHG fluxes in low temperature treatment which may be comparable to episodic freeze/thaw events.

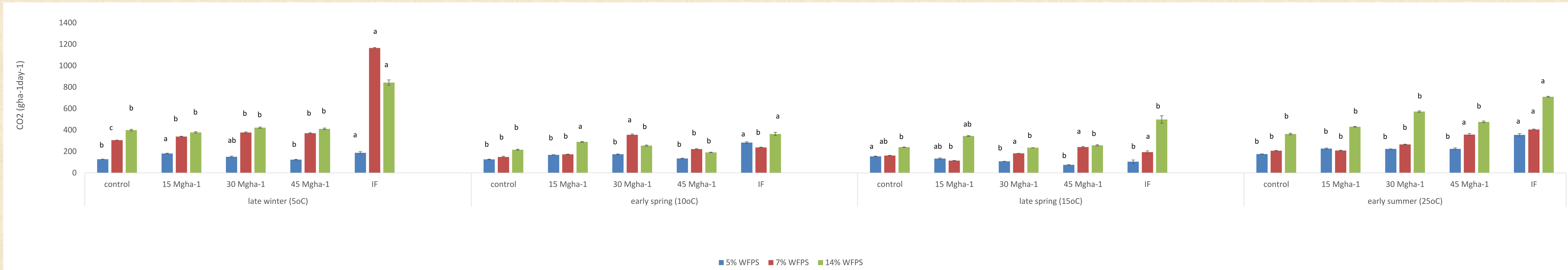

Fig. 1. CO_2 fluxes from soils mixed with variable compost rates and inorganic fertilizer and subjected to different soil moisture levels during 8-week incubation and increasing temperature.

- Highest CO_2 emissions from IF under 7 and 14% WFPS in early summer likely caused by priming of already low soil total organic C
- Increasing moisture enhanced microbial activity and resulted in higher CO_2 emissions

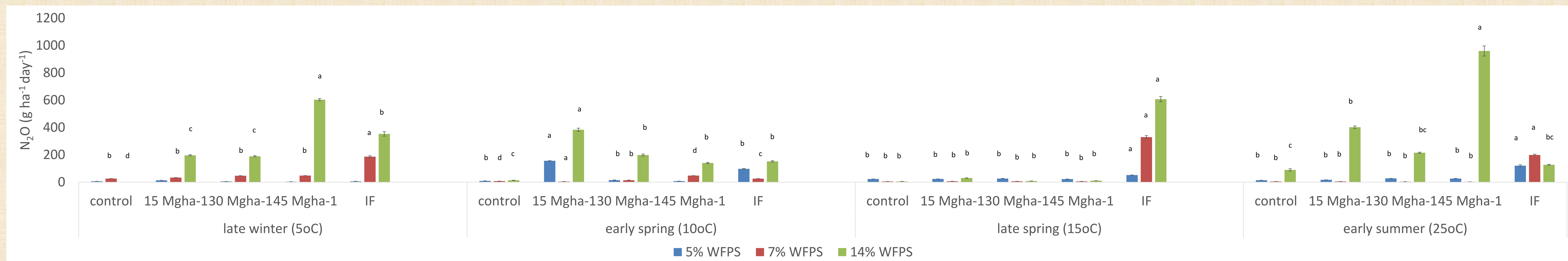

Fig. 2. N_2O fluxes from soils mixed with variable compost rates and inorganic fertilizer and subjected to different soil moisture levels during 8-week incubation and increasing temperature.

- 45 Mgha^{-1} of compost results in the highest N_2O emissions in the summer while IF produces most N_2O emissions in late spring. Nitrification was likely the most important process contributing to the N_2O emissions

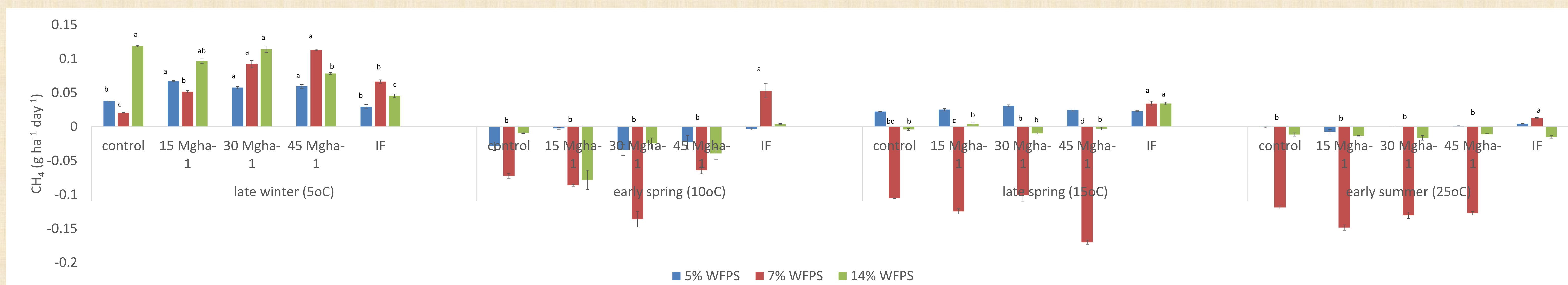

Fig. 3. CH_4 fluxes from soils mixed with variable compost rates and inorganic fertilizer and subjected to different soil moisture levels during 8-week incubation and increasing temperature.

- Enhanced CH_4 assimilation in all compost amended soils as warming increased in soils with 7% WFPS.
- Increasing moisture to 14% resulted in decline in CH_4 assimilation.
- IF resulted in CH_4 production across all moisture treatments and all temperatures.

Conclusions

- Transitioning toward warmer seasons results high N_2O emissions from soils amended with 45 Mg ha^{-1} of compost.
- Disturbance of the soil while applying compost (especially by tilling it in) is enough to cause significant nutrient loss through GHG emissions especially during wet winters.
- Warming helps soils act as CH_4 sink rather than a source.
- Inorganic fertilizer contributes to the highest CO_2 and is always a CH_4 source.

Acknowledgements: This project was funded through grants from USDA transitions to Organic Research and Extension Initiative, Wyoming Dept. of Agriculture and Hatch Funds