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Total number of authors:
11

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

Available online at www.sciencedirect.com

ScienceDirect

Procedia Environmental Sciences 29 (2015) 164 – 165

Procedia Environmental Sciences

Agriculture and Climate Change - Adapting Crops to Increased Uncertainty (AGRI 2015)

GWAS of barley phenotypes established under future climate conditions of elevated temperature, CO_2, O_3 and elevated temperature and CO_2 combined

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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 ($[CO_2]$) and ozone ($[O_3]$) at the end of the 21st century[1]. The ambient control had 19/12°C (day/night) and $[CO_2]$ at 385 ppm. Three single-factor treatments had elevated temperature +5°C day/night, $[CO_2]$ at 700 ppm or $[O_3]$ at 120 ppb, and in a two-factor treatment the combination of elevated temperature and $[CO_2]$ 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 $[CO_2]$ 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 ($-\log_p > 2.95$)[2]. Markers were found associated with grain yield under all three single factor treatments temperature, $[CO_2]$ and $[O_3]$, as well as with stability over treatments.

Peer-review under responsibility of the organizing committee of the Agriculture and Climate Change - Adapting Crops to Increased Uncertainty (AGRI 2015)
doi:10.1016/j.proenv.2015.07.241

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.

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

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