



Role of natural organic matter in soil denitrification: Data of a long-term fertilization experiment

Ronny Surey (1), Jürgen Böttcher (2), Eva K. Lippold (1), Alexander Fechner (1), Leopold Sauheitl (2), Ines Merbach (3), Carsten W. Mueller (4), Klaus Kaiser (1), and Robert Mikutta (1)

(1) Soil Science and Soil Protection, Martin Luther University Halle-Wittenberg, Germany, (2) Institute of Soil Science, Leibniz Universität Hannover, Germany, (3) Department Community Ecology, Helmholtz-Centre for Environmental Research, Bad Lauchstädt, Germany, (4) Lehrstuhl Bodenkunde, TU-München, Germany

As N_2O shows the highest warming potential of all biogenic greenhouse gases the need to understand controlling factors for its formation became more urgent in the last decades. In this, denitrification is regarded as main source for N_2O from soils. Under anoxic conditions, denitrifying organisms reduce nitrate (NO_3^-) to NO_2^- , NO , N_2O , and finally N_2 . Previous studies have shown that the addition of plant biomass or low-molecular weight C compounds enhances N_2O emissions from soils. The effect of functional soil organic matter (OM) fractions of varying bioavailability (dissolved, particulate, and mineral-associated OM) on soil denitrification is still unclear. These OM fractions differ in their abundance in various aggregate size classes, i.e. in specific micro-habitats (hot spots). Research on the linkage between soil aggregation and denitrifying activity has provided conflicting results, with higher denitrification reported for both, the smallest and largest aggregate fractions. In agricultural soils, the content and quality of OM as well as the extent of aggregation are mainly controlled by fertilization. We used soil samples from six different plots of a static long-term fertilization field experiment in Bad Lauchstädt (Germany) to address the following two questions: (i) how does different fertilization affect quantity and quality of OM as well as aggregation, and (ii) how do amount and composition of OM as well as aggregate size influence denitrification and respective products (N_2O , N_2)? We hypothesize that the application of inorganic or organic fertilizers increases the amount of labile C (particulate and water-extractable OM, aliphatic and O-alkyl C) and that especially organic fertilizers enhance aggregate formation. Higher amounts of labile C, in turn, may result in higher N_2O emissions. We further anticipate that large macro-aggregates contain larger amounts of labile OM, which cause higher N_2O emissions than from smaller sized aggregates. To address these questions, bulk soils of each fertilization treatment were analyzed for OC, TN, water-extractable OC, and N_{min} contents as well as for the functional OM composition by solid-state ^{13}C -NMR spectroscopy. Four aggregate size classes (large and small macro-aggregates, micro-aggregates and silt+clay) were separated by dry sieving and functional OM fractions were isolated by density separation (fPOM, oPOM and MOM). Bulk soils as well as aggregate size fractions were incubated under anoxic conditions for seven days to quantify soil denitrification. Furthermore, we determined the corresponding N_2 production by use of ^{15}N -labeling and the acetylene inhibition technique (AIT) to assess the impact of fertilization on the respective $N_2O/(N_2O+N_2)$ product ratios. The study highlights that especially organic fertilization increases denitrification, with a preferential release of N_2O over N_2 , due to the enrichment of labile C components.