A field study comparing N_2O concentrations with surface fluxes under different farming practices

Faezeh Parastesh[1*], Xiaopeng Gao[1] and Mario Tenuta[1]
[1]Department of Soil Science, University of Manitoba, Winnipeg, Manitoba, R3T 2N2, Canada
*Email: paratee@myumanitoba.ca

University of Manitoba

Background Information

While soil surface greenhouse gas (GHG) emissions have been extensively studied, a notable gap exists in understanding the intricate relationship between these emissions and GHG production within soil profiles along with different farming practices. Exploring these connections is key to developing effective strategies for mitigating N_2O emissions and shaping sustainable soil management practices.

Methodology

- This study was conducted at the TGAS Research Station with four 4-ha fields under cover crop and fertilizer treatments (Figs 1, 3).
- Soil gas samples were collected using the modified silicon diffusive equilibrium sampler (Fig 2) from depths of 5, 15, 30, and 60 cm (refer to Fig 2). Cover crops (winter rye) were planted in the eastern Fields 2 and 3 during the fall of 2021.
- EENF (Entrench and Centuro dribble banded) was applied in the spring of 2022 to the northern Fields 1 and 2, while conventional N fertilizer (100 lbs/ac urea) was applied to the southern Fields 3 and 4. In 2023, SuperU was applied to the southern fields (3 and 4).

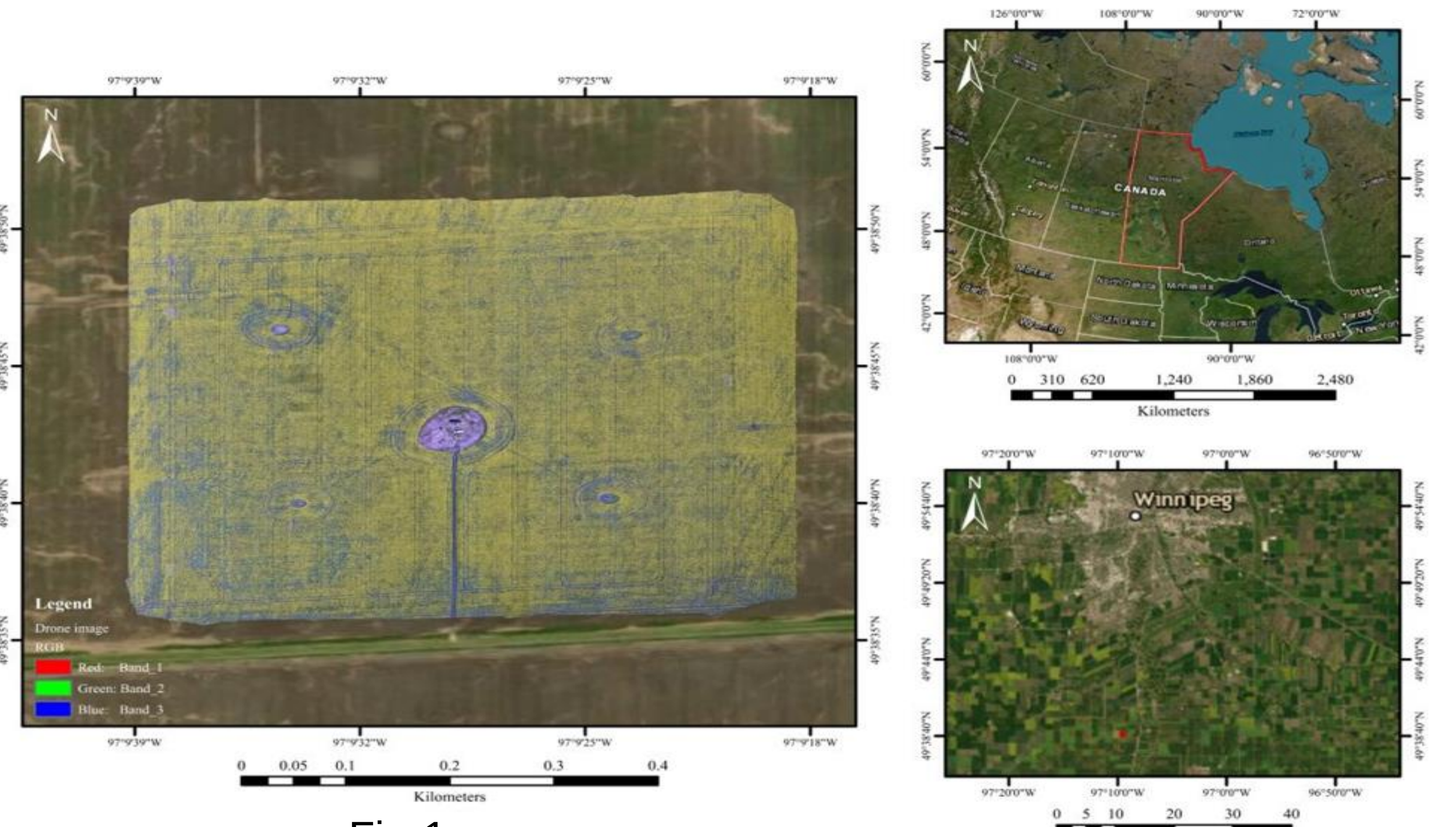


Fig-1

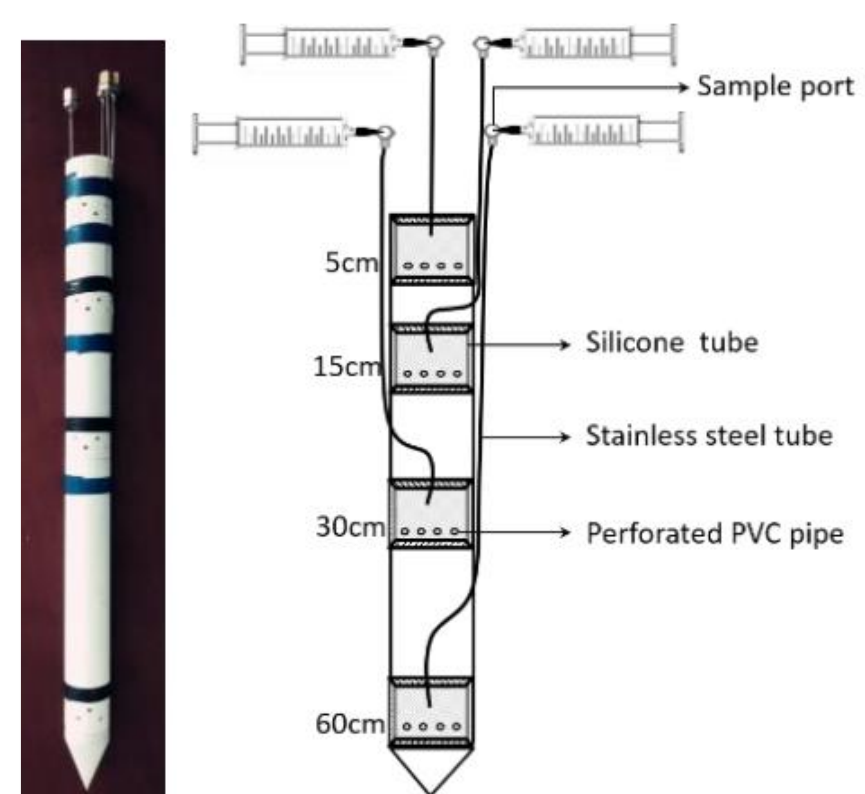


Fig-2

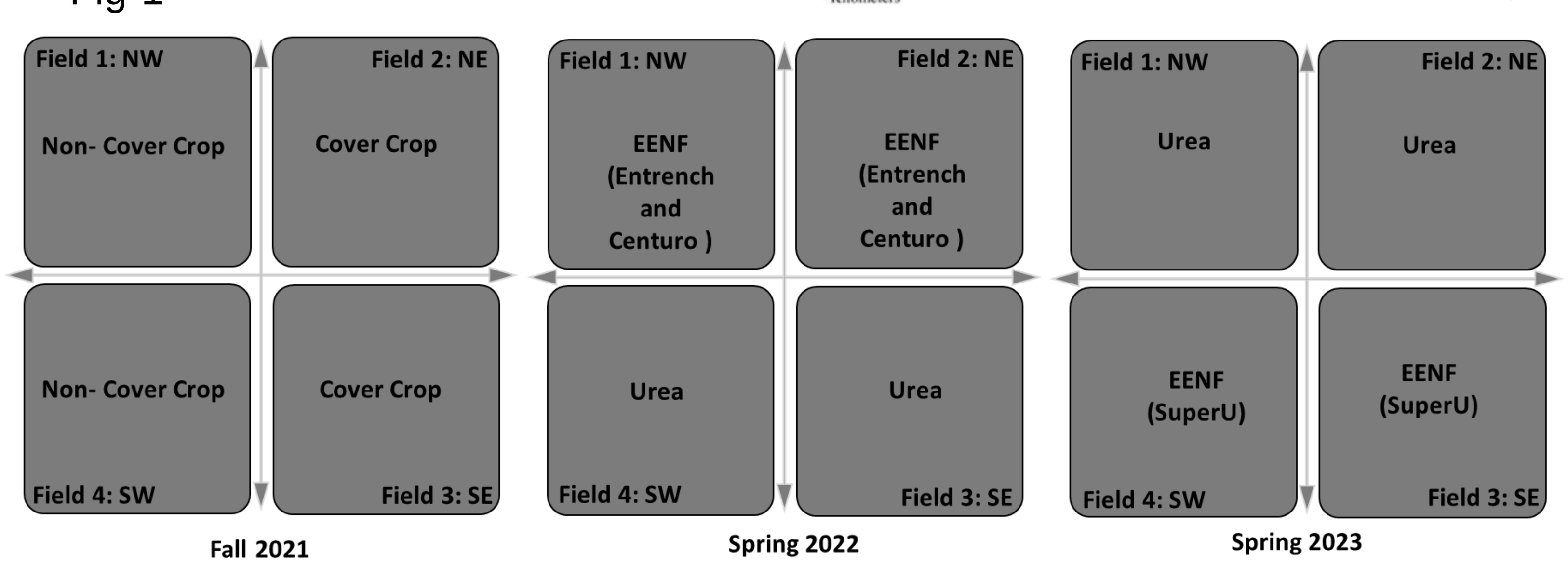
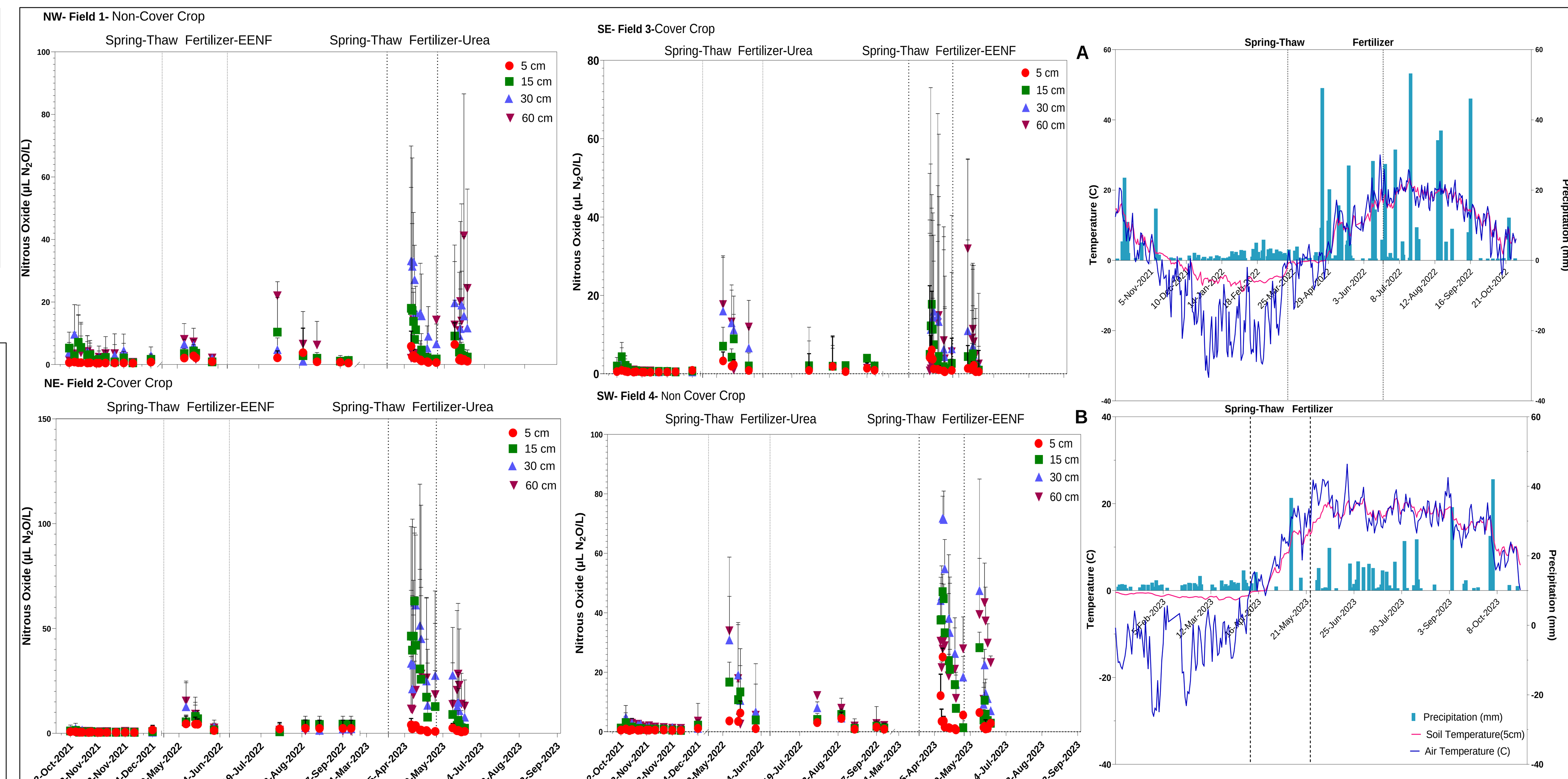


Fig-3

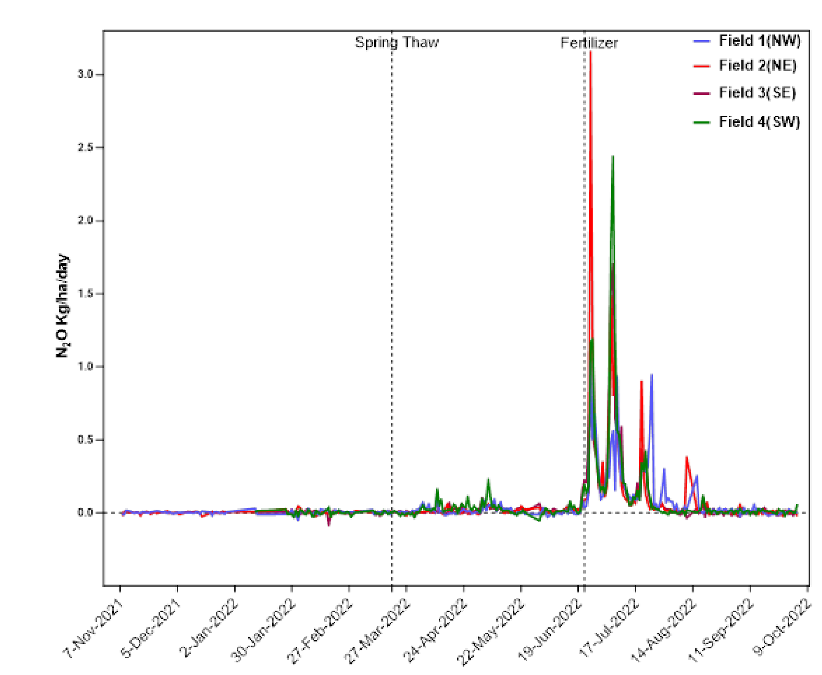
Results

- With increasing temperature and moisture, Soil N_2O concentration at all depths increased during the spring-thaw periods in both years. The increases were more evident in Field 4, which had a wetter condition than other fields.



- N_2O concentrations were observed to vary with depth, with the highest levels consistently recorded at 30 cm depth during the spring thaw, and notable interannual increases were seen, especially at deeper soil layers in 2023.

Depth	Period	Cover Crop			Non-Cover Crop				
		Mean	Median	SE	Mean	Median	SE	n	P
5 cm	Post-harvest (Oct 2021- Des 2021)	0.57	0.43	0.040	0.59	0.58	0.02	156	**0.0039****
15 cm	Post-harvest (Oct 2021- Des 2021)	0.952	0.575	0.100	2.038	0.968	0.281	156	**<0.0001*****
30 cm	Post-harvest (Oct 2021- Des 2021)	1.049	0.639	0.098	2.949	1.379	0.316	156	**<0.0001*****
60 cm	Post-harvest (Oct 2021- Des 2021)	0.862	0.653	0.063	2.435	1.21	0.29	156	**<0.0001*****



- Cover crop significantly reduced median N_2O concentrations at all depths during the post-harvest period, whereas did not affect those during spring thaw.
- The effect of fertilizer on N_2O concentration was significant at 5 cm of soil profile during the growing season.
- No significant relationship was observed between soil profile N_2O concentration and surface flux.

Conclusion

Large variations in soil N_2O concentration were observed and could be associated with variations in soil temperature and moisture across the field. The highest N_2O concentration levels were observed at 30 cm depth during the spring thaw period. Furthermore, the impact of agricultural practices, such as cover cropping and fertilizer application, was found to be depth-dependent, affecting N_2O concentrations differently at various soil layers.

This study is funded by Research Manitoba New Investigator Operating Grants