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Soil pH management by calcareous and siliceous minerals: effect on N2O yield in nitrification and denitrification

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Amelioration of soil pH by liming is necessary and common practice in vast areas of crop production. It is well known that pH is one of the most pervasive factors controlling rates and product stoichiometries in microbially mediated N transformations, including N2O emissions. While liming of acid soils appears to increase N2O reductase activity in denitrification (resulting in less N2O relative to N2), sudden pH raise may boost nitrification and hence N2O emission from ammonia oxidation. Thus, the net effect of liming on N2O emissions is not straightforward, which probably explains why soil pH management has not been embraced as a strategy for mitigating N2O emissions so far. Here we report laboratory incubations in which we determined potential rates and N2O yields in soils from an ongoing field experiment, comparing traditional calcareous limes (calcite, dolomite) with mafic minerals (olivine, different types of plagioclase). The experiment is in its second year, and shows strong pH increase (0.7-1.5, units) in plots with calcareous limes, a weak pH increase ($\sim$ 0.2 unit) in the olivine treatment and no measurable pH increase with the plagioclases. Potential nitrification rates correlated positively with effective soil pH as did the N2O yield, measured as N2O accumulation rate over NO_2- + NO_3- accumulation rate. The N2O yield increased in the order, control < plagioclase < olivine < dolomite < calcite and was significant for calcite and dolomite treated soils. Overall, the N2O yield from nitrification was quite low (0.09 - 0.17%). Potential denitrifications rates showed little response to pH increase (no C source added) but significantly lower N2O product ratios (N2O/(N2O + N2) with increasing pH in the order, calcite < dolomite < olivine < plagioclase < control. Given the overall low N2O yield of nitrification as compared to that of denitrification (10 – 100%), the observed increases in N2O yields of nitrification are unlikely to override a significant reduction in N2O production by denitrification under fluctuating oxic-anoxic conditions. The results will be discussed relative to high-resolution N2O fluxes measured by an automated field flux robot (using fast box technique) in the same liming experiment.