Microbiological assessment of lime application to agricultural soils

Universität für Bodenkultur Wien
Department für Wald- und Bodenwissenschaften

Evi Deltedesco[1] , Lisa-Maria Bauer[2], Hans Unterfrauner[3], Robert Peticzka[2], Franz Zehetner[1], Katharina M. Keiblinger[1]
Contact: evideltedesco@gmail.com

[1] University of Natural Resources and Life Sciences, Vienna, Department of Forest and Soil Sciences, Institute of Soil Research
[2] University of Vienna, Department of Geography and Regional Research
[3] Technical Office for landscape ecology, landscape planning and landscape management, Vienna

Contents

Universität für Bodenkultur Wien
Department für Wald- und Boden-wissenschaften

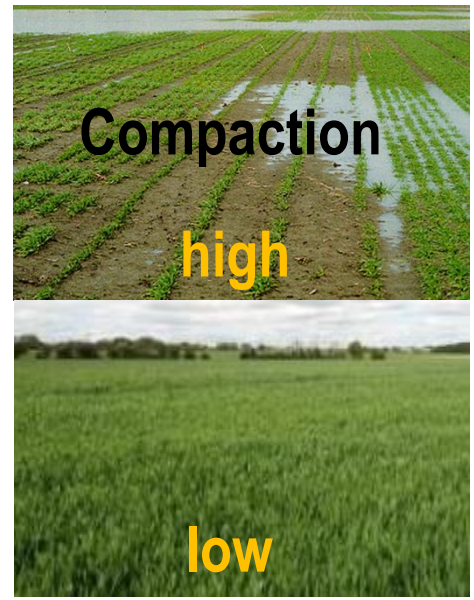
1. General introduction
    - Soil compaction
    - Dispersion vs. flocculation
    - Possible solutions
    - Research questions
2. Materials and methods
    - Experimental approach (pot experiment)
    - Soil sampling
    - Lab analyses
3. Selected results
4. Summary
5. Conclusion

1. Soil compaction

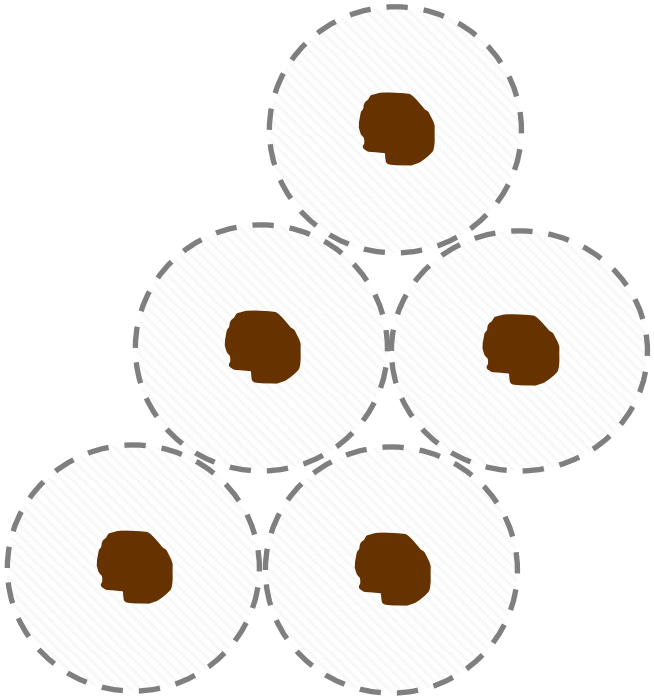
Universität für Bodenkultur Wien
Department für Wald- und Boden-wissenschaften

- Causes of soil compaction
  - Mechanization in agriculture and forestry
  - Construction of piplines, mining of minerals, etc.
  - Trampling of grazing animals

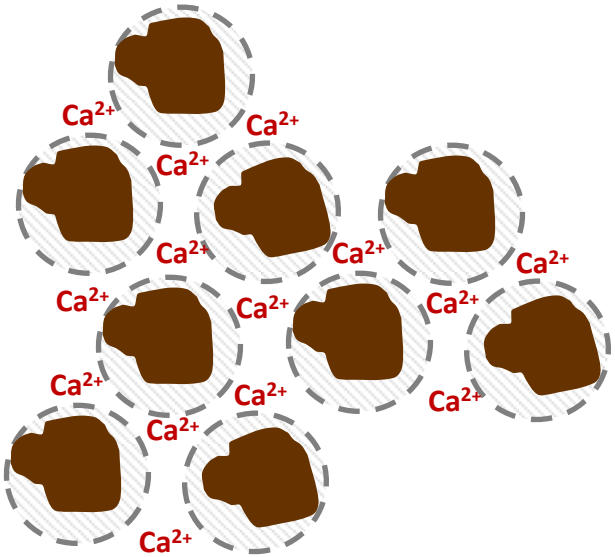
- Impacts
  - Degradation of aggregate stability
  - Reduction of macropores
  - Reduction of water and air permeability
  - Poor root penetration
  - Decline of the habitat for soil organisms



Dispersion



Flocculation



Universität für Bodenkultur Wien
Department für Wald- und Boden-
wissenschaften

Possible solutions

Universität für Bodenkultur Wien
Department für Wald- und Boden-wissenschaften

- Limestone

  $CaCO_3 + H_2O \rightarrow Ca^{2+} + HCO_3^- + OH^-$

  pH between 6.9 and 8.2 (in equilibrium with CO_2 in the soil air)

- Quicklime

  $CaO + H_2O \rightarrow Ca(OH)_2 \rightarrow Ca^{2+} + 2\ OH^-$

  pH can rise up higher into the strongly alkaline range (pH > 10)
  and may lead to immediate structural stabilization by flocculation

Research Question

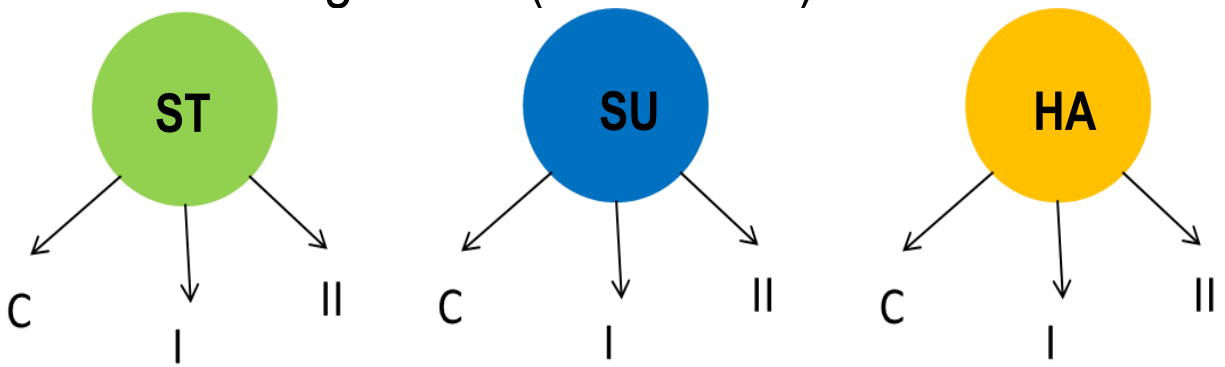
Universität für Bodenkultur Wien
Department für Wald- und Boden-wissenschaften

How does the soil microbiology react to the application of limestone and quicklime (applied as a measure for the stabilisation of soil structure)?

2. Materials and Methods

Universität für Bodenkultur Wien
Department für Wald- und Bodenwissenschaften

- Silty/clayey soils with evidence of stagnant water
  - Lower Austria (Strengberg)
  - Upper Austria (Pollham)
  - Burgenland (Kemeten)

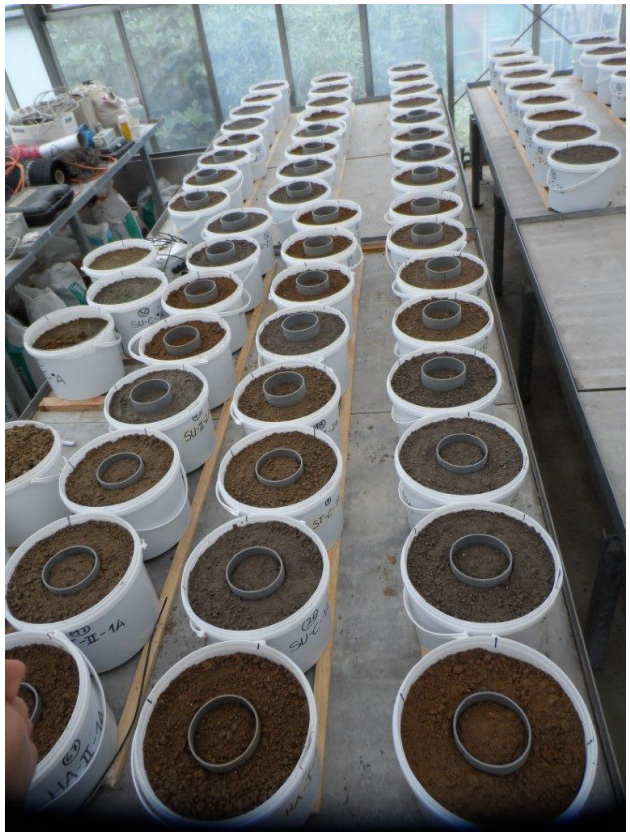


- 4 replicates
- ∑ = 36 pots for soil microbiology

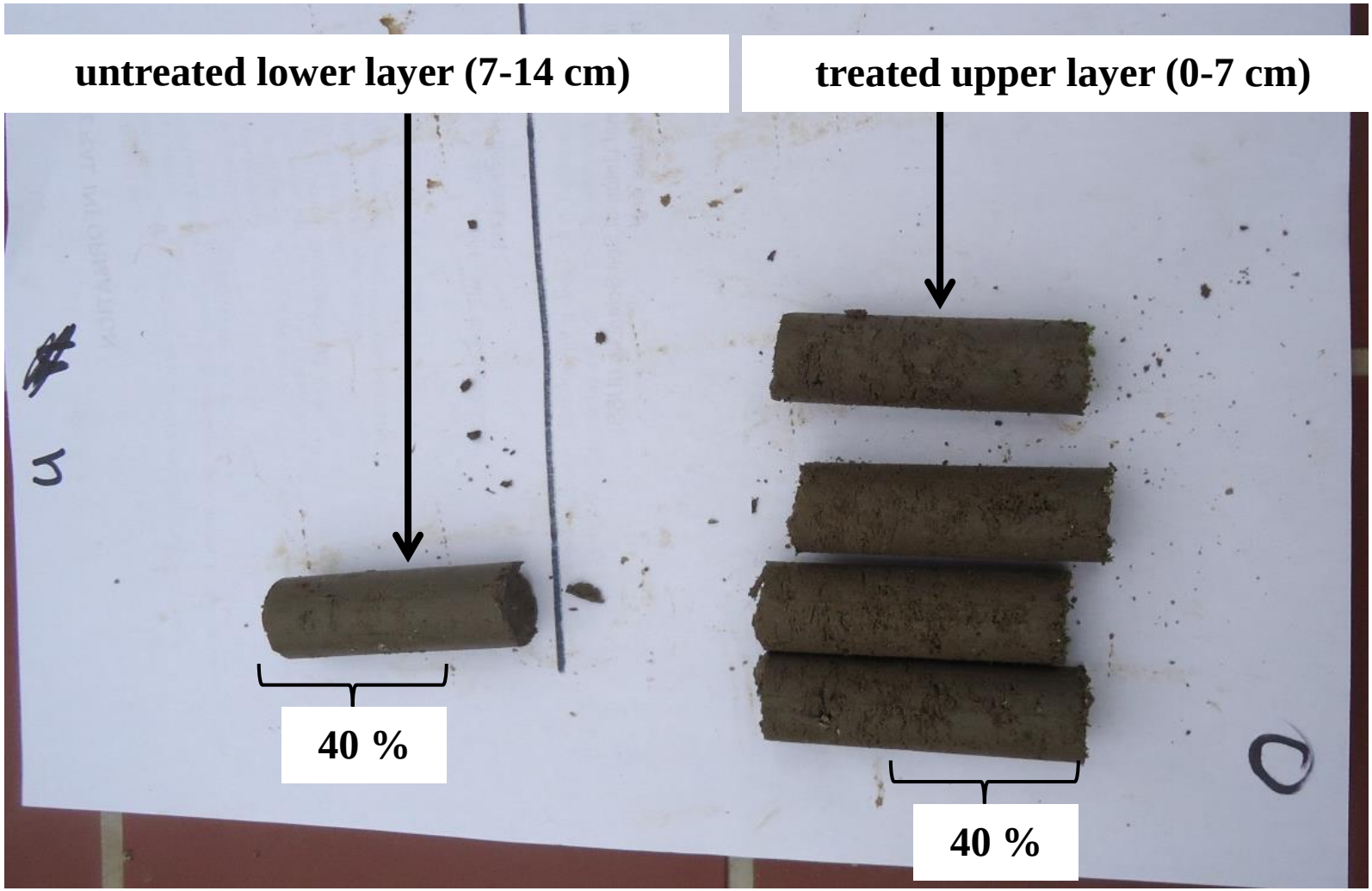
- **C** = control
- **I** = CaO
- **II** = $CaCO_3$

- **ST** = Strengberg
- **SU** = Pollham
- **HA** = Kemeten

Experimental approach



- Greenhouse pot experiment for a duration of **3 months** in a **randomized block design**
- Upper soil layer (0-7 cm) was mechanically treated with a small garden shovel
- Application of CaO and $CaCO_3$ (application rate: 2000 kg ha^{-1})
- Incorporation of the 2 liming materials with a “garden claw“

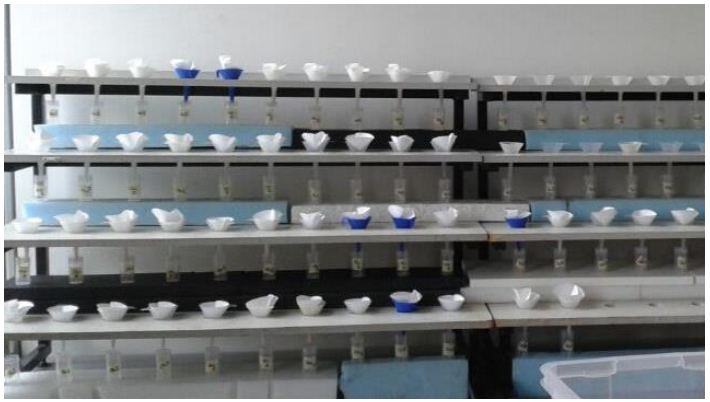


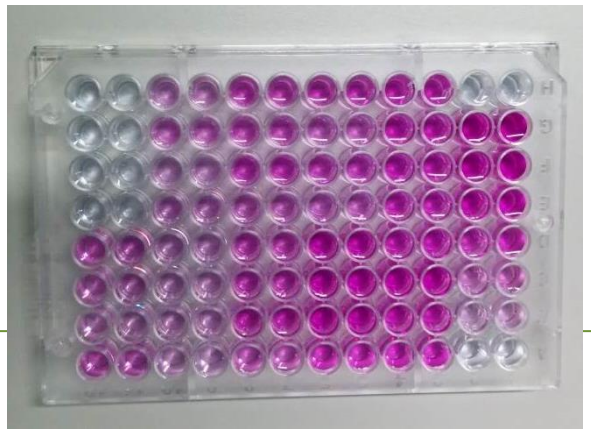
- Mini drilling cores sieved < 2 mm → *Homogeneity of the samples*

Lab analyses

Universität für Bodenkultur Wien
Department für Wald- und Boden-wissenschaften

- pH
- Nitrate-nitrogen (NO_3-N)
- Ammonium-nitrogen (NH_4-N)
- Enzyme activities
- Microbial biomass C and N (C_{mic} and N_{mic})
- Respiration measurements (CO_2)
- PLFAs (still in progress)

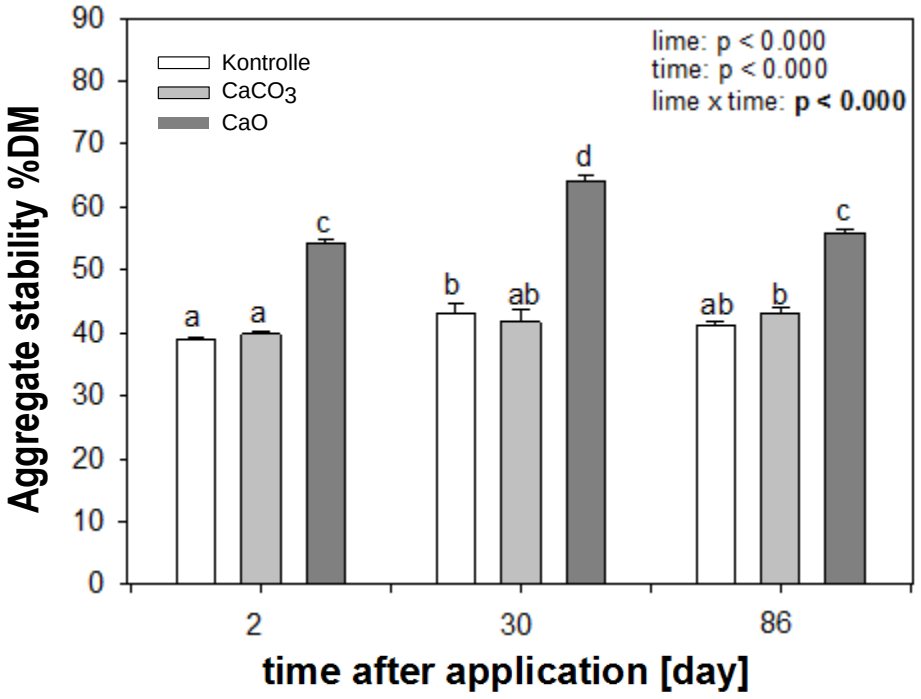




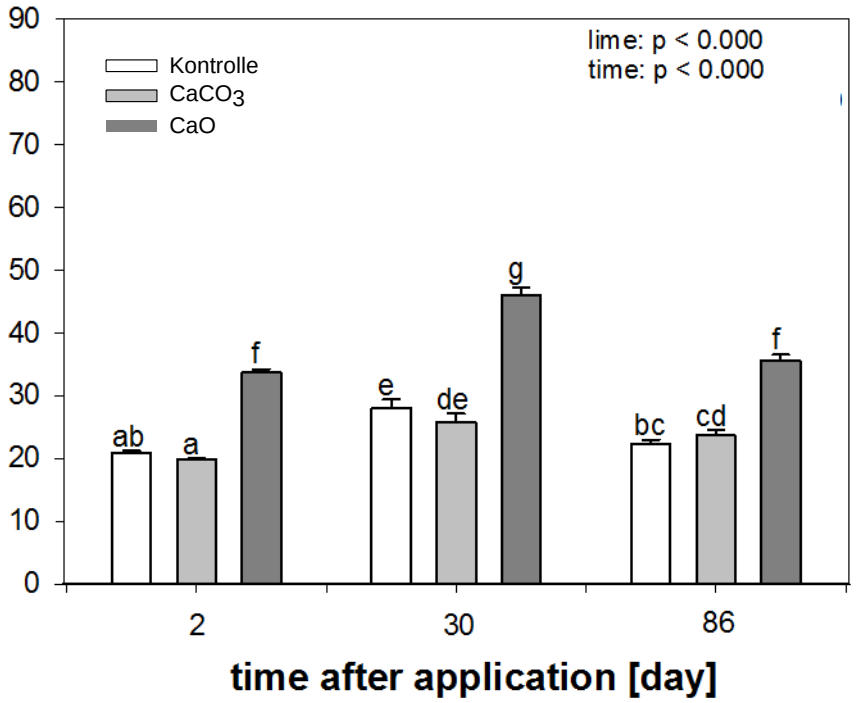
3. Results (Lisa)

Aggregate stability

Strengberg



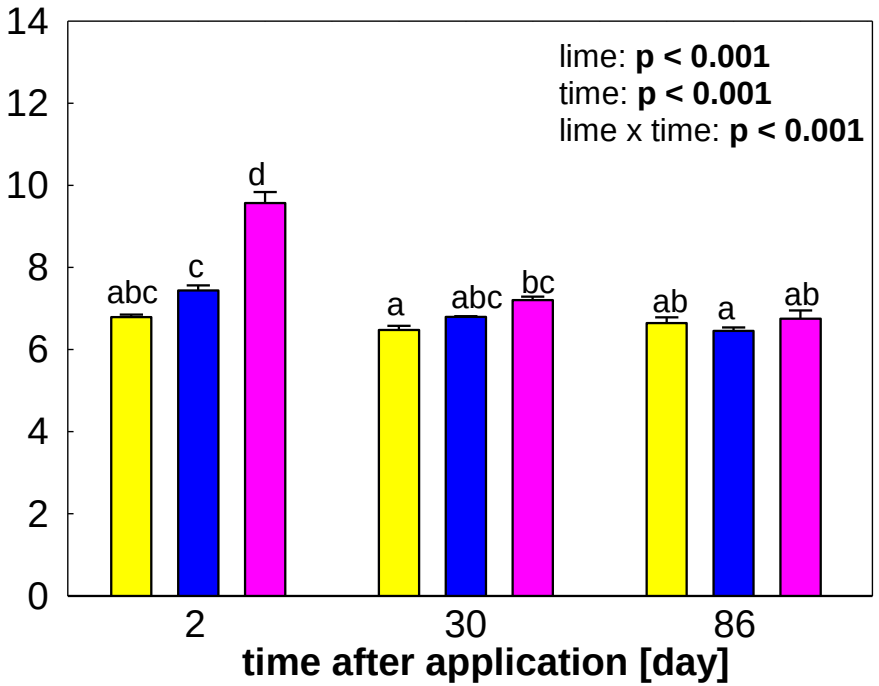
Kemeten



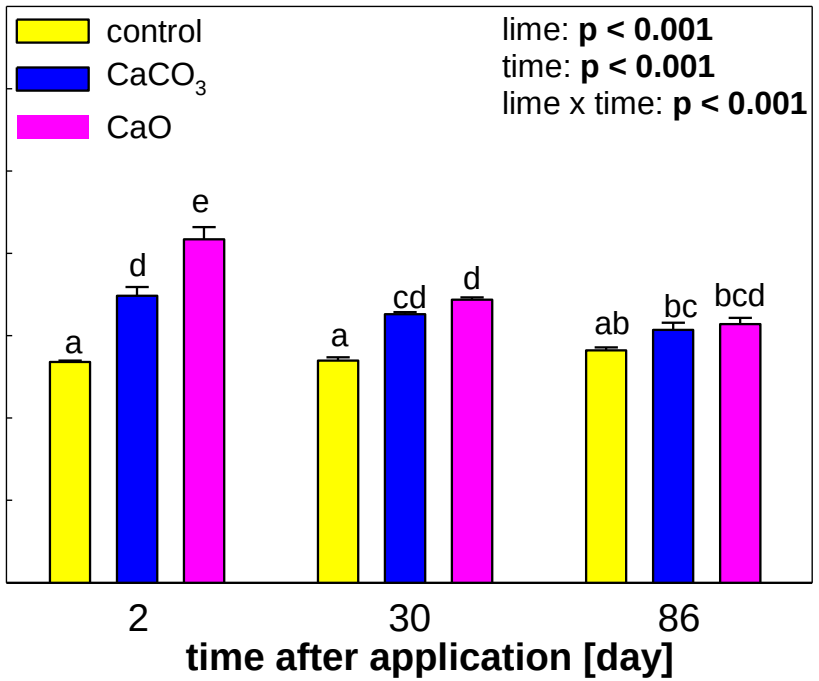
3. Results

pH

Strengberg



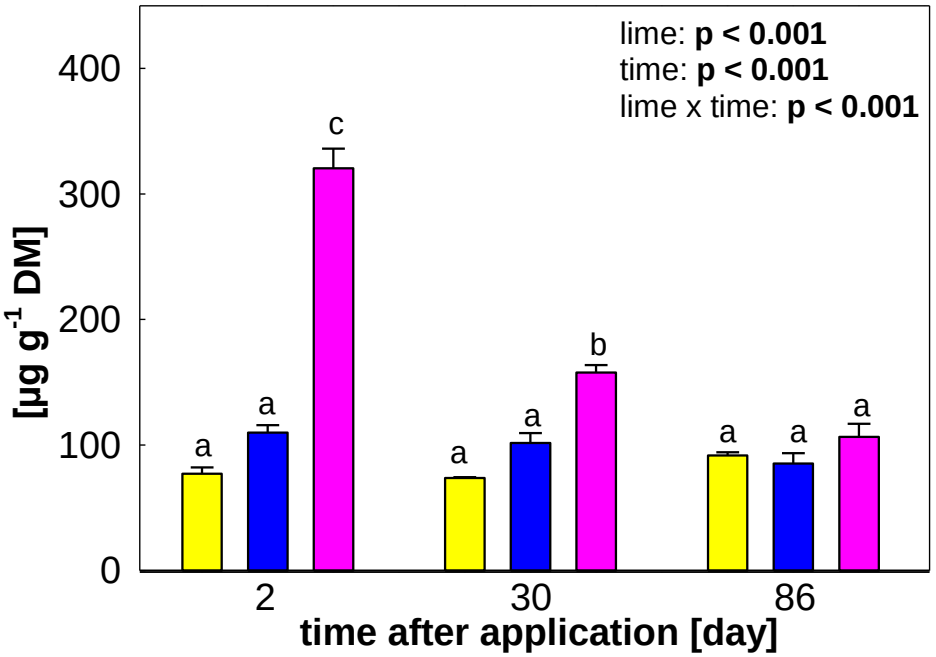
Kemeten



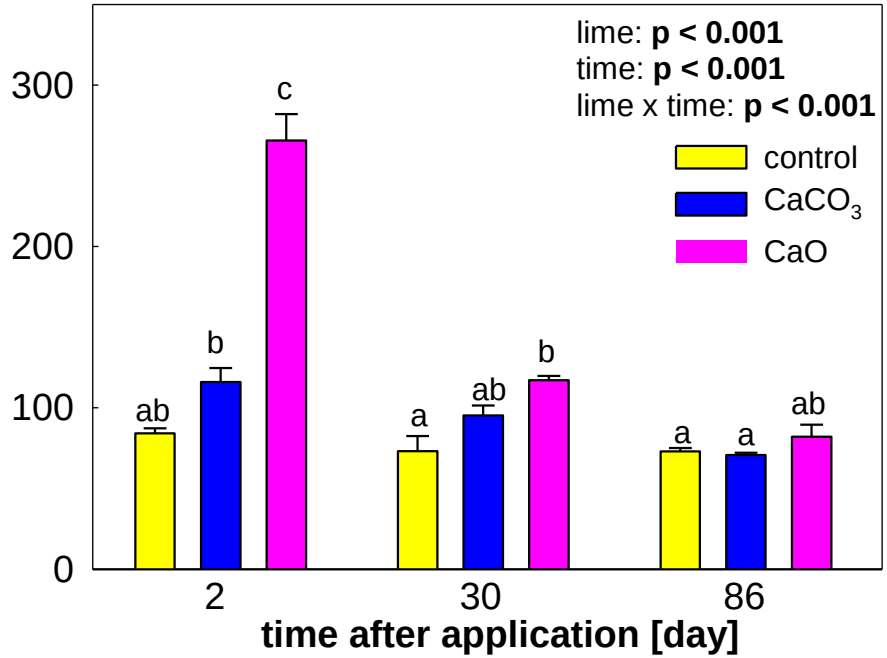
Results

Dissolved organic carbon (DOC)

Strengberg



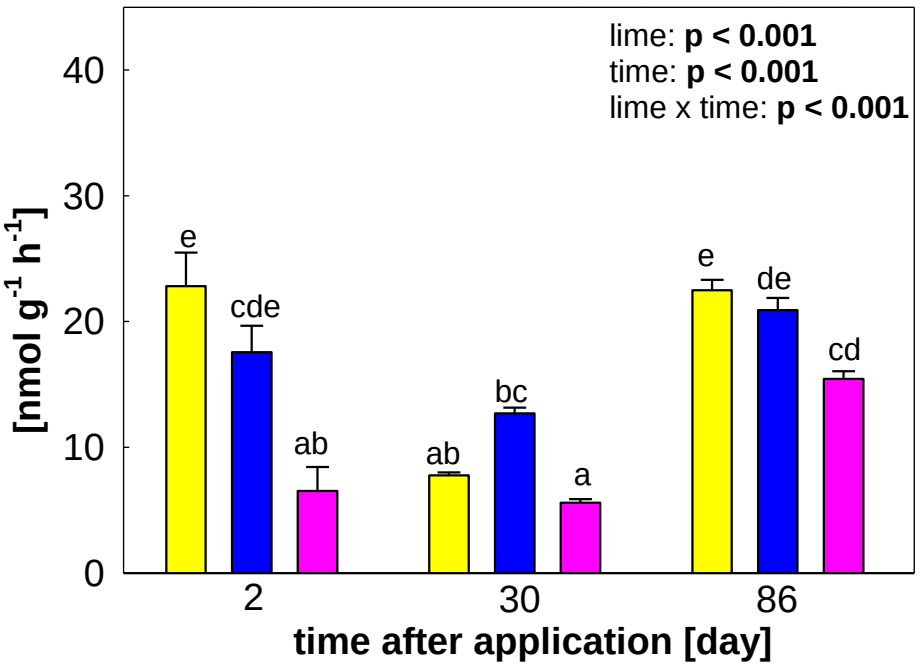
Kemeten



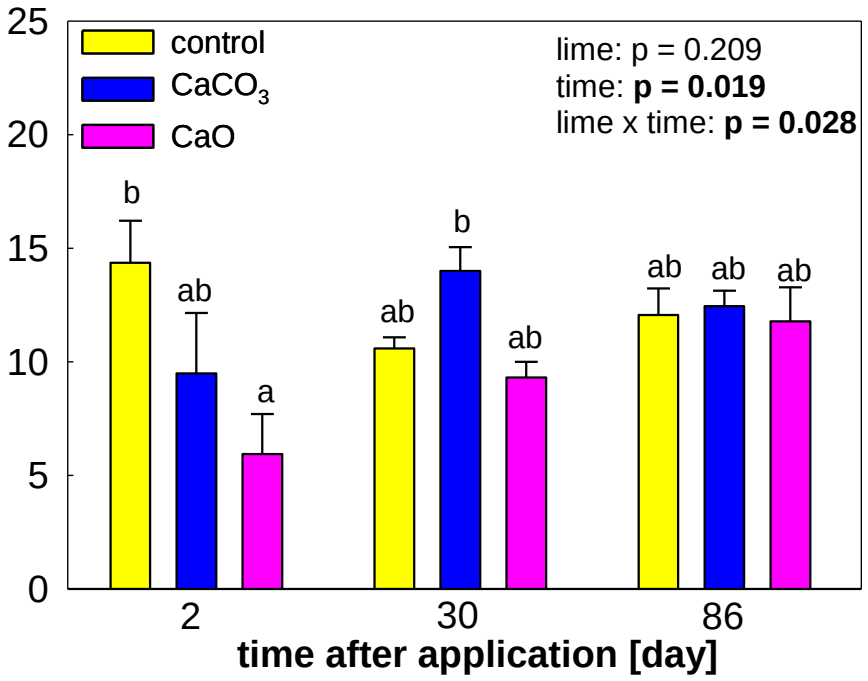
Results

Protease activity - hydrolytic enzyme activity

Strengberg



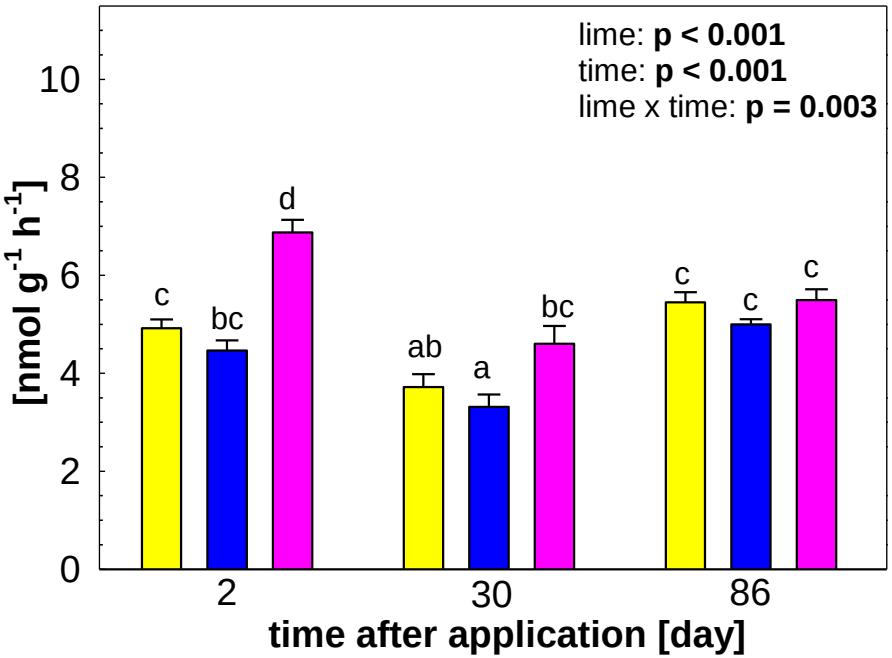
Kemeten



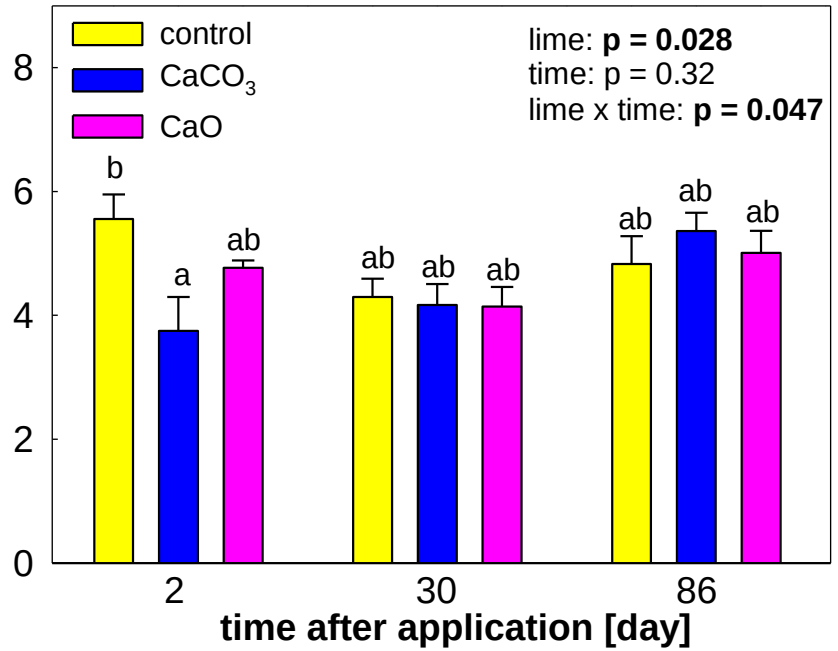
Results

Peroxidase activity - oxidative enzyme activity

Strengberg



Kemeten



4. Summary

Universität für Bodenkultur Wien
Department für Wald- und Boden-wissenschaften

- **pH**: increase after CaO application
- **DOC**: increase after CaO application; no effect of $CaCO_3$
- **Protease activity**: reduction after CaO application
- **Peroxidase activity**: increase after CaO application

- **Time effect**: short-term impact on microbial parameters

5. Conclusion

Universität für Bodenkultur Wien
Department für Wald- und Boden-wissenschaften

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.

THANK YOU for your attention

Universität für Bodenkultur Wien
Department für Wald- und Bodenwissenschaften

cheers:

Firma Bodenkalk, Hans Unterfrauner, Katharina Keiblinger, Franz Zehetner, Robert Peticzka, Sonja Leitner, Axel Mentler, Lisa-Maria Bauer, Georg Pardeller, Dong Liu, Johanna Reifer, Johannes Pichler

07.10.2014