The impact of liquid organic fertilization and associated application techniques on $N_2$ and $N_2O$ fluxes from agricultural soils

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Fertilizing arable soils with liquid manures affects gaseous N losses to the atmosphere including NO, $N_2O$ and $N_2$ as well as nitrate leaching. These emissions impair nitrogen use efficiency of crops and contribute to the greenhouse effect and stratospheric ozone destruction and pollution of aquatic resources. Their extent depends on the complex interaction between manure application techniques and properties of manures and soil. Whereas the types of manure effects on N transformations and associated gaseous fluxes are known, their prediction is still poor because previous investigations mostly excluded $N_2$ flux.

Our mesocosm experiment addresses the questions, (1) how liquid manure fertilization and its application mode impact $N_2$, $N_2O$ and $CO_2$ fluxes from agricultural soil, and (2) how the water and dissolve organic carbon content and the pH of the manure amended soil change between the soil layers. We use these data to set up a dataset to test and develop new biogeochemical model approach to describe the manure-soil interactions.

A sandy arable soil (Fuhrberg, Germany) was used for the experiments and amended with artificial slurry (artificial liquid and cow digestate mixture) in various treatments. The soil was incubated in laboratory incubation systems over 10 days. $N_2$, $N_2O$ and $CO_2$ fluxes were quantified by gas chromatography and isotope-ratio mass spectrometry. Incubations were conducted with (surface or injected application) or without (control) of slurry treatment and initial water content was adjusted equivalent to 40% and 60% water-filled pore space. The environmental conditions were kept constant during that experiment.

The average $N_2+N_2O$ flux decreased at the 40% WFPS surface and injected treatments with 70% and 60%, respectively, compared to the non-fertilized control. For the 60% WFPS surface and injected treatments, the average $N_2+N_2O$ flux increased with more than 610% and 1690%, respectively. The results show that the initial water content and the application method can influence drastically the $N_2+N_2O$ flux of the manure amended soil.