Geophysical Research Abstracts,
Vol. 11, EGU2009-6278-6, 2009
EGU General Assembly 2009

Nitrogen loss from high N-input vegetable fields: a) Direct N2O emissions b) Spatiotemporal variability of N species (N2O, NH4+, NO3-) in soils

I. Palmer (1), H. Pfab (2), R. Ruser (2), and S. Fiedler (1)

(1) Institut für Bodenkunde und Standortslehre, Universität Hohenheim, Germany (ipalmer@uni-hohenheim.de), (2) Institut für Pflanzenernährung, Universität Hohenheim, Germany

Nitrous oxide (N2O) is a greenhouse gas contributing to stratospheric ozone depletion. Soils are considered to be the major (70%) source for atmospheric N2O. Agriculture in general accounts for about 85% of the anthropogenic N2O emissions. Whereas 80% of these, are emitted from ag-riculturally used soils.

Such estimations of N2O fluxes are associated with a high degree of uncertainties. Uncertainty of source strength estimates mainly results from local scale variability of known and unknown sources. It is not known how much uncertainty is due to unmeasured sources. For example, considerations of N2O fluxes from soils used for intensive vegetable production within inventories are still missing.

We speculate that these types of arable soils act as ‚hot spots' for N2O. Given conditions (1) high N-input due to fertilization in concert with (2) easily mineralizable harvest residues should pro-mote disproportional high reaction rates in N-cycling and enhance N2O production as a by-product of nitrification and denitrification.

Our investigation focused on the influence of: (1) N-input level (Ammonium Sulfate Nitrate (ASN)) below and above common N doses used for "good agricultural practice". (2) Application of modified fertilizers including nitrification inhibitor DMPP (Dimethylpyrazolphosphate, ENTEC®) and depot fertilization (pseudo-CULTAN) in comparison to non-fertilized control and common ASN application. (3) Effects of plant residues on N-cycling and (4) the deduction of mitigation strategies to reduce the potential N-loss from theses sites.

The study was carried out during summer and autumn 2008 on a field cropped with cauliflower, located at the "Heidfeldhof" (South-West Germany; MAT 10.5°C, MAP 660 mm). Three different N-species (N2O; within gaseous soil phase, ammonium (NH4+) and nitrate (NO3-) extracted from bulk soil) were measured weekly in three different soil depths (0-25 cm; 25-50 cm and 50-75 cm) in a fully randomized field design. At same depths water filled pore space was calculated. In total 10 different treatments were tested with 4 replicates each.

We hypothesized that:

(1) Distinct N-species, their portion and level, vary across a spatial and temporal scale dependent from N-input amount and modification of fertilizer. (2) High N-input is accompanied by enhanced microbial activity which results higher N2O concentration in soils. (3) Disturbance due to management (fertilization, plant residues) leads to short-term accu-mulation in N2O concentrations.

We found a fast response of all measured N-species after fertilization as well as after application of harvest residues in all treatments. Ammonium and nitrate increased immediately in 0-25 cm after N-input in all treatments, whereas with increasing soil depth the response is delayed.

The highest fertilizer level results in the highest amounts of ammonium and nitrate. Nitrogen fer-tilization led to distinctively higher N2O concentration in air filled pores compared to the non-fertilized soil (control), in all three depths in all fertilizer variations.

In general, highest level of fertilizer was accompanied by highest concentrations of nitrous oxide in the gaseous soil phase in all depths investigated. This effect is significant and most clearly in 0-25 cm. In 25-50 cm and 50-75 cm, other parameters seem to play a more important role.

The most significant differences between fertilizer types occur in 0-25 cm as well. Plots fertilized with ENTEC® show significantly higher N2O concentrations than the control plots, but are sig-nificantly lower than an ASN or depot fertilization of the same level.

These results are in good accordance with the direct N2O-emissions measured in the same plots.

A small time lag was observed in the N2O concentration in soil air in comparison to the above-ground emissions after system disturbance like fertilization or harvest.

It can be concluded that high N-input as typical for vegetable production (both as fertilizer or easily mineralizable plant residues) cause a considerable risk if N losses.
Reducing the N-dose by 23 % (good agricultural practice) as well as application of a nitrification inhibitor decreased the N2O concentration in soil gaseous phase without any yield depression, whereas the depot fertilization showed no decreasing effect. Further research on the fate of N in intensive vegetable production will be done to characterize the pools of N2O production and its role in N-Cycle more precisely by using 15N-isotopic labeled fertilizer.