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Combined N_2O mitigation and CO_2 trapping: A step toward a carbon negative agriculture?

Pål Tore Mørkved (1,3), Nina Simon (1), Peter Dörsch (2), and Lars Reier Bakken (2)

(1) Institute for Energy Technology, Kjeller, Norway , (2) Norwegian University of Life Sciences, Ås, Norway, (3) Centre for Geobiology, University of Bergen, Bergen, Norway

Plant production emits considerable amounts of Nitrous Oxide (N_2O), and a reduction of these emissions is difficult to achieve. Lab and field experiments have shown, however, that the ratio of denitrification products (N_2O/N_2) increase with decreasing soil pH, most likely because low pH inhibits the assembly of the enzyme N_2O reductase which transforms N_2O to N_2. Liming increases soil pH, which will lower the N_2O/N_2 product ratio of denitrification, hence reducing the emission of N_2O. The effect of this reduction on climate forcing may be offset, however, by the CO_2 released from the lime itself, as well as the burst of soil organic carbon and N_2O emissions induced by the rapid perturbation of soil pH by the lime.

We conducted a set of laboratory experiments that explore the effect of alternative minerals or rocks on soil pH and N_2O and CO_2 emission. The materials used are olivine (forsterite) and anorthosite, which consumes H^+ at dissolution and, on the long term, the dissolved Mg and Ca form carbonates with CO_2. The laboratory experiments focus on the effect of these minerals and their grain size distribution on soil pH and N_2O emissions.

Incubation experiments show that olivine amendments cause moderate increase in soil pH and substantial decrease in net N_2O production in long-term aerobic incubations. The denitrification product ratio ($N_2O/(N_2+N_2O)$) after anarobisation also decreased substantially. Dolomite amendment caused an immediate pulse of CO_2-emission (carbonate CO_2 and more long lasting increase in microbial respiration (oxygen uptake and CO_2 production). In contrast, forsterite or anorthosite amendment caused only marginal increase in respiration (and no emission of carbonate CO_2 for obvious reasons). Although the anorthosite had a weaker effect on soil pH than forsterite it affected N_2O emission in some proportion to the change in pH.