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

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Nitrous oxide is a climate relevant trace gas. It contributes 7.9 % to the total anthropogenic greenhouse gas emission and it is also involved in stratospheric ozone depletion. Approximately 85 % of the anthropogenic N2O emissions result from agricultural activities, more than 50 % are produced during microbial N-turnover processes in soils. Especially soils with high N-input (N-fertilizer and high amount of N in plant residues) like vegetable cropped soils are assumed to cause high N2O losses.

The aims of the study presented were (i) to quantify the N2O loss from a vegetable field (lettuce-cauliflower crop rotation), (ii) to calculate an emission factor for the study site in Southwest Germany and to compare this factor with the default value provided by the IPCC (2006) and (iii) to test the emission reduction potential (Ammonium Sulfate Nitrate fertilizer, ASN either by reduced N-fertilization) in comparison with common N doses used for good agricultural practice or by the use of a nitrification inhibitor (DMPP), a banded N-application (lettuce) or a depot fertilization measure (pseudo-CULTAN in order to suppress nitrification).

N2O fluxes determined with the closed chamber method were highly variable in time with strongly increased flux rates after N-fertilization in combination with rainfall or irrigation measures and after the incorporation of cauliflower crop residues.
Using the mean soil nitrate contents of the top soil of our investigated treatments (0-25 cm depth), we could explain approximately 60 % of the variability of the cumulative N2O losses during the vegetation period of lettuce and cauliflower.

The cumulative N2O emissions ranged between 0,99 kg N2O-N ha-1 from the unfertilized control plots (vegetation period) and 6,81 kg N2O-N ha-1 from the plots with the highest N-dose. Based on the guidelines of the IPCC (2006), we calculated an emission factor around 0,9 % for the cropping season. This value is in good agreement with the default value of the IPCC. However, the IPCC default value is recommended for annual emission estimations. Since we found strongly increased emissions after harvest of the cauliflower and further increased emission during thawing of frozen soil in winter can be expected, our data indicate, that the default value might underestimate the N2O emissions from fertilized vegetable fields in our region.

Reducing the N-dose by 23 % (good agricultural practice) which corresponds to 45 kg N ha-1 a-1for lettuce and 86 kg N ha-1 a-1 for cauliflower decreased the N2O emission without any yield depression, the same results could be obtained if a nitrification inhibitor was used. In contrast, the pseudo-CULTAN application of ASN in the soil did not reduce the N2O losses as compared to then broadcast ASN application.