PROJECT TITLE

Optimizing Drought Stress Simulation to Enhance Greenhouse-to-Field Transferability in Barley Breeding

CONSORTIUM

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SUMMARY OF THE REPORT

Drought stress is a major constraint to barley production under changing climate conditions. A key challenge in drought research is transferring results from controlled greenhouse experiments to natural field environments, as greenhouse trials often only partially capture the environmental complexity relevant for genotype selection. Assumedly, adjusting watering regimes multiple times during plant development may improve the predictive value of greenhouse experiments and support more reliable early-generation selection for drought resilience.

To test this hypothesis, sixteen diverse barley genotypes, including wild barley introgression lines and elite cultivars, were evaluated under eight watering treatments using a high-throughput, automated phenotyping platform (APPP-B for medium-sized plants at IPK Gatersleben). The treatments differed in terms of the amount of watering and the timing (Figure 1).

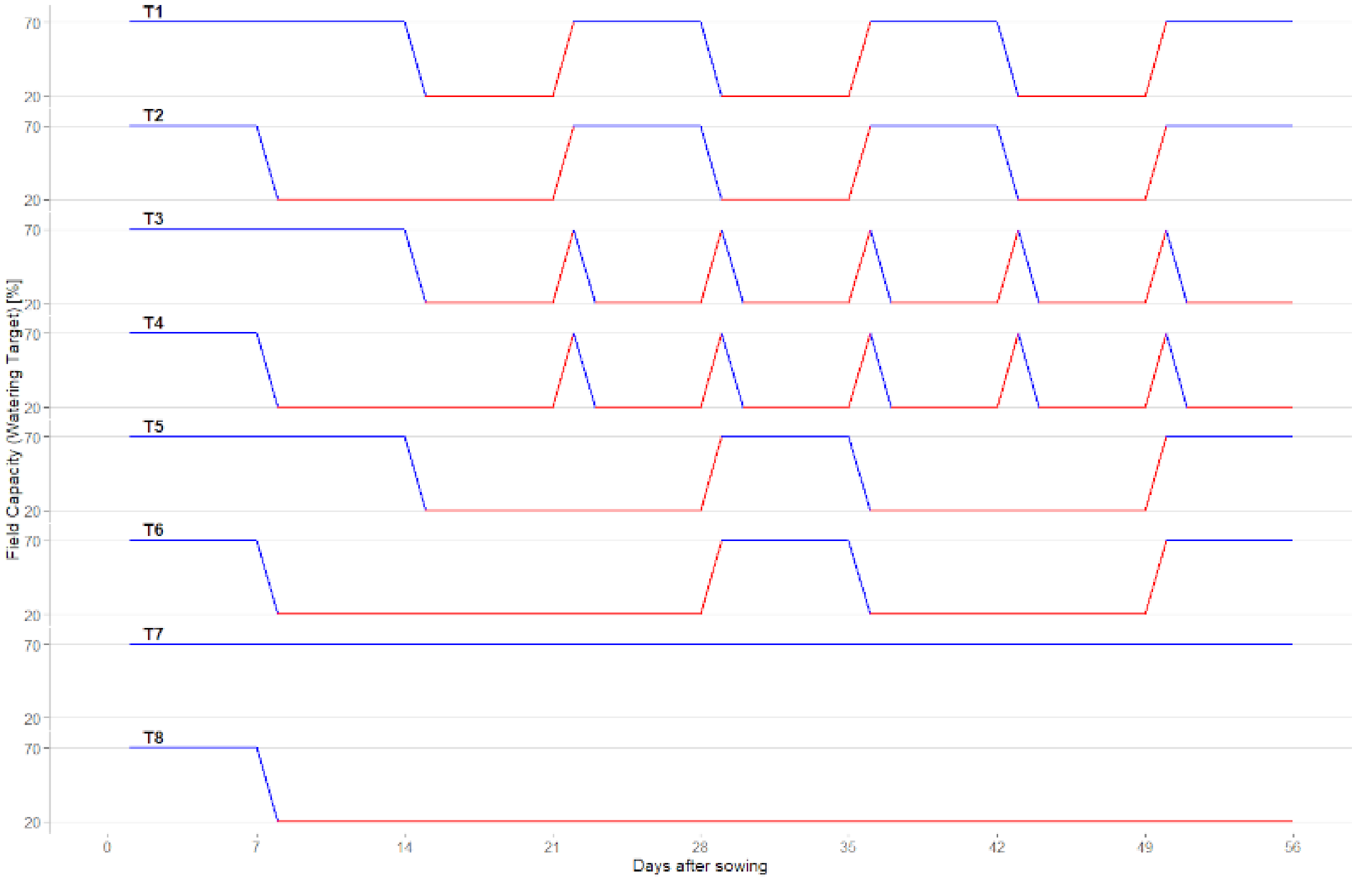

Figure 1. The different treatments applied. This figure illustrates the eight different treatments and their watering targets based on field capacity (FC). Each horizontal line represents the watering target per treatment during specific time intervals. Blue and red color indicates watering and drought phases, respectively.

Alternating watering treatments, mimicking natural conditions, promoted tillering but reduced ear fertility, harvest index, and yield, compared to constant stress or well-watered conditions. However, in general, the correlations between the alternating watering treatments and field data were higher than those between the constant conditions and field data. The highest comparability with field drought data was observed for a treatment that alternated weekly between watering and drought phases (T2), although this depended on the target environment (Figure 2).

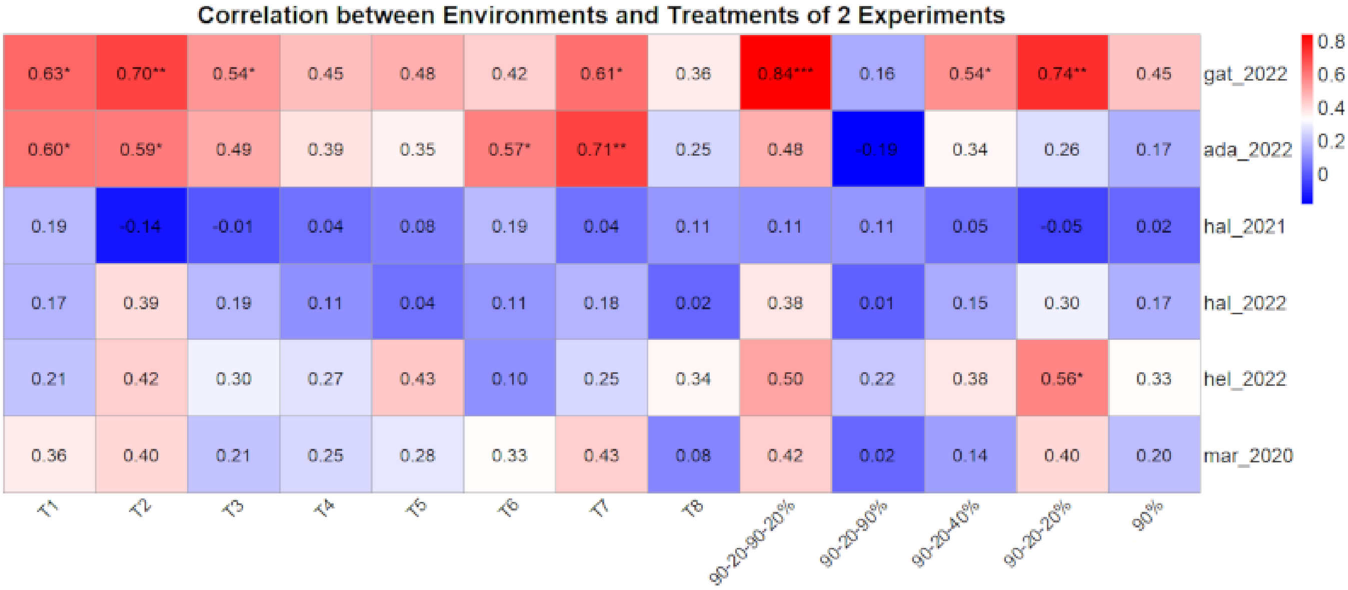

Figure 2. Pearson's correlation coefficients between fertile ear weight for 13 different watering treatments and grain yield for six field experiments, calculated across 14 shared wild barley introgression lines. Correlation strength is represented by color intensity (blue = negative, red = positive), with significance levels indicated by asterisks ($p < 0.05$ = *, $p < 0.01$ = **, $p < 0.001$ = ***).

Overall, the design of the watering regime strongly influences the reliability of greenhouse drought simulations and the choice of the right design is key for the transferability to field performance. Several genotypes demonstrated stable yields across drought scenarios and field conditions, suggesting drought resilience. Therefore, optimised drought treatments are essential for improving the transferability of results from the greenhouse to the field, enabling the early selection of advanced genotypes that can adapt to changing precipitation patterns in agriculture.

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