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Denitrification as a Source of NO Emissions using Isotope Techniques

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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. Depending on the environmental conditions such as substrate availability, pH and water filled pore space (WFPS) N2O emissions have been attributed to both processes, whereas NO emissions are thought to predominantly derive from nitrification. This is due to the fact that the environmental factors which promote denitrifying conditions also restrict gaseous diffusivity causing consumption of the highly reactive NO. Recent findings however challenge this assumption indicating that denitrification can be a significant source of NO.

Attributing gaseous emissions to specific soil processes is still difficult; however, advanced isotopic methods show great potential. Labelling methods rely on the use of 15N enriched substrates, whereas isotopomer analyses rely on differences in the utilisation of heavy vs light N and O isotopes at natural abundance. The present study analysed the effect of different enrichment levels on gaseous emissions using the gas-flow-soil-core technique (Cardenas et al 2003). This system provides continuous measurements of NO, N2O as well as N2 fluxes by exchanging the normal atmosphere with a mixture of He:O_2 (80:20). This was combined with 15N labelled isotopic techniques and isotopomer measurements to determine the source and processes responsible for the measured N-emissions.

Nutrient solutions were applied containing KNO_3 with 15N at natural abundance, 5 atom% and 20 atom% enrichment at a rate of 75 kg N ha-1 together with glucose at a rate of 400 kg C ha-1. Results showed that at the higher level of enrichment gaseous emissions were affected by showing an increase in emissions of NO and N2O. Additionally, under denitrifying conditions (high WFPS and NO_3- availability) denitrification played a key role in NO emissions.

Emissions will be simulated from an extension of the dual porous PoreXpert model (Laudone et al, 2011). These results will confirm the proximity of the critical percolation path (added NO-) to the hot spots of microbes, indicating the preference for the use of added NO_3- versus native NO_3-.

References:
Cárdenas et al (2003). Soil Biology and Biochemistry 35, 867-870
Laudone et al. (2011) Journal of Hydrology 409, 283–290