Influence of Soil Biodiversity and Farming Innovations on the Mineral Nutrition and Stress Tolerance of Wheat Plants for Improved Resilience to Climate Change Impacts

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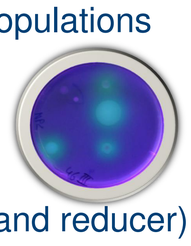
BIOFAIR aims to research **soil biodiversity** under different farming practices and environmental stressors to **anticipate impacts** of climate change on belowground processes and **provide adaptation strategies**. Focus is given to grain quality traits, such **as vitamins and mineral nutrients**, and to technological baking properties, such as flour viscosity, to ensure a **high value for human nutrition** and **future sustainability of wheat production**.

Soil biodiversity: Which organisms maintain soil functions and how is soil life affected by climate change?

Here the physiological performance of wheat plants together with the activity of the associated rhizosphere micro- and mesofauna populations in multiple climate scenarios, biodiversity eco-system functioning relationships are assessed and investigated.



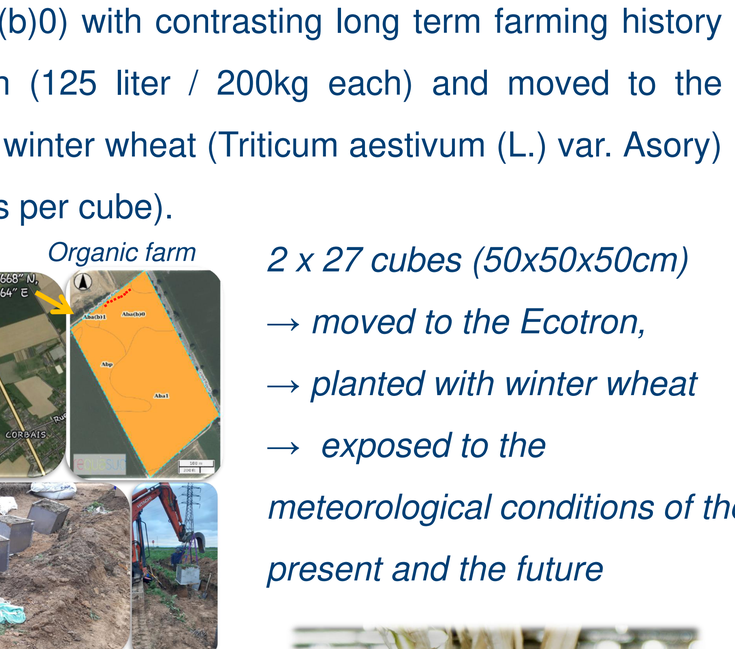
(Focused on *Pseudomonas fluorescens*, manganese oxidizer and reducer)

What is an **Ecotron**?

"An Ecotron is a set of **replicated experimental** units where **ecosystems** are confined in enclosures allowing simultaneously control of environmental conditions and the **online measurement of ecosystem processes**" (CNRS, 2016)

The **Ecotron at TERRA Gembloux Agro-Bio Tech**

Controlled variable	Range	Regulation precision
Air relative humidity (%)	7 - 95	5
Air renewal (m^3/h)	0 - 200	10
Air temperature (°C)	4 - 40	1
Biosafety	L2	-
Calm air speed (m/s)	0.1 – 0.3	0.1
Carbon dioxide (CO_2 ppm)	[ext.] - 800	10
Chamber air pressure (Pa)	Ext. P – 15	5
Irradiation (PAR m^{-2} s^{-1})	0, 60 - 1200	20
Number of rain event per day (-)	0 - 13	-
Ozone (O_3 ppb)	10 - 300	10
Rain event volume (l)	0.2 - 7	0,02
Soil basal temperature (°C)	5 - 20	1
Soil basal water potential (kPa)	-100 - 30	1
Turbulent air speed (>0.5m/s)	on/off	-



First results: Especially for conventionally managed soils the future climate scenario is associated with an increased severity of root rot symptomatic for take-all disease and leaf damage with symptoms of *Septoria* infections.

Conventional vs. Organic Farming:

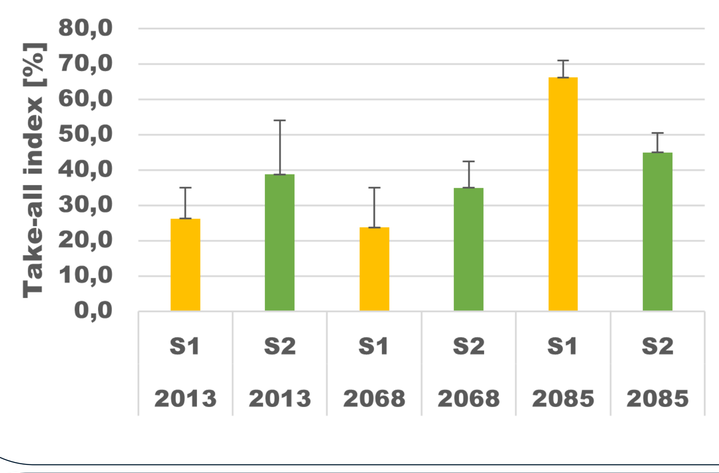
How can crop and soil management practices improve the acquisition of mineral nutrients by wheat plants for enhanced resilience to climate change impacts?

Two related soils (both classified Aba(b)0) with contrasting long term farming history were sampled as intact soil monolith (125 liter / 200kg each) and moved to the Ecotron. The cubes were planted with winter wheat (Triticum aestivum (L.) var. Asory) at a density of 308 seeds m^2 (77 seeds per cube).

Conventional farm *Organic farm*

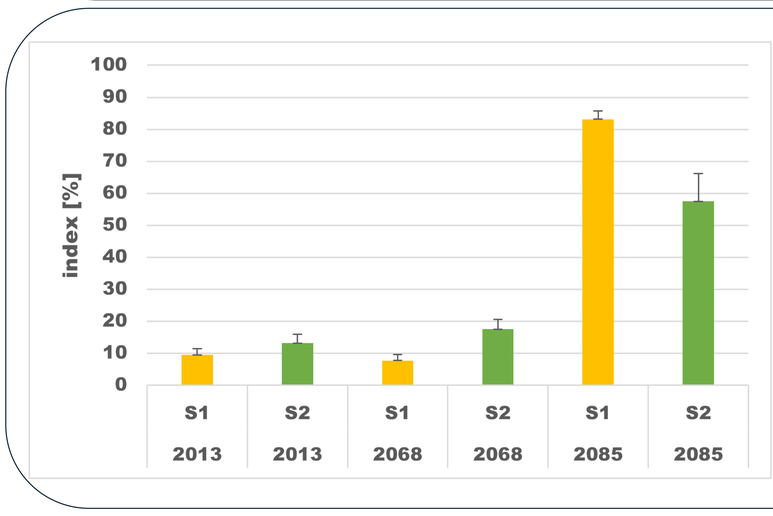
2 x 27 cubes (50x50x50cm)
→ moved to the Ecotron,
→ planted with winter wheat
→ exposed to the meteorological conditions of the present and the future

Particular emphasis is put on the interaction between alterations in soil and root microbiology, phytohormones, stress enzymes, mineral nutritional status of the wheat plants, and their impact on phytopathological diseases like take-all (caused by the root fungus *Gaeumannomyces graminis*).



Severity of root rot symptomatic for take-all disease under three different climate scenarios with soil from conventional and organic management

S1 = conventional soil
S2 = organic soil



Severity of leaf damage with symptoms of *Septoria* infestation under three different climate scenarios with soil from conventional and organic management

S1 = conventional soil
S2 = organic soil

Out-look: Further investigations shall elucidate to what extent the increased disease severities are associated with deleterious alterations in microbial root colonization and impairments in mineral nutrient acquisition making the plants more susceptible to abiotic and biotic stresses.