



Using the Triple Labelling Technique to apportion N₂O Emissions to Nitrification and Denitrification from different Nitrogen Sources at different Water-Filled-Pore-Spaces

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Nitrous oxide (N₂O) is considered to be an important greenhouse gas (GHG) accounting for approximately 6% of the current global warming. The atmospheric N₂O concentration has been increasing since the Industrial Revolution, with soils representing its major source, making the understanding of its sources and removal processes very important for the development of mitigation strategies. In soils N gases are mainly produced via nitrification and denitrification. It is assumed that under dry/aerobic conditions nitrification is the dominant N consuming process, while denitrification becomes dominant under wetter conditions promoting anaerobicity. Nitrification and denitrification may occur simultaneously in different microsites of the same soil but there is often uncertainty associated with which process dominates in a particular soil under specific conditions. N₂O predominantly derives from incomplete denitrification of nitrate (NO₃⁻). The existence of different pools of NO₃⁻ in soils, namely the native soil pool, and the fertiliser-added one, has been suggested through a series of laboratory incubation experiments (Mejjide et al., 2010; Bergstermann et al., 2011) using the denitrification incubation system, DENIS (Cardenas et al., 2003), in which soil cores are incubated under an N-free atmosphere, allowing direct measurements of all emitted N gases (NO, N₂O and N₂) as well as CO₂. A third pool, NO₃⁻ produced from nitrification of applied NH₄⁺, can also be a source of N₂O via denitrification and also from nitrification.

In this study labelling of substrate-N with ¹⁵N is used to quantify the underlying gross N transformation rates and link them to N-emissions to identify the production and consumption pathways and temporal dynamics of N₂O. In three experiments twelve soil cores each were incubated in the DENIS to measure gaseous emissions, while parallel incubations under the same conditions were set up for destructive soil sampling at 7 time points. Using the triple labelling technique - i.e. applying NH₄NO₃ with either the N at the NH₄⁺ or at the NO₃⁻, or in both places being labelled - this study investigates the effects of a low, medium and high water filled pore space (55, 70, 85%) in a clay soil on gaseous N emissions and investigates the source and processes leading to N₂O emissions.

To assess the utilisation of applied NO₃⁻ vs nitrified NO₃⁻ from applied NH₄⁺, the model developed by Müller et al. (2007) is used to calculate the immobilisation of added NO₃⁻ and NH₄⁺, nitrification of added NH₄⁺, mineralisation of organic N and subsequent nitrification by the analysis of the ¹⁵N in the soil. Gross transformation rates, indicating the relative importance of added NO₃⁻ and NO₃⁻ derived from nitrified added NH₄⁺ are calculated.

Bergstermann et al. (2011) *Soil Biol. & Biochem.* 43, 240-250.

Mejjide et al. (2010) *Eur. J. Soil Sci.* 61, 364-374.

Cárdenas et al. (2003) *Soil Biol. & Biochem.* 35, 867-870.

Müller et al. (2007) *Soil Biol. & Biochem.* 39, 715-726.