EGU General Assembly, held online 4-8 May, 2020

Analysis of N2O emissions and isotopomers to understand nitrogen cycling associated with multispecies grassland swards at a lysimeter scale

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Abstract
Nitrous oxide (N2O) is a potent greenhouse gas associated with nitrogen fertiliser inputs to agricultural production systems. Minimising N2O emissions is important to improving the efficiency and sustainability of grassland agriculture. Multispecies grassland swards composed of plants from different functional groups (grasses, legumes, herbs) have been considered as a management strategy to achieve this goal. Numerous soil nitrogen transformation pathways can lead to the production of N2O emissions. These transformation pathways are regulated by soil microbial communities and the environmental conditions and management practices that impact on them. Much research has been carried out on N cycling and N2O emissions from predominantly grass monoculture systems. However, there is a lot yet to understand about how agricultural grasslands with diverse plant communities influence soil N cycling and N2O emissions. A lysimeter experiment was set up as a completely randomised block design and carried out over a full year to investigate N2O production, and nitrogen cycling associated with four sward types. The swards four swards were: perennial ryegrass (PRG, Lolium perenne); PRG and low white clover (PRG + LWC, Trifolium repens); PRG and high white clover (PRG + HWC); PRG, WC and ribwort plantain (PRG + WC + PLAN, Plantago lanceolata) managed at 250, 90, 0, and 45 kg N ha-1yr-1, respectively. Fertiliser N was applied by syringe as urea in splits at suitable timings to meet grass growth demands. N2O fluxes were measured using a static chamber technique and additional samples were taken after the final flux sample to measure the associated N2O isotopomers using a novel Cavity Ring Down Spectroscopy technique. Leachate volumes were measured on a weekly basis and composite monthly samples were used to determine the total amount of N leached from each treatment over the full year. Herbage was harvested on a monthly basis to measure DM yield (kg DM ha-1), total N (%) and N yield (kg N ha-1).This work reports on the N2O emissions and N leaching associated with the four sward treatments and related these N losses to the treatments DM yields and N uptake as an estimation of the efficiency of these differing grassland management strategies. N2O isotopomer measurements were used to indicate N transformation pathways driving N loss over the growing season particularly around periods of peak N2O emissions.