Nitrous Oxide Emission and Methane Oxidation Potential in the Pastoral Soil under Intensive Dairy Farm Management

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Introduction Anthropogenic nitrous oxide (N_2O) emissions from agricultural soils are estimated to contribute ~14% of New Zealand's greenhouse gas (GHG) inventory (New Zealand Climate Change Office 2007). The global annual soil sink for methane (CH_4) was estimated to be 3-9% of the atmosphere's removal rate (Smith et al., 2000). We report N_2O emission and CH_4 oxidation rates in freely and poorly drained soils on an intensively managed dairy farm following a cattle urine application.

Materials and methods The two soils examined were located beneath pasture grazed by dairy cattle in Waikato region of New Zealand (37.8°S, 175.3°E) with average annual rainfall of 1240 mm and air temperature of 14℃. Cow urine was applied to create experimental urine patches in the soils at 10 L/m2 (650 kg N/ha). Fluxes of N_2O and CH_4 were measured using static chambers (diameter 250 mm, height 130 mm), with 3 replicates for urine patches and controls, over 100 days in autumn and winter seasons. Gas samples were analysed by gas chromatograph with a 63Ni-electron capture detector (ECD) for N_2O and a flame ionization detector (FID) for CH_4. Soil and relevant environment parameters were measured/monitored over the trail period.

Results There were eight occasions for both soils when N_2O fluxes in the urine patches exceeded the 100-day average. For the freely drained soil, seven of these days occurred during the first 3 weeks after urine application and accounted for 61% of total emissions. Higher than average daily emissions occurred throughout the 100 days of measurement for the poorly drained soil, and 4 of these days during the first 3 weeks after urine application accounted for 41% of total emissions. For both soils, N_2O emissions of the urine-amended plots always exceeded the controls. Nitrous oxide emission factors (EF3) were 1.3 and 0.4% for the poorly and freely drained soils respectively.

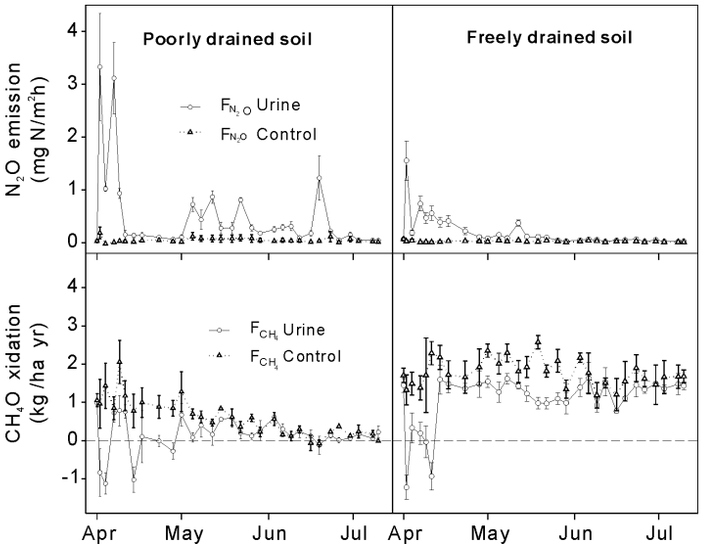

Figure 1 *Nitrous oxide emission and CH_4 oxidation rates measured over 100 day trial period ($n=3$).*

Following urine application, the poorly drained soil was a net source of CH_4 on Days 2, 3, 13, 22, 27 and 79. On the day of urine application and 7 and 9 days later, the freely drained soil was also a net source of CH_4. Over 100 days, for the poorly drained soils, the integrated CH_4 oxidation rates were 0.6±0.1 and 0.2±0.1 kg C/ha yr for the Controls and Urine plots, respectively. For the freely drained soil, the corresponding rates were 1.8±0.2 and 1.1±0.2 kg C/ha yr.

Conclusions Applying urine markedly increased soil's N_2O emissions. The integrated N_2O emitted from poorly drained soil was 3 times than that from freely drained soil. Cattle urine application reduced the CH_4 oxidation rates of freely and poorly drained soils for up to two months and by 0.7±0.2 and 0.4±0.1 kg C/ha yr. Overall, the two soils' responses were not significantly different.

References

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