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Plant-microbial interactions in organic and conventional farming systems: changes in responses to drought.

Emily Oliveira Hagen[1,2], Qing Sun[1], Yujie Liu[1], Raphaël Wittwer[2,3], Valentin Klaus[1], Thomas Keller[2,4], Nina Buchmann[1] and Marcel Van der Heijden[2,3,5]

Affiliations: [1]**Grassland Sciences, ETH Zürich**, [2]Agroscope Reckenholz, [3]University of Zürich, [4]Swedish University of Agricultural Sciences, [5]Utrecht University

emily.hagen@usys.ethz.ch

1 Introduction

Over the last 30 years Swiss temperature has increased with an annual average warming rate of 0.35°C/decade. In addition, Swiss Climate Change models (CH2011) predict a mean reduction in Swiss summer precipitation by mid of the century of around 15%. It is unclear, however, how different farming systems will cope with irregular and rush climatic conditions.

2 Method overview

Fig. 1. FAST trial, in Rümlang. Four blocks, each holding 4 plots of organic and conventional farming managements with and without tillage (highlighted in different collors). At each farming system plot there is a drought and a control subplots. Aerial photo of FAST trial: Raphaël Wittwer

Soil Physics:

- Quantification of soil pore size distribution
- Soil water retention capacity
- Gas transport properties
- Least limiting water range (LLWR)
- Mechanical resistance to penetration
- Chemical analysis (N, P, pH)
- SOC content
- Aggregate size and stability

Drought simulation with rain shelters:

- Soil water content and temperature (dynamic)
- Climatic data (Precipitation, Temperature)
- Yield of control and drought plots

Fig. 2. Rain shelter used to promote drought at the specific farming system plots in field. Note the green tubes, their function is to capture the rain water and disposing it away from the plot, avoinding that it flows back and hinders drought.

Root microbiome and Plant-microbe interactions:

- DNA Sequencing, network analysis
- Mycorrhizal-Fungi (AMF) abundance and function (nutrient and water uptake)

Fig. 3. Maize root from first year field season.

3 Materials

- **Plant root and soil** will be collected at **4 timepoints**: before drought, drought climax, recovery 1 and recovery 2 (shortly before harvest) to assess **system resilience**.
- Plant and soil material from each subplot will be collected each year from **Maize, Pea-barley and Winter Wheat**, according to the crop rotation of the FAST field trial.
- **Fine roots** will be sampled for **AMF colonization** analysis.
- Yield and management information will input an **economic assessment** model.

4 Guiding questions and hypothesis

Hypothesis

- **Tillage intensity** affects soil structure and water availability.
- Soil microbial diversity is higher at **organic farming** systems.
- **Greater microbial diversity** and plant-microbes interaction promotes **higher resilience**.
- **Crop yields and grain quality** differ among systems.
- Under water stress, conventional and organic farming are **economically comparable**.

Drought Simulation

- Which farming system is more resilient to drought?
- Do plants change their water and nutrient sources?
- Does soil and root microbial composition change?
- How important are microbial association to overcome stress?
- Which farming system is economically more viable under stress?

Farming Systems

- How is the soil physically structured?
- Which are the soil hydraulic properties?
- How is the soil microbial community structured?

5 Conclusion

Climate change poses a variety of challenges to food production, and only by understanding the mechanisms behind systems responses are we able of better preparing to a variety of changing conditions.

In the long run, our research aims at providing farmers and policy makers with field validated information on how different systems resist and recover from an imminent hazard: drought.

6 References

1. CH2011: Swiss Climate Change Scenarios CH2011, C2SM, MeteoSwiss, ETH, NCCR Climate, OcCC, Zurich, CH, 88 pp., 2011.
2. Farmer picture: https://unsplash.com/photos/XztLBuMHwu8

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