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Effects of pH on nitrogen transformations and soil microbiology in a long-term liming field trial

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Liming to increase soil pH is a common agricultural practice to mitigate acidification of cultivated soils and optimize crop yields. However, changes in soil pH have pervasive effects on various soil processes including microbial activity. Notably, soil pH has been identified as a strong regulator of gaseous emissions from denitrification with increasing ratios of nitrous oxide (N_2O) to dinitrogen (N_2) emissions (N_2O/N_2 ratio) at lower soil pH. Therefore, liming as such could also be a potential option to mitigate N_2O soil emissions. Within the EU ERA-NET project MAGGE-pH, studies of soil microbiology in response to long-term pH changes in a coarse sandy soil was initiated in 2018 in Jyndevad, Denmark. The study site was a long-term liming field trial established in 1942 with four levels (and three replicates) of lime (0, 4, 8 and 12 Mg/ha) applied recurrently at intervals of few years to keep the soil pH at around certain target levels. The current levels of soil pH was around 3.8, 5.0, 6.4 and 6.8 (soil pH measured in solution of 0.01 M $CaCl_2$). The soil was cropped to spring barley and in the season of 2018, N_2O emissions were measured during three field campaign periods using the closed chamber technique. The results substantiated that liming to increase soil pH mitigated N_2O emissions as compared to the un-limed references. Further, laboratory assays with soil samples from the replicated field plots, showed that N_2O/N_2 ratios from denitrification enzyme activity was strongly controlled by soil pH, i.e., with gradually decreasing ratios at increasing soil pH. A strong regulatory effect of soil pH was also seen for soil nitrification potential, however in this case the process rates were gradually increasing at increasing soil pH. Further assays of soil microbial processes such as beta-glucosidase activity also showed gradually increasing rates at increasing soil pH. Profiles of microbial carbon substrate utilization will be studied to further identify the link between liming-induced pH changes and soil microbiology with the overall aim of mitigating N_2O emissions.