EGU21-8135, updated on 09 May 2021
https://doi.org/10.5194/egusphere-egu21-8135
EGU General Assembly 2021

Nitrous oxide emission from agricultural soils in response to nitrification inhibitor and N-fertilizer amount

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Nitrogen (N) fertilization in agricultural soils significantly contributes to the atmospheric increase of nitrous oxide (N_2O). Application of nitrification inhibitors (NIs) is a promising strategy to mitigate N_2O emissions and improve N use efficiency in agricultural systems. We studied the effect of 3,4-dimethylpyrazol phosphate (DMPP) as an NI on N_2O mitigation from soils with spring barley and spring rape. We used both manual and automatic chamber technologies to capture the spatial and temporal dynamics of N_2O emissions. Intensive manual chamber measurements were conducted two months after fertilization and fortnightly afterwards. A mini-plot experiment with different levels (0 %, 50 %, 100 %, 150 %, and 200 %) of standard N fertilizer application and 100% N with NI was also conducted for two months in soil planted with spring barley. N_2O emissions were affected by the N amount and by the use of NI. Higher emissions were observed in treatments with high N levels and without NI. The effect of NI in reducing N_2O emissions from spring barley plots was significant in the small chamber experiments, where NI reduced N_2O emissions by 47 % in the first two months after fertilization. However, the effect of NI on N_2O reduction was non-significant in the full-plot chamber experiment for the whole season. In contrast, NI significantly reduced (56 %) the seasonal N_2O emissions from the soils planted with spring rape. After the initial peaks following the fertilizer application, high N_2O fluxes were observed following substantial rain events. The continuous flux measurements in automated chambers showed the dynamic of N_2O changes during the whole season, including some peaks that were unobservable with manual chambers because of the low temporal resolution. The concentration of nitrate was higher in the soils treated with mineral N without NI compared to soils treated with NI, which clearly showed the inhibition of the nitrification process with the application of NI. The grain and biomass yield were not affected by the use of NI. In conclusion, application of NI is an efficient mitigation technology for N2O emissions in the period following the fertilizer application, but had little effect on subsequent emissions following rain events.

Keywords: nitrification inhibitors, DMPP, nitrous oxide, mitigation, agricultural soils