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Coupling isotopic, reporter and molecular techniques to verify links between plant C flow and denitrification

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Recent technical advances for quantifying denitrification rates, denitrifier-N2O:N2 product ratios and linking these to the underpinning microbiology, have provided new insights into interactions between C and N processes, and flexibility of microbial function in response to changing environmental conditions and management.

The availability of organic C is considered paramount for the production and reduction of the greenhouse gas nitrous oxide (N2O) during denitrification in the rhizosphere. Despite this, the role of organic C in the regulation of N2O- and N2-genic enzymes is poorly understood. Stable isotopes are fundamental in resolving this. Here we will present selected results from experiments in which we have applied stable isotope techniques to verify the effect of plant C in driving denitrification, and the potential feedbacks of this on climate change.

Changes in C input to soil, such as under elevated atmospheric CO2, is significant for N2O production and reduction. Following application of 15N-labelled fertiliser to Lolium perenne swards we showed increased denitrifier-N2O and N2 production under elevated pCO2 (60 Pa) in the Swiss FACE experiment. This was attributed to greater below ground C allocation providing the energy for denitrification, and emissions were strongly positively correlated with TOC. The N2-to-N2O ratio was also raised under elevated pCO2, which indicates important feedbacks effects are occurring with climate change, mediated through plant C flow.

Little is known about the effect of different C substrates in regulating N2O and N2 production nor their effects on community structure, activity or species selection of denitrifying bacteria in the rhizosphere. We provide the first evidence for differences in N2O and N2 production with different C compounds typically present in root exudate, which suggest differences in regulation of the NO and N2O reductases, or preference for different C compounds in the rhizosphere denitrifier community. Such differences in gaseous N production are being related to the function and activity of the denitrifier community associated with this root C flow, with the link between C flow and denitrifier activity being verified by stable isotope probing and nanoSIMS imaging. Further ecophysiological evidence is presented of reporter gene expression by denitrifiers in response to different substrate classes of rhizosphere C.