

The impact of soil amendments Terra Preta, Perlhumus, and Biochar on nutrition transfer and plant performance of a German barley cultivar (*Lexy*) cultivated in poor marginal substrate and water deficiency

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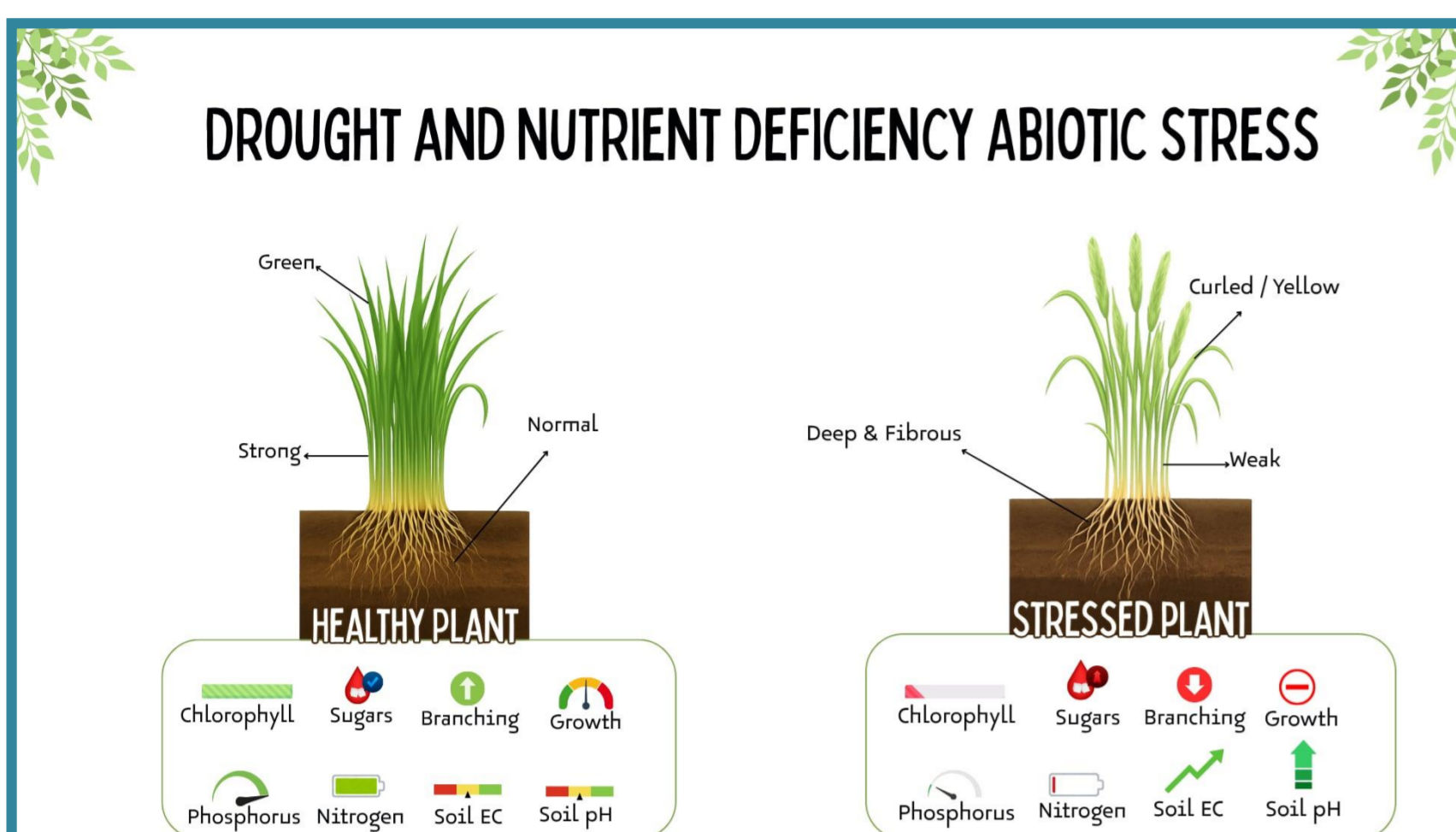
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Motivation: Problems VS sustainable solutions

Problems

- Soil losses of carbon in arable soil worldwide.
- Soil fertility decline
- Marginal and polluted soils must be used increasingly for plant production in the future.



- Drought is one of the most relevant abiotic stresses affecting plant and soil properties.

Solution: Increasing soil carbon can be achieved by carbon-rich soil amendments

Biochar: charcoal derived from the pyrolysis process in the absence of Oxygen (saturated with NPK for fertilization)



Terra-preta: artificial carbon-rich additive, highly fertile black soil ('dark earth')



Perlhumus: organic granular soil conditioner, rich with Humic acid, can improve soil properties and microorganisms' activity.



METHODS

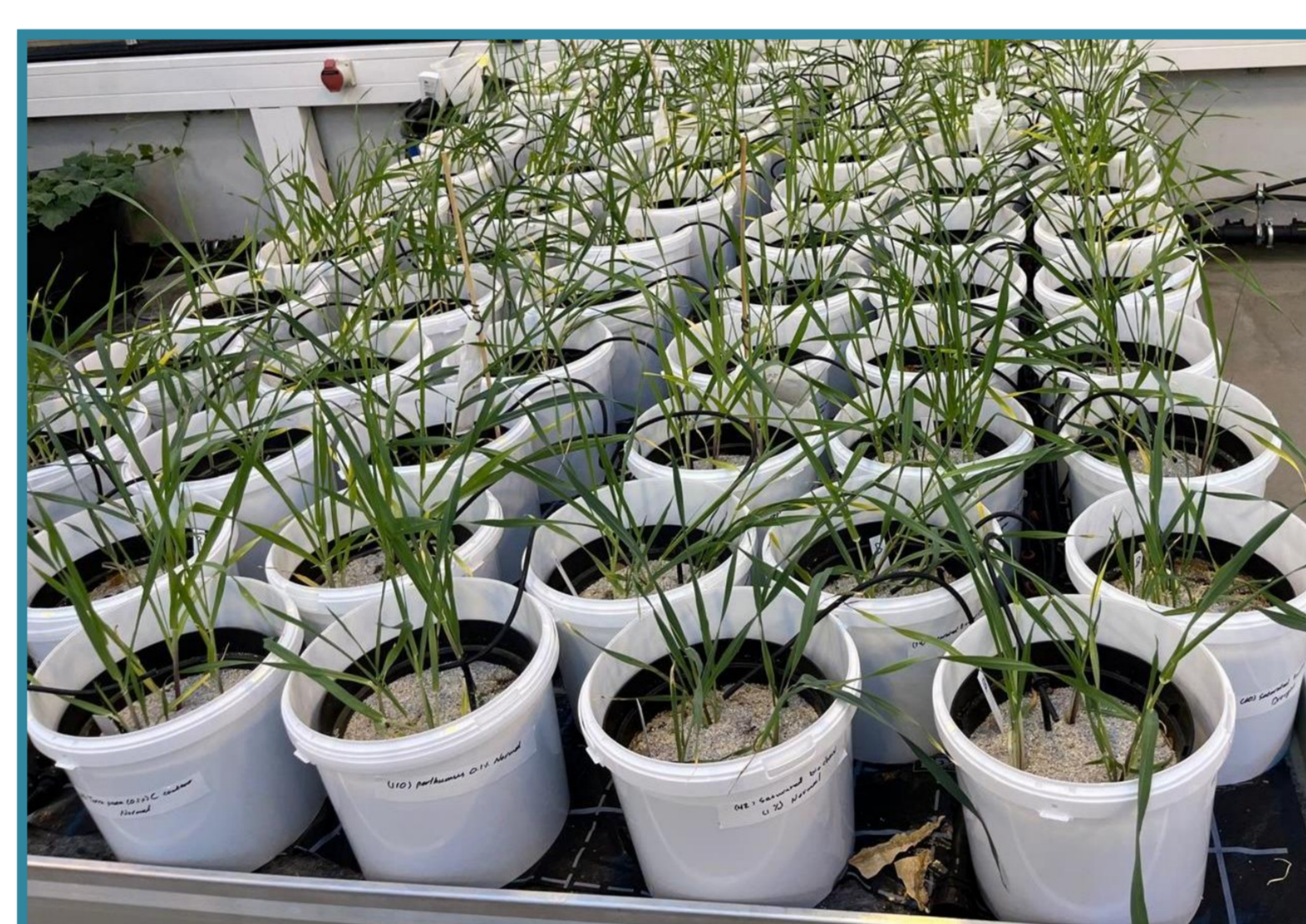


Biochar saturated with Hakaphos Blue



Water holding capacity measurement

Pot experiment (02-05/2024), greenhouse conditions



Drought stress was applied to half of the plants.

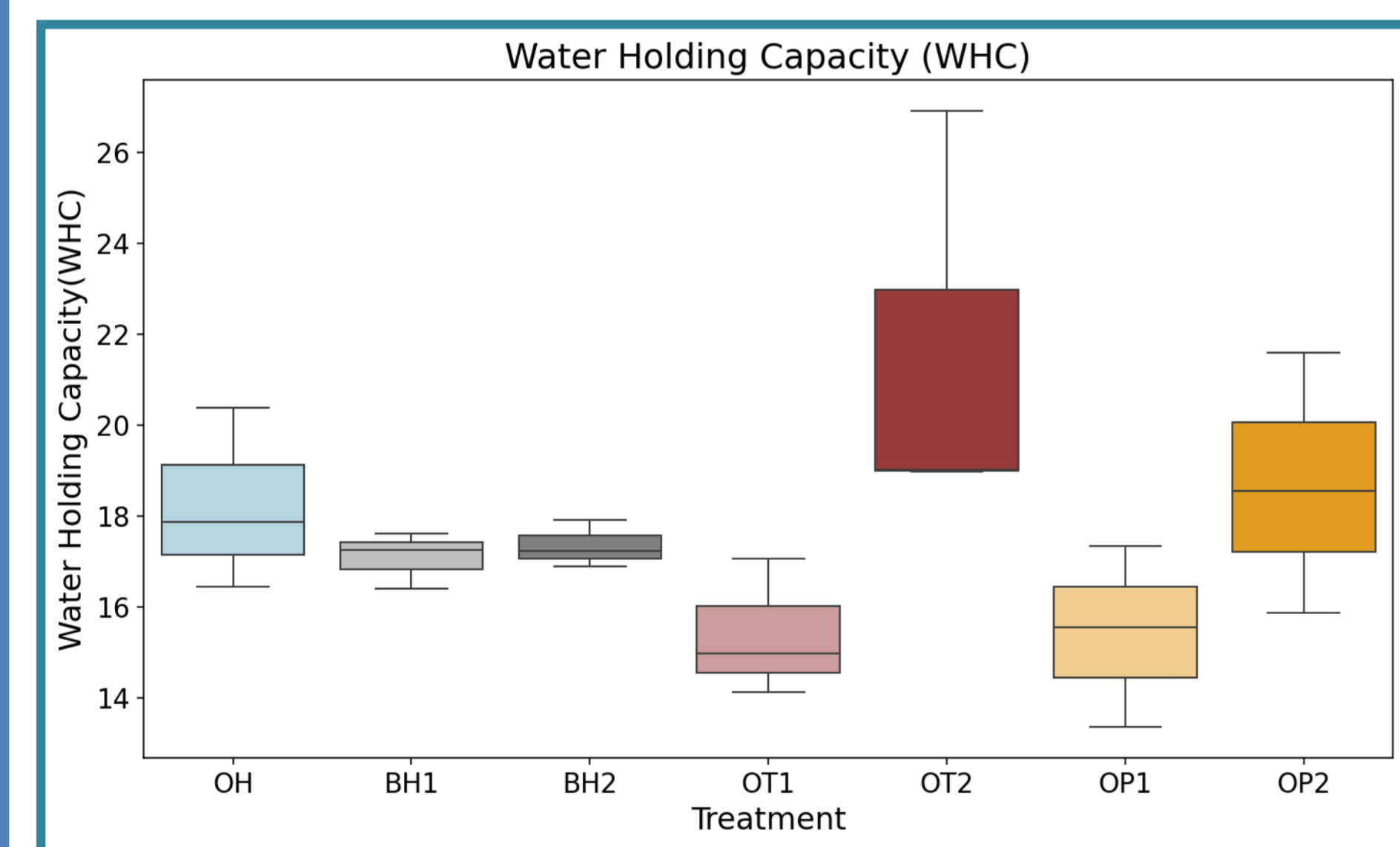
- Pots were filled (ratio 3:1) with Quartz sand + Speyer soil 2.1
- Optimizing treatments up to 90 kg/ha using Hakaphos Blue.
- Resulting in soil carbon content of 0,1 and 1%

Scale-up (06-10/2023), FZ Juelich crop garden

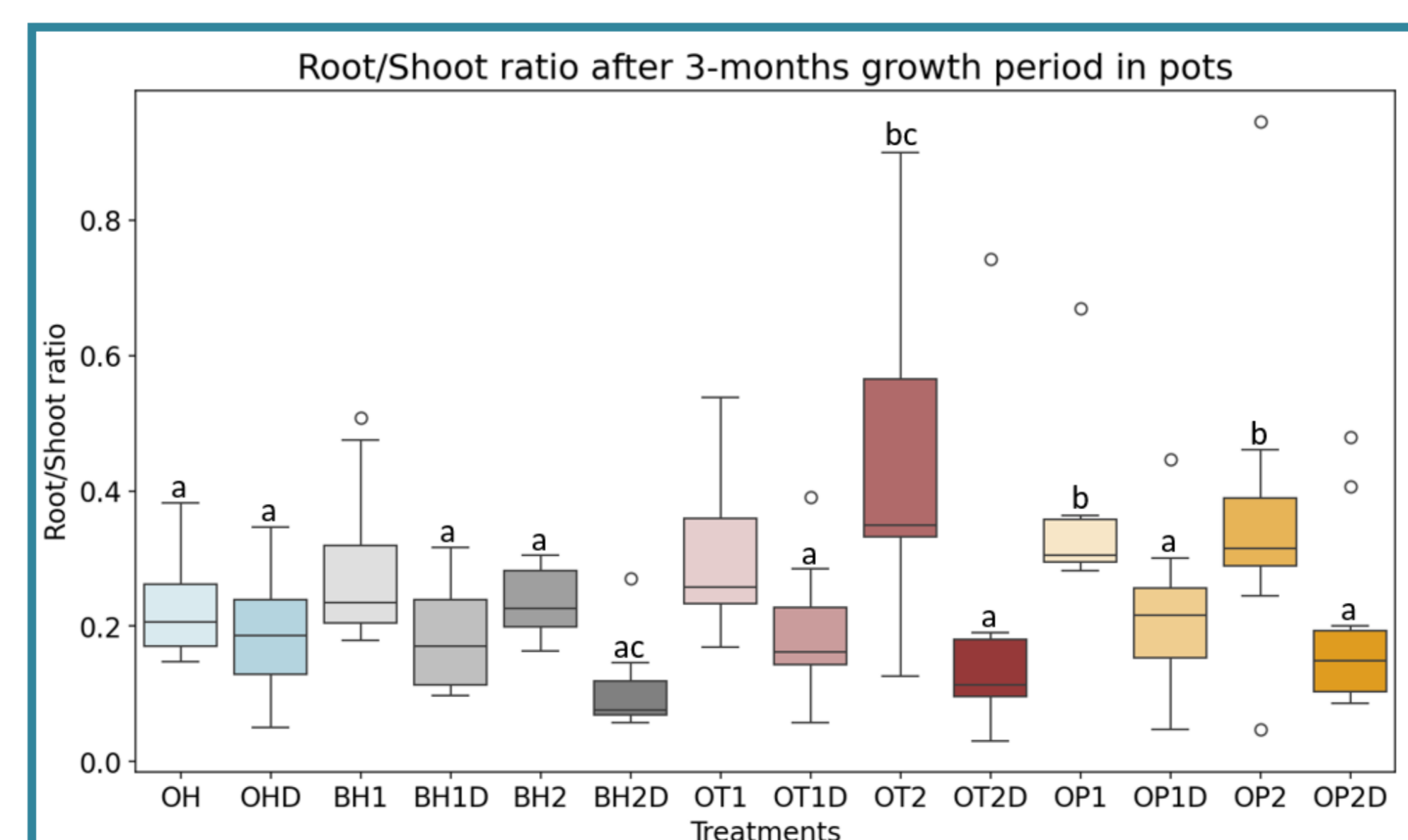
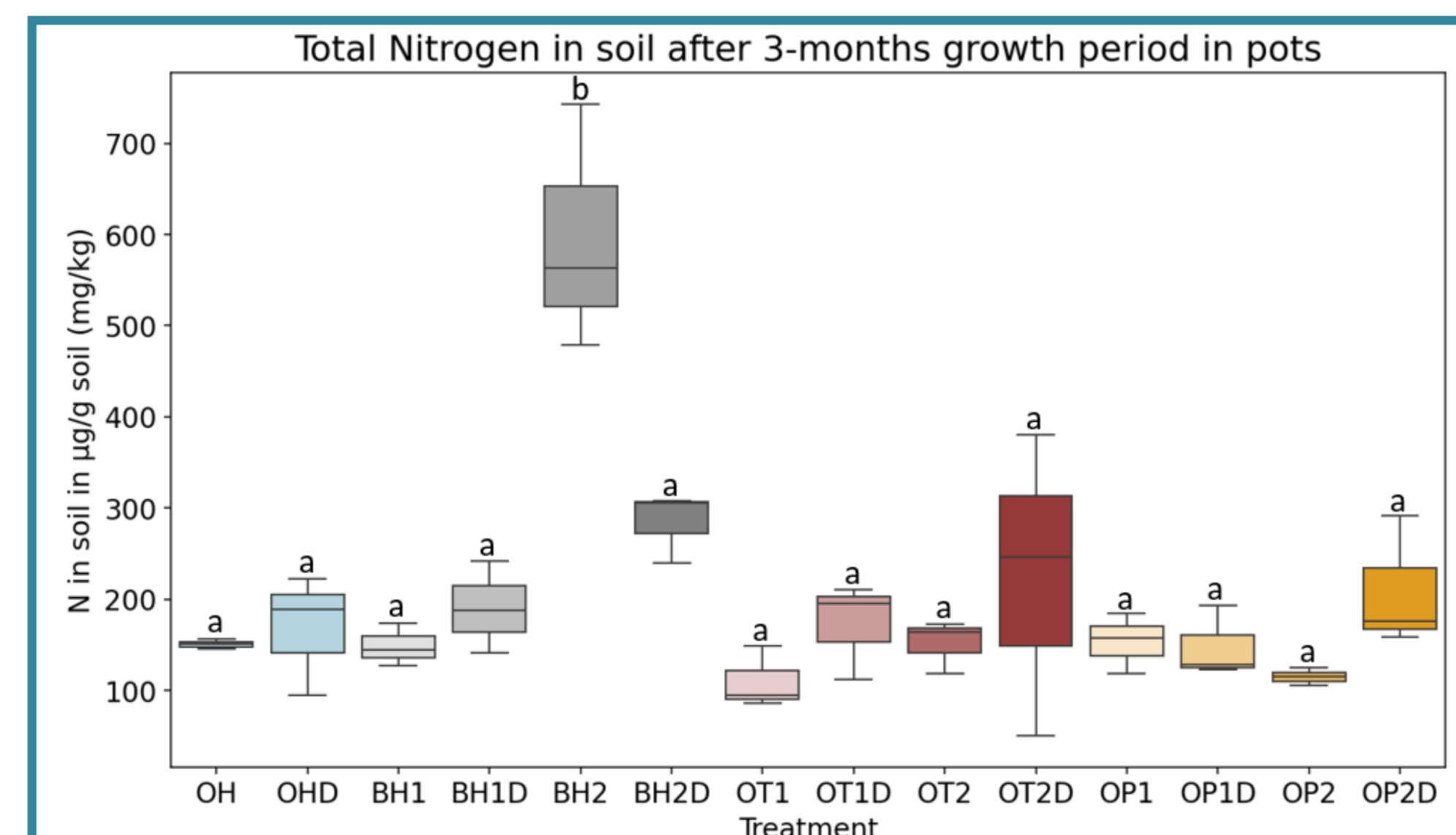


- Optimizing soil up to 0.1% carbon concentration, and 90kg N/ha.
- Placed in big pots (bins), containing practically nutrient-free sandy soil from marginal land near coal-mining area

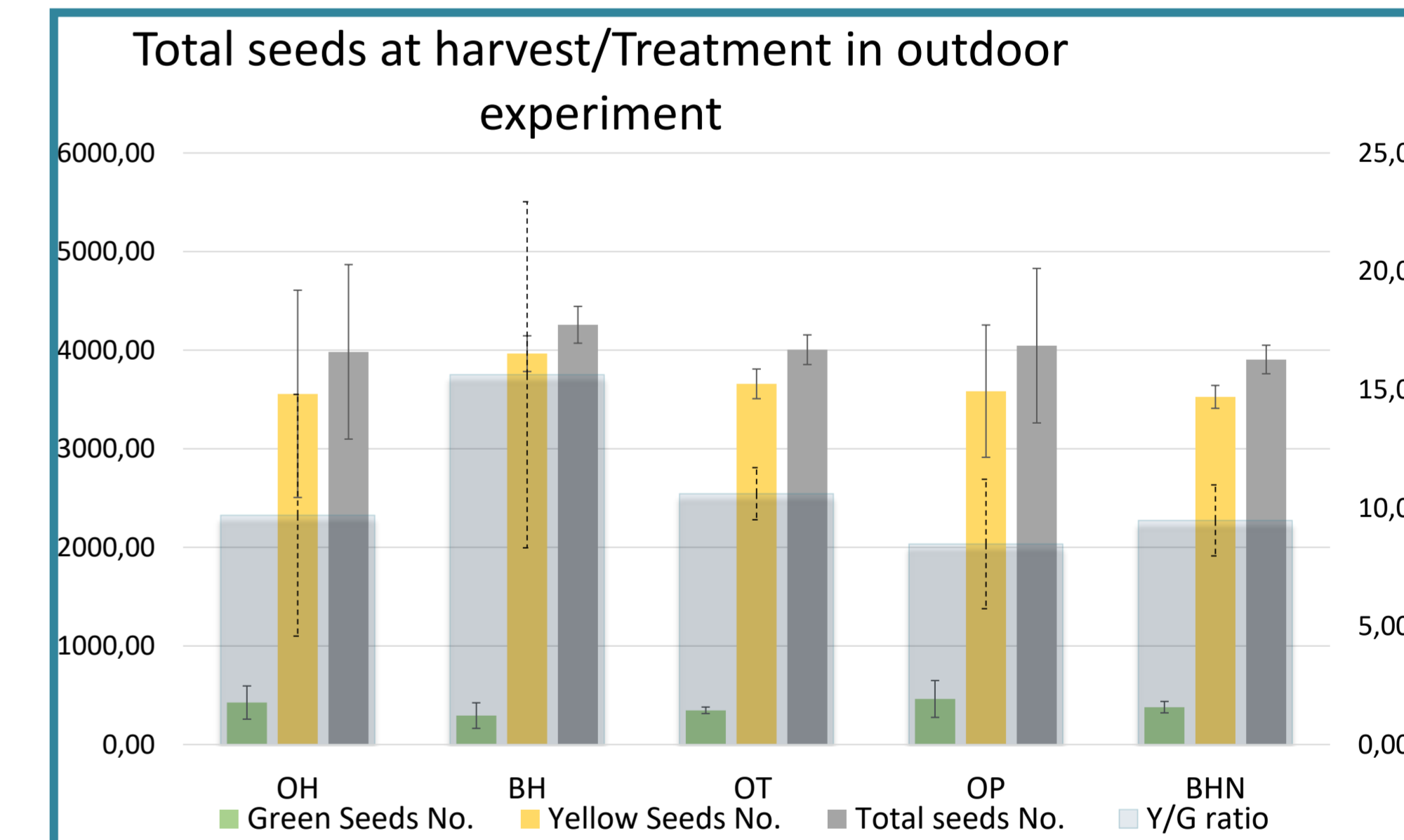
RESULTS & DISCUSSION



- Increasing soil carbon by 1% Terra preta and Perlhumus increased WHC by 19% and 2%, respectively.
- Most of the plants in the drought treatments died and could not handle the drought stress.
- Soil nitrogen was higher in the drought plant due to less consumption by the weak/dead plants.
- Higher content of plant-available phosphate (not shown) carbon-rich soil amendment treatments compared to the control. Phosphate levels decreased in drought treatment, except for 1% Terra preta.
- In drought stress conditions, the plants root/shoot ratio decreased significantly in carbon-rich treatments, especially in 1% Terra preta and Perlhumus.



- ✓ BH: Biochar, OT: Terra-preta soil, OP: Perlhumus, D: Drought treatment, (1,2: 0,1%,1% C-concentration, respectively).
- ✓ The letters represent the significance between the treatments at $p < 0.05$, as determined by one-way ANOVA and the Tukey post-hoc test.



- ✓ BH: Saturated-Biochar with NPK, BHHN: Biochar mixed with NPK OT: Terra-preta soil, OP: Perlhumus, 0,1% C-concentration.
- ✓ Second scale for G/Y ratio

- Increasing carbon concentration increased the barley yield
- Saturated Biochar (BH) is better for improving plant growth parameters and yield than mixing with soil (BHN).
- Saturated biochar (BH) supported the fastest ripening process between treatments, followed by Perlhumus (OP).
- Terra preta (OT) enabled the highest seed germination (not shown), lowest in Perlhumus (OP).
- Generally, increasing the C-content could decrease nutrient leaching, especially in saturated biochar.
- No significant difference in plant performance was revealed, and more emphasis needs to be put to seed quality.

CONCLUSION AND REMARKS

- Future focus on field experiments over many years is recommended to follow long term effect of different carbon-rich amendments on nutrient transfer and soil/ plant interaction in marginal lands.
- Nitrogen content increased in drought, while phosphate decreased, this needs further investigation especially for e.g. nitrogen use efficiency (NUE) overall.
- In greenhouse conditions, Terra preta soil is the best soil amendment for plant performance and soil improvement.
- In the out-door experiment, nutrient-saturated biochar had the best effect on plant growth and yield.

ACKNOWLEDGEMENTS

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