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Relative gas diffusivity as a controller of soil N2 and N2O fluxes

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Animal grazing may induce soil compaction and has been shown to enhance emissions of the greenhouse gas nitrous oxide (N2O). The dominant substrate for N2O production is urea, supplied to the soil in ruminant urine. While studies have examined the effects of water-filled pore space on N2O emissions there has been less attention paid to the role of soil physical properties, such as relative gas diffusivity (Dp/Do), on N2O emissions and associated emissions of dinitrogen (N2). Three experiments were performed on soil cores maintained at a range of soil bulk densities (1.1 to 1.5 Mg/m3) and soil matric potentials (-10 to -0.2 kPa). These soil cores received urea at 700 kg N/ha to simulate a urine deposition event. Using the 15N tracer technique we measured N2 and N2O fluxes in order to investigate the role of soil Dp/Do as a controlling factor the magnitude of N2 and N2O fluxes and the reduction of N2O. As soil compaction and soil moisture contents increased soil Dp/Do declined. This in turn resulted in slower rates of nitrification. The mean cumulative fluxes of N2O, as a percentage of N applied, ranged from <1 to 16% after 35 days. Cumulative N2 fluxes as a percentage of N applied, ranged from <1 to 60% after 35 days. Soil compaction and soil matric potential interacted to influence Dp/Do which in turn was seen to be a strong determinant of the magnitude of both N2O and N2 fluxes. As Dp/Do values decreased a critical value was reached where N2O fluxes rapidly switched from being at a maximum to a minimum while at the same time N2 production intensified. This was also reflected in the N2:N2O ratios, based on cumulative fluxes, which ranged from <1 to 25. When compared with water-filled pore space the Dp/Do variable proved to be a better predictor of the switch from N2O production to N2 production.