Soil Moisture Content Controls The Denitrification Loss of Urea-N From Silty Clay Soil

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INTRODUCTION

- **Denitrification loss of N from N-fertilizers like urea is the potential source of N_2O flux from agroecosystems.**
- **Soil moisture content controls denitrification loss of mineralizable N.**

OBJECTIVES

- **To evaluate the influence of soil moisture content on N_2O emissions from urea-N fertilizer from silty clay soil.**
- **To evaluate denitrification losses of urea-N with and without additions of nitrification inhibitor, nitrapyrin (NP).**

METHODS

- **Surface soils of 0-15 cm depth were collected from North Dakota State University Sub-surface Water Management Research site, near Fargo, ND.**
- **The soils were air dried and ground to pass a 2mm sieve.**
- **Briefly, 100 g of air dried soils, amended with urea-N (with or without NP) across three moisture regimes, were incubated in an airtight 1 L mason jars at 25 °C in the laboratory.**
- **Headspace samples were collected for 140 days from a sampling port (with butyl rubber septum) in a jar lid, using a 30 mL syringe.**
- **Gas samples were analyzed for N_2O concentration using a Dani Master gas chromatograph, equipped with electron capture detector (Parkin and Venterea, 2010).**
- **N_2O production rates were calculated from the time elapsed headspace concentration and volume, and soil mass.**
- **At the termination of the experiment, soils were analyzed for inorganic N contents.**
- **Emission factor (%) = $\left(\frac{N_2O_{fert} - N_2O_{control}}{N\ applied}\right)$ x 100 (Gagnon et al., 2011)**

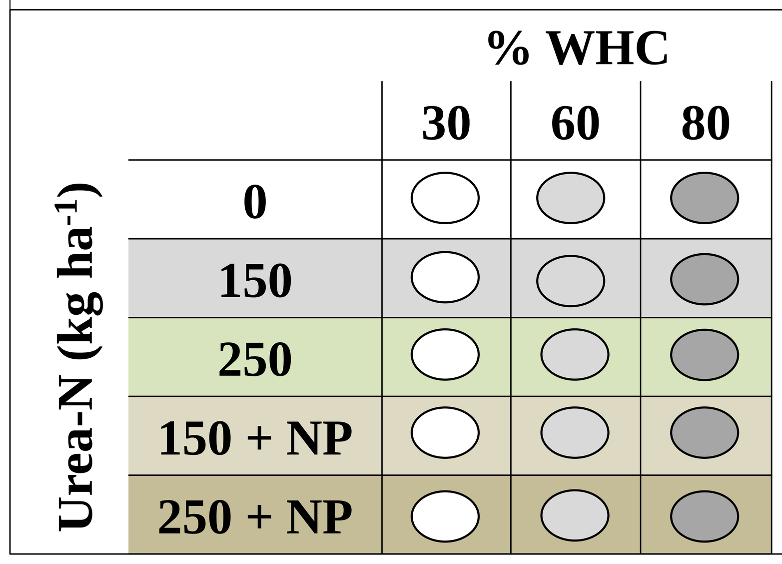
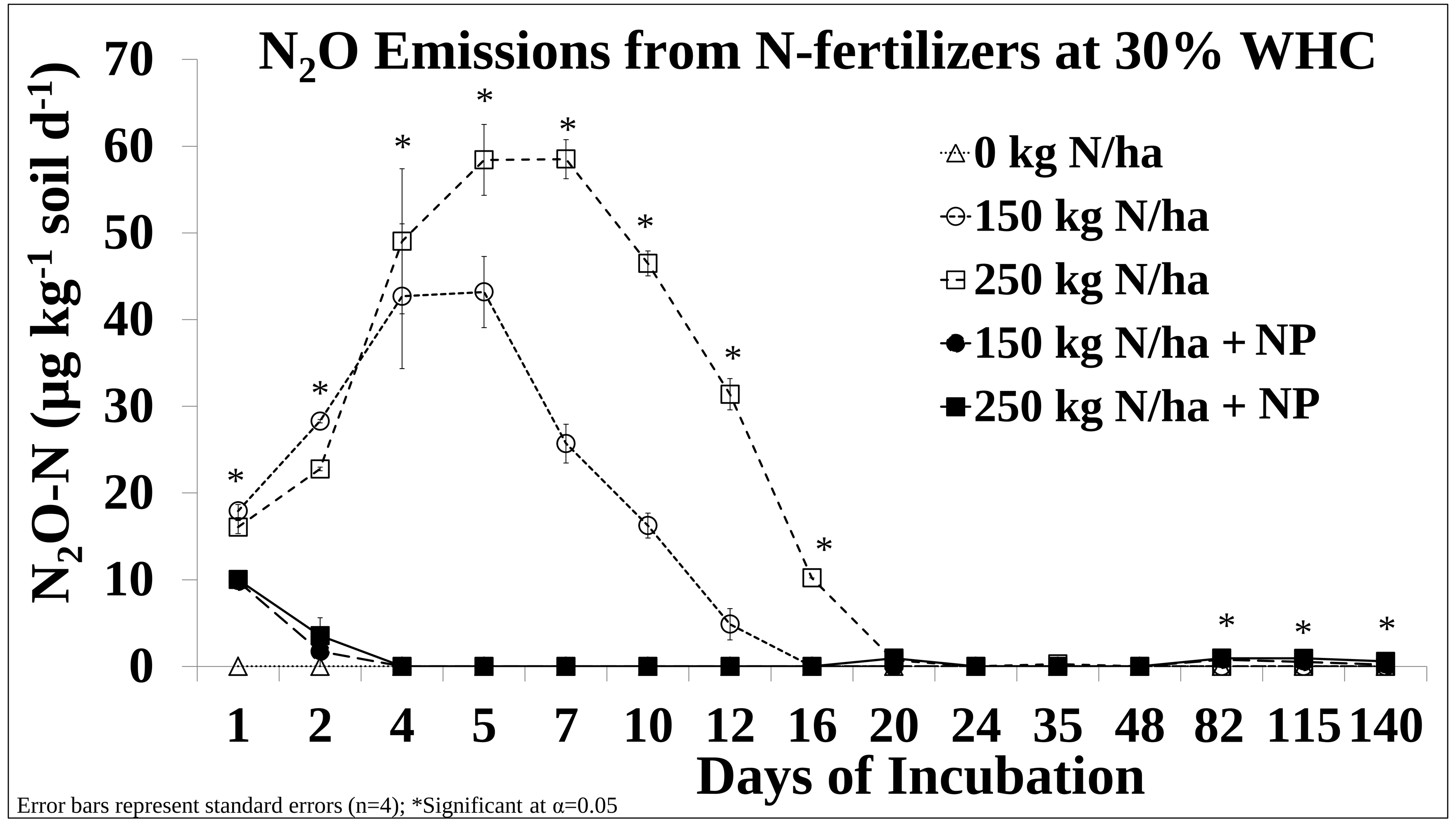


Fig: Diagrammatic representation of soil moisture contents (30, 60, and 80 % WHC) and N-fertilizer levels (with and without nitrification inhibitor, NP) employed in the experiment.

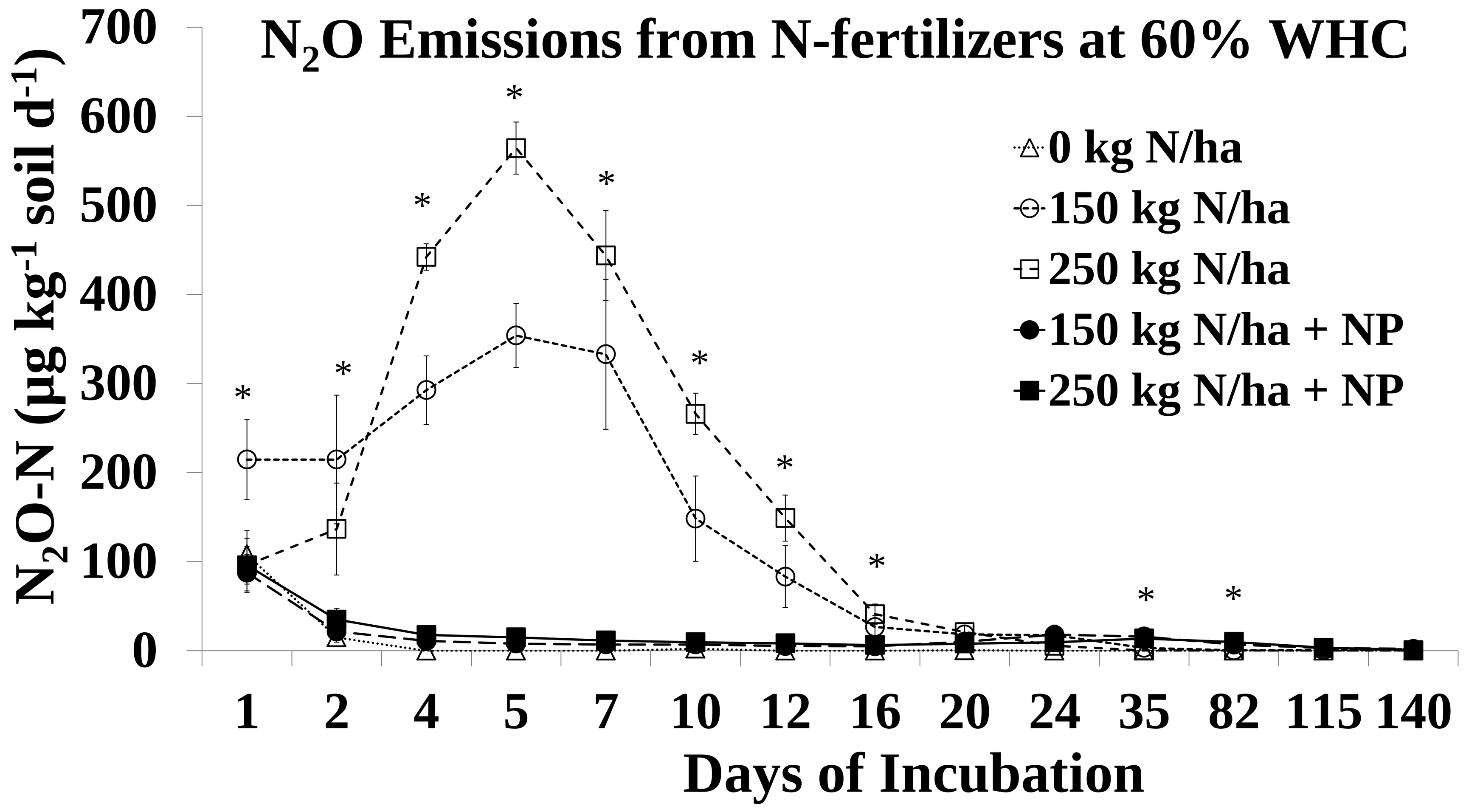
RESULTS

Physical and Chemical Properties of Soil used in the Study

pH	EC (ds m^{-1})	Sand (g kg^{-1})	Silt (g kg^{-1})	Clay (g kg^{-1})	NH_4^+-N (mg kg^{-1})	NO_3^--N (mg kg^{-1})
8.24	0.16	23	467	510	2.76	34.6



Error bars represent standard errors (n=4); *Significant at α=0.05



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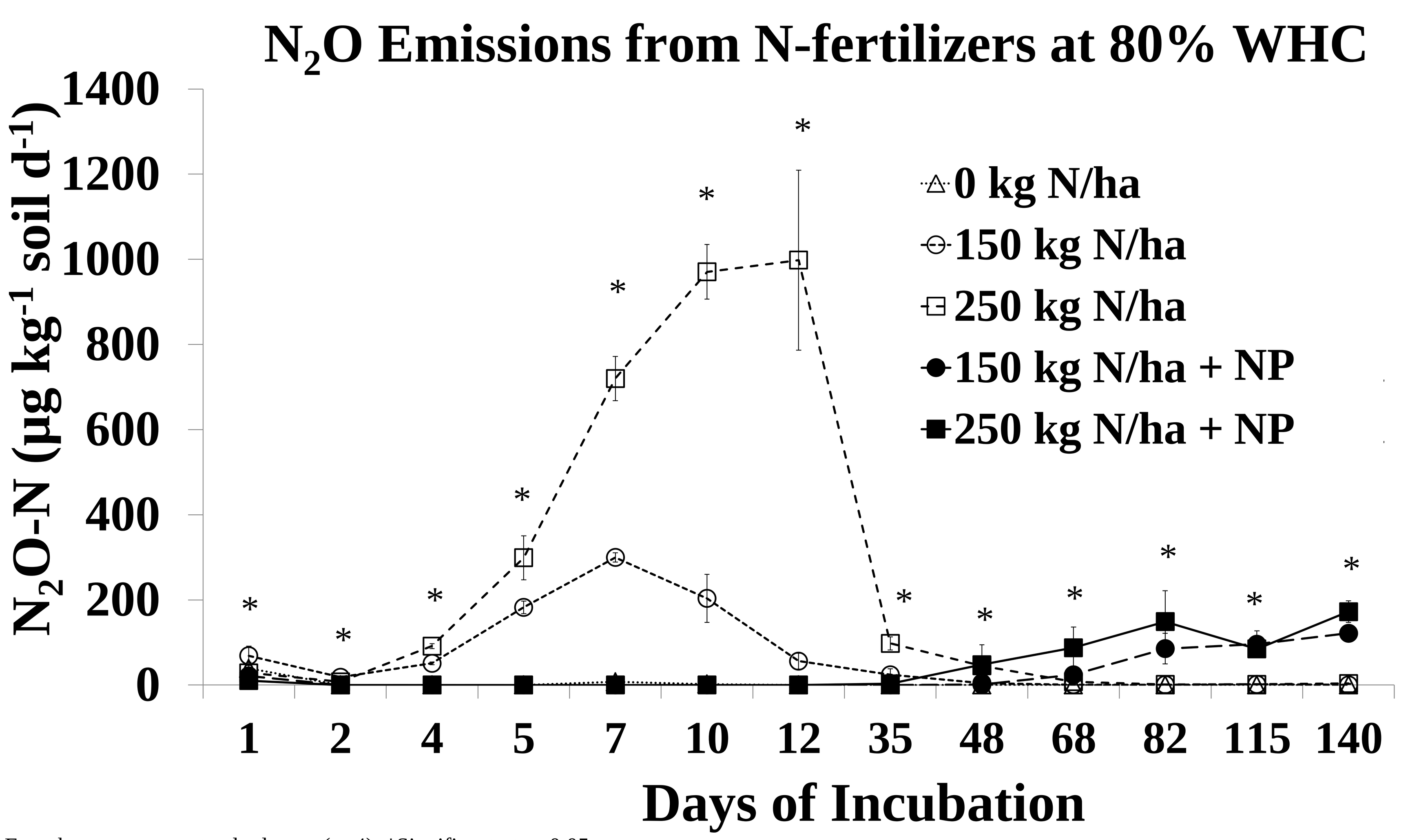

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Effect of %WHC and N-Fertilizer on Cumulative N_2O-N Emissions

WHC x N-Fertilizer	WHC			LSD (α=0.05)
	30%	60%	80%	
N-Fertilizer	-----Cumulative N_2O-N (μg kg^{-1})-----			
Control (0 N)	0 ^{cB†}	126 ^{bA}	48 ^{dAB}	82
150 kg N ha^{-1}	179 ^{bC}	1759 ^{aA}	912 ^{bB}	460
250 kg N ha^{-1}	294 ^{aC}	2171 ^{aB}	3272 ^{aA}	887
150 kg N ha^{-1} + NP	13 ^{cB}	396 ^{bA}	349 ^{cdA}	231
250 kg N ha^{-1} + NP	17 ^{cB}	693 ^{bA}	554 ^{bcA}	347
LSD (α=0.05)	30	680	496	-

†Different lowercase letters within a column and different uppercase letters within a row are different at α=0.05

Effect of %WHC and N-Fertilizer on Residual Inorganic-N Content

WHC x N-Fertilizer	WHC			LSD (α=0.05)
	30%	60%	80%	
N-Fertilizer levels	----------------------mg kg^{-1}----------------			
Control (0 N)	64 ^{cB†}	111 ^{cA}	4 ^{cC}	39
150 kg N ha^{-1}	268 ^{bA}	266 ^{bA}	78 ^{bB}	42
250 kg N ha^{-1}	361 ^{abA}	363 ^{aA}	208 ^{aB}	35
150 kg N ha^{-1} + NP	356 ^{abA}	278 ^{bA}	63 ^{bB}	163
250 kg N ha^{-1} + NP	394 ^{aA}	390 ^{aA}	211 ^{aB}	57
LSD (α=0.05)	115	42	35	-

†Different lowercase letters within a column and different uppercase letters within a row are different at α=0.05

Effect of %WHC and N-Fertilizer on % Emission Factor (EF)

WHC x N-Fertilizer	WHC			LSD (α=0.05)
	30%	60%	80%	
N-Fertilizer	----------------------EF (%)------------------			
150 kg N ha^{-1}	0.075 ^{aC†}	0.683 ^{aA}	0.361 ^{bB}	0.214
250 kg N ha^{-1}	0.074 ^{aC}	0.517 ^{aB}	0.815 ^{aA}	0.214
150 kg N ha^{-1} + NP	0.005 ^{bB}	0.113 ^{bAB}	0.126 ^{cA}	0.117
250 kg N ha^{-1} + NP	0.004 ^{bB}	0.143 ^{bA}	0.128 ^{cA}	0.106
LSD (α=0.05)	0.011	0.231	0.169	-

†Different lowercase letters within a column and different uppercase letters within a row are different at α=0.05

CONCLUSIONS

- **Above 60% WHC, significant amount of applied urea-N can be subjected to denitrification loss from silty clay soils.**
- **Addition of NP to urea-N fertilizers shows the potential of reducing N_2O emissions by 65-94% under laboratory conditions.**

REFERENCES

- Gagnon, B., N. Ziadi, P. Rochette, M.H. Chantigny, and D.A. Angers. 2011. Fertilizer source influenced nitrous oxide emissions from a clay soil under corn. Soil Sci. Soc. Am. J. 75: 595-604.
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