Geophysical Research Abstracts
Vol. 13, EGU2011-10780, 2011
EGU General Assembly 2011

Nitrous oxide emissions from temperate grassland soils as affected by seasonal dairy soiled water application and soil type

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Nitrous oxide is a potent greenhouse gas (GHG) emitted to the atmosphere during nitrification and denitrification, particularly following application of N to soil as fertiliser. Approximately a third of Ireland's GHG emissions are from the agricultural sector (very high, by European standards) and N2O emissions from soils account for about half of this. Therefore, decreasing N2O emissions from fertiliser N applied to soils is important to decrease Ireland's overall GHG emissions. One of the forms of organic fertiliser N widely applied is dairy soiled water (DSW). This dilute effluent is produced on dairy farms through washing down the milking parlour and holding areas and contains significant quantities of N. It is typically applied to grassland soils. The seasonal effect of DSW application on N2O emissions was examined using intact soil monolith lysimeters (30 cm diameter, 70 cm depth) with two contrasting grassland soils; a well-drained sandy loam acid brown earth (Cambisol), and a poorly drained silt loam gley (Gleysol). N2O emissions were measured using the closed chamber technique, sampling on 63 occasions over the year of the experiment. All lysimeters were managed agronomically at 198 kg N ha-1 yr-1. There were 4 treatments; N applied as calcium ammonium nitrate (CAN) fertiliser only (FN), and three treatments in which DSW was substituted for CAN at an equivalent total N rate during May-August (T1), September-December (T2) and January-April (T3). DSW was applied at the legal maximum rate of 50,000 l ha-1 every six weeks during the application period. Fresh DSW was sampled, analysed and prepared for application by dilution to give a total nitrogen (TN) content of 660 mg l-1 and an application rate of 33 kg N ha-1. Substituting DSW for CAN during the grass growing season (T1 and T3) significantly decreased total annual N2O emissions (3.97 and 3.89 kg N ha-1yr-1, respectively) when compared to FN (6.36 kg N ha-1 yr-1). In contrast, annual emissions when DSW was applied during the winter (T2) were not significantly different from FN. Emissions tended to peak at approximately 0.02 to 0.03 kg N ha-1day-1 within 5 days of DSW application and then decrease again to background levels by day 21. During the winter however, these emissions tended to remain high for longer. Mean daily losses for May-Aug and Jan-Apr DSW applications were 0.009 and 0.015 kg N ha-1day-1, respectively, but these increased to 0.021 for Sep-Dec applications. Surprisingly, no significant difference was found between N2O emissions from the two soils, despite the contrast in soil type and drainage conditions. The lack of a significant difference may be due to heterogeneity in the poorly drained gleysol; mean emissions from the gleysol were higher, but were also highly variable. The mean emission factor (EF) recorded for DSW in this study (1.71