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Effect of cattle urine addition on the surface emissions and subsurface concentrations of greenhouse gases from a UK lowland peatland.

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Grazing systems represent a substantial percentage of the global anthropogenic flux of nitrous oxide (N_2O) as a result of nitrogen addition to the soil. Cattle urine has been shown to stimulate N_2O production due to the dual effect of a large pool of readily available N and C and increased soil water content. Studies indicate that even short-term grazing can cause a significant increase in N_2O emissions, particularly when combined with compaction and seasonal water-table rise. Peat soils have different physical and chemical characteristics to mineral soils including higher organic carbon content, higher porosity and greater variation in hydraulic properties due to swell and shrink. Peat soils have been shown to have increased N_2O emissions with respect to mineral soils as a result of a combination of these factors, particularly when amended with fertilisers or livestock excreta.

Many lowland peatland environments in the UK are under seasonal grazing management and cattle are increasingly being introduced to manage fen vegetation in lowland peatland. In this study, we simulated small urination events on a conservation area of UK peat grassland that is intensively grazed for a short period of time during autumn seasonal water-table rise. We measured subsurface and surface emissions of N_2O, methane (CH_4) and carbon dioxide (CO_2) alongside soil physical and chemical changes to determine the key mechanisms of greenhouse gas production and transport.

CO_2emission peaked at 5200 mg CO_2 m^{-2} d^{-1} directly after application from a background value of 905 mg CO_2 m^{-2} d^{-1}. CH_4 flux decreased to -2000 μg CH_4 m^{-2} d^{-1}two days after application (control plots -580 μg CH_4 m^{-2} d^{-1}); however, net CH_4 flux was positive from urine treated plots and negative from control plots. N_2O emission peaked at 37 mg N_2O m^{-2} d^{-1} 12 days after application (1.08 mg N_2O m^{-2} d^{-1} in control plots). Subsurface CH_4 and N_2O concentrations were higher in the urine treated plots than the controls. There was no effect of treatment on subsurface CO_2 concentrations. Subsurface N_2O peaked at 500ppm 12 days after and 1200ppm 56 days after application. Subsurface NO_3^- concentration peaked at approximately 300 mg N kg dry soil^{-1}12 days after application.

Results indicate that denitrification is the key driver for N_2O release in peatlands and that production is strongly related to increased soil moisture. N_2O production at depth continued long after emissions were detected at the surface. Increased study of the interaction between subsurface gas concentrations, surface emissions and soil hydrological conditions is required to successfully predict greenhouse gas production and emission.