GWAS of Barley Phenotypes Established Under Future Climate Conditions of Elevated Temperature, CO2, O3 and Elevated Temperature and CO2 Combined

Ingvordsen, Cathrine Heinz; Backes, G.; Lyngkjær, M. F.; Peltonen-Sainio, P.; Jensen, J. D.; Jalli, M.; Jahoor, A.; Rasmussen, M.; Mikkelsen, Teis Nørgaard; Stockmarr, Anders; Jørgensen, R. B.

Published in:
Procedia Environmental Sciences

Link to article, DOI:
10.1016/j.proenv.2015.07.241

Publication date:
2015

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
GWAS of barley phenotypes established under future climate conditions of elevated temperature, CO₂, O₃ and elevated temperature and CO₂ combined


*Technical University of Denmark, Frederiksborgvej 399, 4000 Roskilde, Denmark
bUniversity of Kassel, Nordbahnhofstr. 1a, 37213 Witzenhausen, Germany,
cUniversity of Copenhagen, Thorvaldsensvej 40 1871 Frederiksberg, Denmark
dMTT Agrifood Research Finland Plant Production Jokionen 31600, Finland
eNordic Seed A/S, Kornmarken 1, 8464 Galten, Denmark
fNordic Genetic Resource Centre, Smedievägen 3, 230 53 Alnarp, Sweden

Abstract

Climate change is likely to decrease crop yields worldwide. Developing climate resilient cultivars is one way to combat this production scarcity, however, little is known of crop response to future climate conditions and in particular the variability within crops.

In Scandinavia, barley is widely cultivated, but yields have stagnated since the start of this century. In this study we cultivated 138 spring barley accessions in a climate phytotron under four treatments mimicking forecasted levels of temperature, carbon dioxide concentration ([CO₂]) and ozone ([O₃]) at the end of the 21st century. The ambient control had 19/12°C (day/night) and [CO₂] at 385 ppm. Three single-factor treatments had elevated temperature +5°C day/night, [CO₂] at 700 ppm or [O₃] at 120 ppb, and in a two-factor treatment the combination of elevated temperature and [CO₂] was applied.

Treatment effects were assessed on grain yield, grain protein concentration, grain protein harvested, number of grains, number of ears, aboveground vegetative biomass and harvest index. In addition, stability of the production was calculated over the applied treatments for the assessed parameters.

In the climate scenario of elevated temperature and [CO₂] the grain yield of barley decreased 29% and harvested grain protein declined 22%. Vast variation was identified among the individual barley accessions, which should be exploited by plant breeders in the development of climate resilient cultivars.

A genome-wide association study (GWAS) of recorded phenotypes and 3967 SNP-markers identified 60 marker-trait associations (-log₁₀p>2.95). Markers were found associated with grain yield under all three single factor treatments temperature, [CO₂] and [O₃], as well as with stability over treatments.
To our knowledge, this is the first study that evaluates numerous barley accessions under future climate conditions and identifies candidate markers for abiotic stress tolerance - markers that could be used in the development of cultivars to secure future primary production.

© 2015 The Authors. Published by Elsevier B.V. Peer-review under responsibility of the organizing committee of the Agriculture and Climate Change - Adapting Crops to Increased Uncertainty (AGRI 2015).

Keywords: Breeding; climate change; combined treatment; Hordeum vulgare; production parameters, SNP markers

References
