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

Azeem Tariq¹, Klaus Steenberg Larsen², Line Vinther Hansen¹, Lars Stoumann Jensen¹, and Sander Bruun¹

¹Department of Plant and Environmental Sciences, University of Copenhagen, Copenhagen, Denmark (azeem@plen.ku.dk)
²Department of Geosciences and Natural Resource Management, University of Copenhagen, Copenhagen, Denmark

Nitrogen (N) fertilization in agricultural soils significantly contributes to the atmospheric increase of nitrous oxide (N₂O). Application of nitrification inhibitors (NIs) is a promising strategy to mitigate N₂O emissions and improve N use efficiency in agricultural systems. We studied the effect of 3,4-dimethylpyrazol phosphate (DMPP) as an NI on N₂O 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 N₂O 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. N₂O 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 N₂O emissions from spring barley plots was significant in the small chamber experiments, where NI reduced N₂O emissions by 47 % in the first two months after fertilization. However, the effect of NI on N₂O reduction was non-significant in the full-plot chamber experiment for the whole season. In contrast, NI significantly reduced (56 %) the seasonal N₂O emissions from the soils planted with spring rape. After the initial peaks following the fertilizer application, high N₂O fluxes were observed following substantial rain events. The continuous flux measurements in automated chambers showed the dynamic of N₂O 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