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Evaluating Soil Oxygen as a Control on N_2O Emissions from Ruminant Urine Patches under Different Irrigation Frequencies

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Abstract:
Urine patches from grazing ruminant animals are a significant source of nitrous oxide (N_2O) emissions, and irrigation is increasingly used to improve forage quality and yield for grazing cattle. The objective of this study was to test whether irrigation frequency influenced N_2O emissions from urine patches on a free-draining grazed pasture soil. It was hypothesized that greater irrigation frequency would increase soil moisture thereby lowering soil oxygen (O_2), and that these O_2-limited conditions would increase the potential for N_2O to be reduced to nitrogen gas (N_2), resulting in lower N_2O emissions. A field trial tested the effects of two irrigation frequencies and urine deposition on N_2O fluxes measured daily for 35 days. Denitrification potential measurements using the acetylene inhibition technique were completed to infer $N_2O/(N_2O+N_2)$ ratios, and soil O_2 concentrations were measured continuously at three depths within the soil profile. While a more frequent irrigation treatment resulted in a lower $N_2O/(N_2O+N_2)$ ratio, this did not give rise to lower N_2O emissions. Nitrous oxide fluxes were not influenced by irrigation frequency, and approximately 0.09% of the nitrogen applied as urine was emitted as N_2O from both irrigation treatments. Neither N_2O nor soil O_2 varied with individual irrigation events. Soil O_2 ranged from 17 to 20% expect following urine deposition, where it temporarily decreased to 13%. Soil O_2 measurements failed to explain N_2O emissions, but a relationship was derived between N_2O fluxes and estimates of soil gas diffusivity (*Dp/Do*). This work is the first to show how soil O_2 concentrations vary under a urine patch and under different irrigation treatments, and supports *Dp/Do* as robust predictor of N_2O emissions *in situ*.

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