Wheat ACE

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Effect of elevated CO_2 concentrations on morphological and physiological traits of different winter wheat varieties

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Introduction and Problem

Global concentrations of CO_2 are projected to increase to 650 ppm (RCP4.5) by the end of the 21st century. Considering the associated climate changes it becomes more and more relevant how wheat and its pathogens cope with these future climate conditions. As winter wheat (*Triticum aestivum* L.) is one of the most important crops in terms of human nutrition, it is particularly important to maintain its productivity. Elevated CO_2 concentrations have the potential to increase yields and to buffer the negative effects of climate change like drought and heat stress.

Fig.1.: One of four FACE-rings 2022

Infection with Leaf Rust (LR, *Puccinia triticina* Erikss) and Ear Fusarium (FUS, *Fusarium graminearum* Schwabe) could be affected by rising CO_2. The objective of the inter-institute WheatFACE project is to investigate the influence of elevated CO_2 on the morphological and physiological traits of different wheat genotypes. Special attention is paid to plant traits that influence the infestation of LR and FUS, such as stomata number and density, stomatal conductance or leaf area.

Methods

In 2022 we tested 12 different wheat varieties to investigate the effect of CO_2 on growth and development. We compared ambient CO_2 concentrations of 420 ppm (AMB) with elevated concentrations of 600 ppm (ELE) using a Free Air Carbon dioxide Enrichment - Facility (FACE - Facility).

We installed 4 ELE-rings and 4 AMB-rings as control group (Fig.3). Fumigation was conducted from shooting to senescence (31.03.-11.07.2022.) Throughout the growing season, we measured several morphological, physiological and agronomical traits. On two occasions we additionally measured the stomatal conductance. Furthermore, we conducted a partial harvest at mid flowering (BBCH 65) to record morphological adaptations during growth and complete harvest at maturity (BBCH 89) to determine agronomic data such as grain yield and aboveground biomass.

Fig.2.: Experimental design of one of the rings – highlighted are the 24 plots for the 12 different wheat varities.

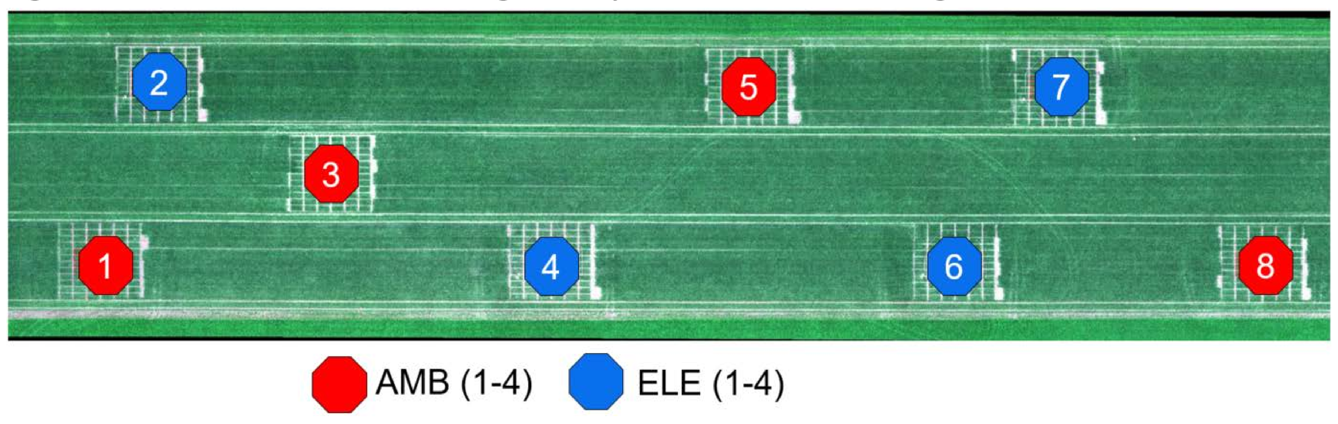

Fig.3.: Distribution of the rings in 2022. Total area 400m long and 66m wide. (2,64 ha)

Results

The results displayed here are the results from the test 2022 and refer only to the ring pair 1 (ring 1 and 2) (Fig 3.).

Fig.3.: Morphological changes in flag leaves of Toras variety. Left side AMB, right side ELE. Leaves were harvested at mid-flowering (BBCH 65).

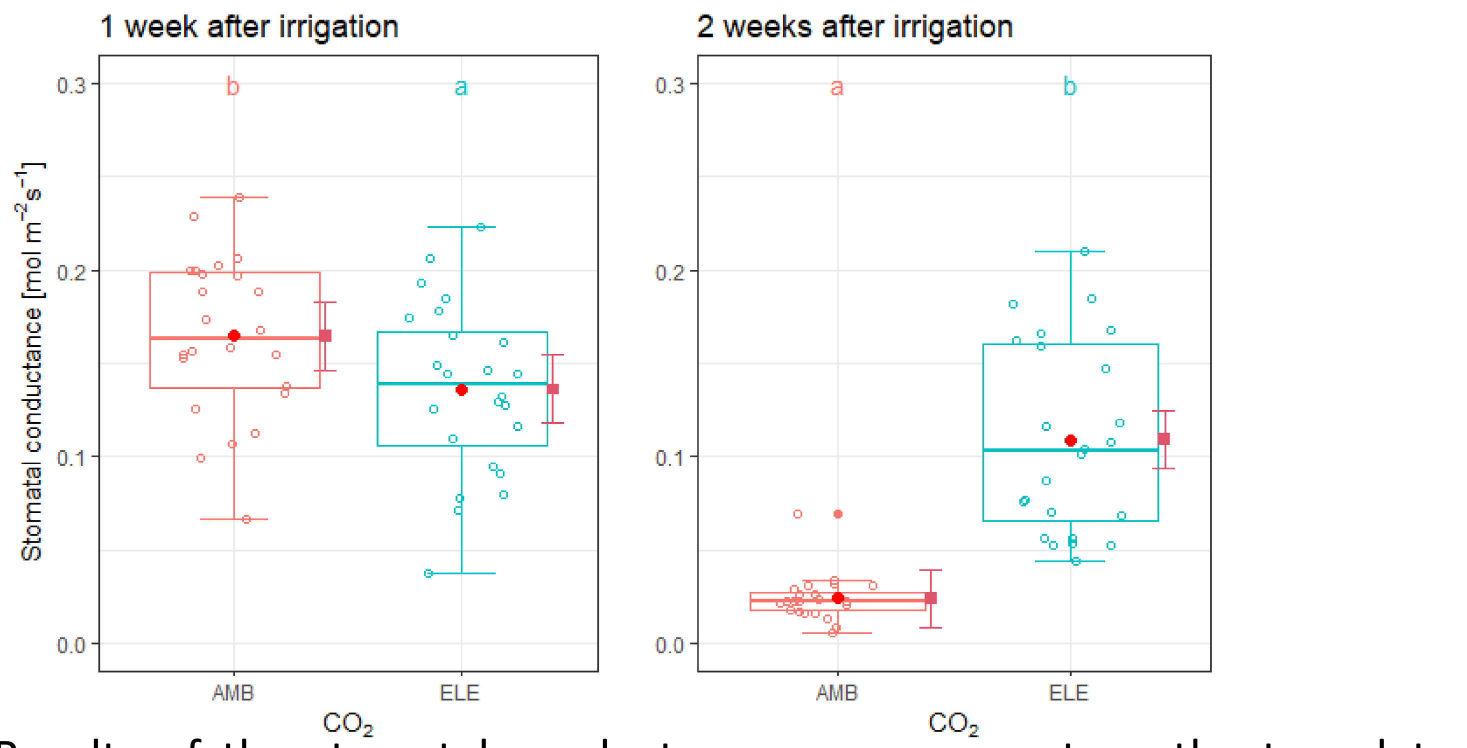

Fig.4.: Results of the stomatal conductance measurement on the two dates (10.06.2022 / 15.6.2022). Groups with the same letter are not detectably different (Tukey-test, α=0,05).

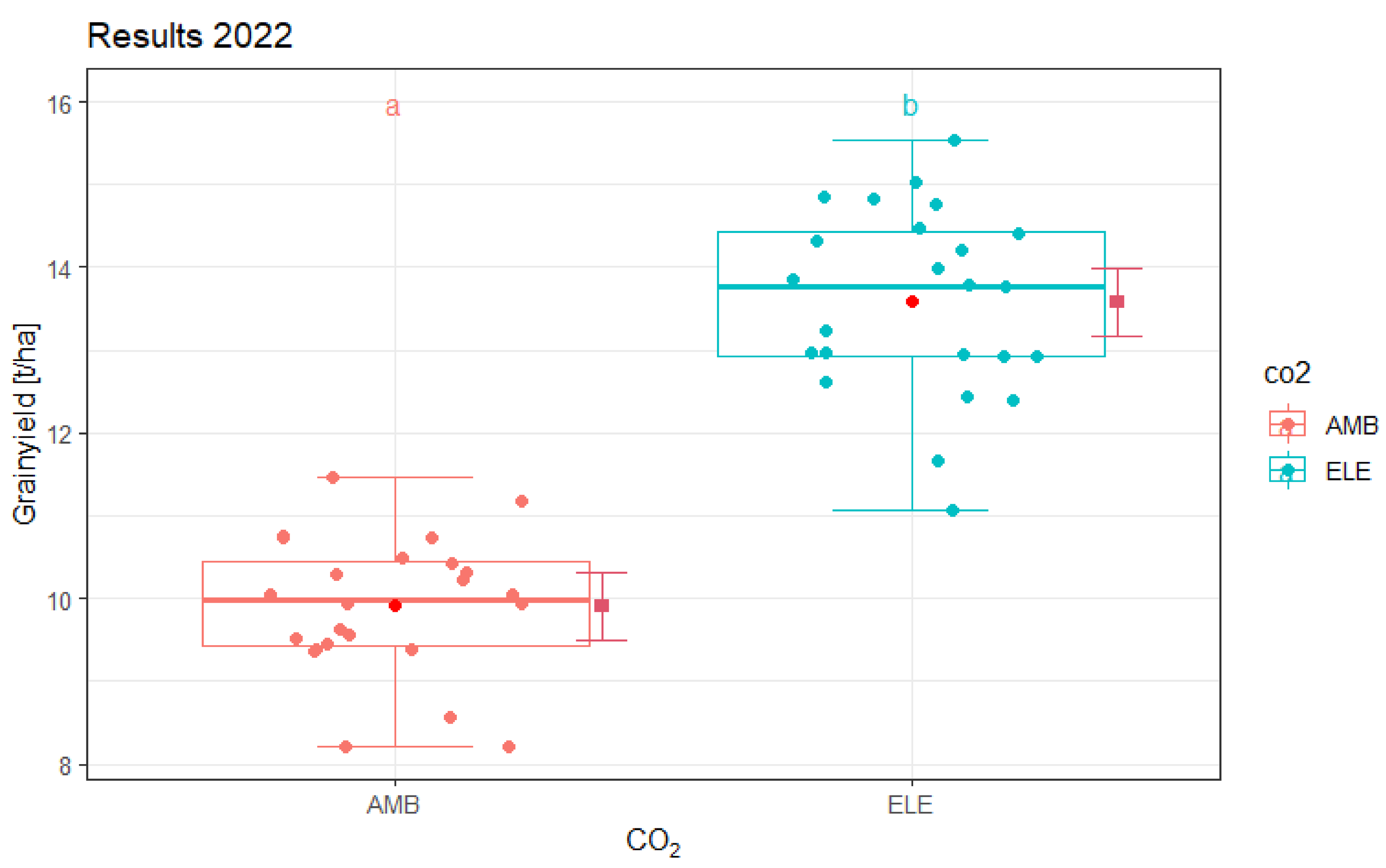

Fig.5.: Results of the harvest show a significant increase in yield for the varieties exposed to elevated concentrations. Groups with the same letter are not detectably different (Tukey-test, α=0,05).

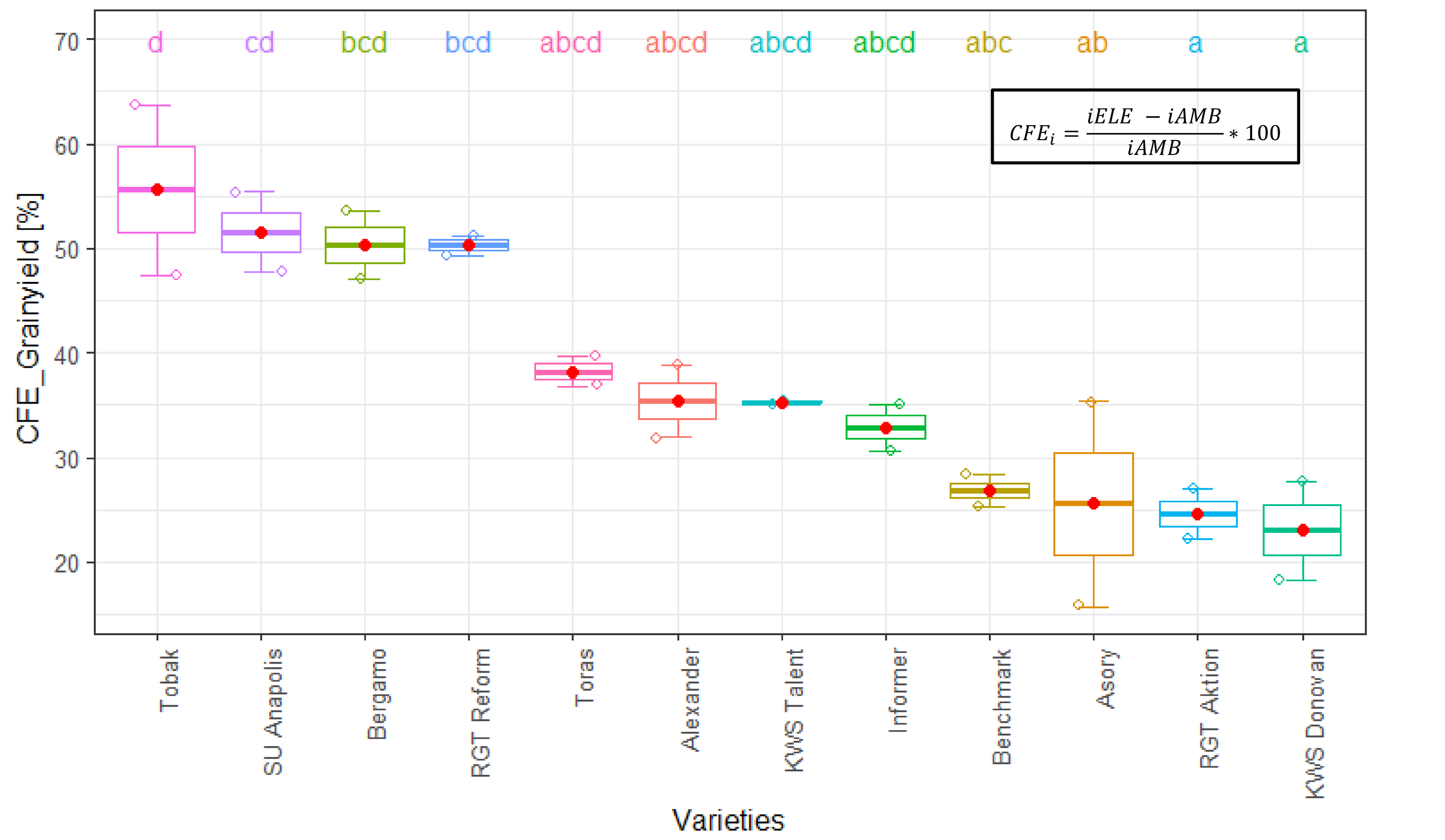

Fig.6.: The CO2-Fertilization effect (CFE) on grain yield could be observed for all genotypes and differs strongly with the genotypes. Groups with the same letter are not detectably different (Tukey-test, α=0,05).

Conclusion & Outlook

In the 2022 trial, the first interesting data and results were collected. Thus, the CFE (grain yield) could be observed for the tested varieties at 600 ppm CO_2. The fluctuations of the CFE between the varieties need further investigation. It could be shown that the varieties react differently and adapt morphologically and physiologically to the increased concentrations.

In 2023 and 2024 we will perform further field trials with new genotypes which will also feature the inoculation of plots with leaf rust and fusarium. Inoculation and sampling of pathogens will be performed by institute RS and A. At PB, we will focus on the CFE and how it differs with the varieties. We want to address the question if the adaption to e[CO_2] lead to changes in quality and yield of the wheat varieties and which of these adaptations may alter the infestation with leaf rust or fusarium.

https://doi.org/10.5073/20221019-083724

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