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Microbiological assessment of the application of quicklime and limestone as a measure to stabilize the structure of compaction-prone soils

Evi Deltedesco (1), Lisa-Maria Bauer (2), Hans Unterfrauner (3), Robert Peticzka (2), Franz Zehetner (1), and Katharina Maria Keiblinger (1)

(1) University of Natural Resources and Life Sciences Vienna, Institute of Soil Research, Department of Forest and Soil Sciences, Vienna, Austria (katharina.keiblinger@boku.ac.at), (2) University of Vienna, Department of Geography and Regional Research, (3) Technical Office for Landscape Ecology, Landscape Planning and Landscape Management, Vienna

Compaction of soils is caused by increasing mechanization of agriculture and forestry, construction of pipelines, surface mining and land recultivation. This results in degradation of aggregate stability and a decrease of pore space, esp. of macropores. It further impairs the water- and air permeability, and restricts the habitat of soil organisms. A promising approach to stabilize the structure and improve the permeability of soils is the addition of polyvalent ions like Ca^{2+} which can be added in form of quicklime (CaO) and limestone ($CaCO_3$). In this study, we conducted a greenhouse pot experiment using these two different sources of calcium ions in order to evaluate their effect over time on physical properties and soil microbiology. We sampled silty and clayey soils from three different locations in Austria and incubated them with and without the liming materials (application 12.5 g) for 3 months in four replicates.

In order to assess short-term and medium-term effects, soil samples were taken 2 days, 1 month and 3 months after application of quicklime and limestone, respectively. For these samples, we determined pH, bulk density, aggregate stability and water retention characteristics. Further, we measured microbiological parameters, such as potential enzyme activities (cellulase, phosphatase, chitinase, protease, phenoloxidase and peroxidase activity), PLFAs, microbial biomass carbon and nitrogen, dissolved organic carbon and nitrogen, nitrate nitrogen and ammonium nitrogen.

In contrast to limestone, quicklime significantly improved soil aggregate stability in all tested soils only 2 days after application. Initially, soil pH was strongly increased by quicklime; however, after the second sampling (one month) the pH values of all tested soils returned to levels comparable to the soils treated with limestone. Our preliminary microbiological results show an immediate inhibition effect of quicklime on most potential hydrolytic enzyme activities and an increase in oxidative enzyme activities. These effects seem to be less pronounced in the medium term.

In summary our results indicate, that the application of quicklime is a feasible measure for immediate stabilization of the structure of compaction-prone soils, showing only short-term impact on most microbial parameters.