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Effects of N and C Distribution on N-Emissions during Denitrification

Nadine Loick (1), Liz Dixon (1), Diego Abalos (2), Antonio Vallejo (2), Catherine Watson (3), Karen McGeough (3), Peter Matthews (4), and Laura Cardenas (1)

(1) Rothamsted Research, SSGS, Okehampton, United Kingdom (nadine.loick@rothamsted.ac.uk), (2) Technical University of Madrid, Chemistry and Agricultural Analysis, Madrid, Spain, (3) Agri-Food and Biosciences Institute, Newforge Lane, Belfast, BT9 5PX, UK, (4) University of Plymouth, School of Geography, Earth and Environmental Sciences, Plymouth, Devon, PL4 8AA, UK

Agricultural soils are a major source of nitric- (NO) and nitrous oxide (N2O) which are produced and consumed by biotic and abiotic soil processes. The dominant sources of NO and N2O are microbial nitrification and denitrification. Which process dominates depends on environmental conditions such as pH and water filled pore space (WFPS) as well as substrate availability which is seldom homogeneous across the whole field. N2O emissions have been attributed to both processes whereas NO emissions are thought to predominantly derive from nitrification. Recent findings challenge the latter assumption indicating denitrification to be a significant source of NO.

The present study investigated the impact that N and C application hot spots have on emissions of NO and N2O as well as the significance of denitrification as a source of NO emissions. This study used the gas-flow-soil-core technique (Cardenas et al 2003) to simultaneously measure three nitrogen-gases (NO, N2O, N2) and CO_2. This was combined with 15N labelled isotopic techniques to determine the source of N-emissions. A nutrient solution containing KNO_3 with 15N at 5 atom% and glucose was applied at a rate of 75 kg N ha-1 and 400 kg C ha-1 to vessels containing three repacked grassland soil cores, where the amendment was either split and applied equally to the three cores or the full rate was applied to only one of the cores, mimicking heterogeneous fertiliser application.

Under field conditions nutrient/fertiliser application is seldom homogeneous across the whole field and our results show a clear effect of the heterogeneous application of nutrients. NO emissions were significantly lower when a high concentration of nutrients was applied to a single core compared to an even distribution over multiple cores. Total emissions of N2O, N2 and CO_2, however, were not affected by application heterogeneity but showed a delay in the occurrence of the peak of all three gases when the nutrients were applied to only one core. In addition results showed that under denitrifying conditions (85% WFPS and presence of easily available NO_3-) denitrification played a key role in NO emissions. We show that denitrification has been an overlooked pathway contributing to NO emissions and that not only the total amount of nutrients applied, but also their distribution has an important impact on NO as well as N2O, N2 and CO_2 emissions.

References:
Cárdenas et al (2003). Soil Biology and Biochemistry 35, 867-870