Nitrogen Use Efficiency in N2 fixing systems

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Project description:
Inefficiencies in N use in agriculture arise from over fertilisation and asynchrony between nutrient supply and crop demand, as soil/climate conditions are often not considered in the management plan and resources are often not exploited. The use of legumes, is a suitable strategy for minimising and optimising N application in agriculture, as symbiotically associated rhizobia are able to fix atmospheric N2 (Biological Nitrogen Fixation, BNF). Fixed N converted to NH4+ or nitrified to NO3- can be used by crops leading to a higher N use efficiency (NUE). However, at the same time, NO3- is prone to leaching and (ca 30%, IPCC, 2006) is therefore a potential source of both indirect water pollution and direct nitrous oxide (N2O) emissions from soils. Although this only represents a small loss of N (0.8 to 1.5% for mineral fertiliser in the UK's direct N2O Emission Factors (EF's)) of urea and ammonium nitrate fertilisers, its environmental impact is large due to its role in climate change and stratospheric ozone destruction. The aim of this study is to determine the rates of N transformations, both in the areas close to the roots and the rest (bulk) of the soil in mixed cropping systems where a legume and a grass or crop species are grown. Legumes are known to be able to fix N2 from the atmosphere in a process called Biological Nitrogen Fixation (BNF) and convert it to ammonium (NH4+) that can further be converted to nitrate (NO3-) in soils. Nitrate is prone to leaching and is also of environmental concern when transformed to nitrous oxide (N2O), a powerful greenhouse and ozone destroying gas. Mixed cropping (or intercropping) is a common practice in agricultural systems across the world and is gaining interest in UK systems due to improvement in N use, management of weeds, pests, improvement of soil physical properties, increases diversity of soil bacteria with increasing plant diversity. It has been highlighted how important it is to study root exudates, the rhizobiome, and their mutual interactions affecting root-root interactions and why these processes should be explicitly investigated to improve our understanding of these interactions in the real world. We will use tracing methodologies to follow the pathways of nitrogen from legume fixation to crop uptake using isotopic techniques in soil cores for a variety of legume and crop species. The results will allow to determine the efficiency of nitrogen use and the selection of the most efficient mixtures.