A 10-day heatwave at flowering superimposed on climate change conditions strongly affects production of 22 barley accessions

Ingvordsen, Cathrine Heinz; Lyngkjær, Michael F.; Peltonen-Sainio, Pirjo; Mikkelsen, Teis Nørgaard; Stockmarr, Anders; Bagger Jørgensen, Rikke

Publication date:
2015

Citation (APA):
Ingvordsen, C. H., Lyngkjær, M. F., Peltonen-Sainio, P., Mikkelsen, T. N., Stockmarr, A., & Bagger Jørgensen, R. (2015). A 10-day heatwave at flowering superimposed on climate change conditions strongly affects production of 22 barley accessions. Poster session presented at Agriculture and Climate Change: Adapting Crops to Increased Uncertainty, Amsterdam, Netherlands.

DTU Chemical Engineering
Department of Chemical and Biochemical Engineering

A 10-days heatwave at flowering superimposed on climate change conditions strongly affects production of 22 barley accessions

CH Ingvordsen[1], MF Lyngkjær[2], P Peltonen-Sainio[3], TN. Mikkelsen[1], A Stockmarr and RB Jørgensen[1]
[1]Technical University of Denmark, Denmark.[2]University of Copenhagen, Denmark.[3]MTT Agrifood Research Finland, Finland

INTRODUCTION Extreme climate events are projected to be among the future most challenging constraints to plant development. Heatwaves as well as floods and droughts cause acute changes in the growth environment determining our primary production (Collins et al., 2013). Europe experienced extreme heatwaves in 2003 and 2006. In 2003, a 21 % decrease in the French wheat production was found from temperatures up to 6 °C above long-term means and precipitation being less than 50 % of the average (Ciais et al., 2005). One strategy to mitigate the this decrease from heatwaves is to identify resilient cultivars and incorporate them in breeding programs.

EXPERIMENT Four basic treatments with projected levels of temperature and [CO_2] as might be expected at the end of this century (~RCP8.5; IPCC, 2013) was applied as single factors or in combination throughout the growing period (Fig. 1). At the time of flowering a 10 day-heatwave of 33/28 °C (day/night) was superimposed on the treatments (Fig. 1).
At maturity plants were harvested and threshed individually and grain, vegetative biomass, harvest index (HI) and grain yield per ear were determined.

RESULTS The applied heatwave decreased grain yield with the strongest decrease in the treatment with elevated [CO_2] (43 %; Fig. 2). However, vast variation existed between accessions (Fig. 3). In the treatment of elevated temperature and [CO_2] combined, the superimposed heatwave decreased grain yield of accessions 2-80 %. The heatwave further changed allocation by increasing aboveground vegetative biomass. The most likely future climate scenario of elevated temperature and [CO_2] in combination and with the superimposed heatwave was found to decrease overall grain yield by 52 % compared to present day conditions.

CONCLUSION The identified variation in the set of barley accessions in response to multifactor climate treatments was high as such, however, the ability to cope with heatwaves and avoid severe yield losses of less than 29 % was not identified in the accessions included. In fact, these results emphasize the threat that temperature extremes exert to crop production systems.

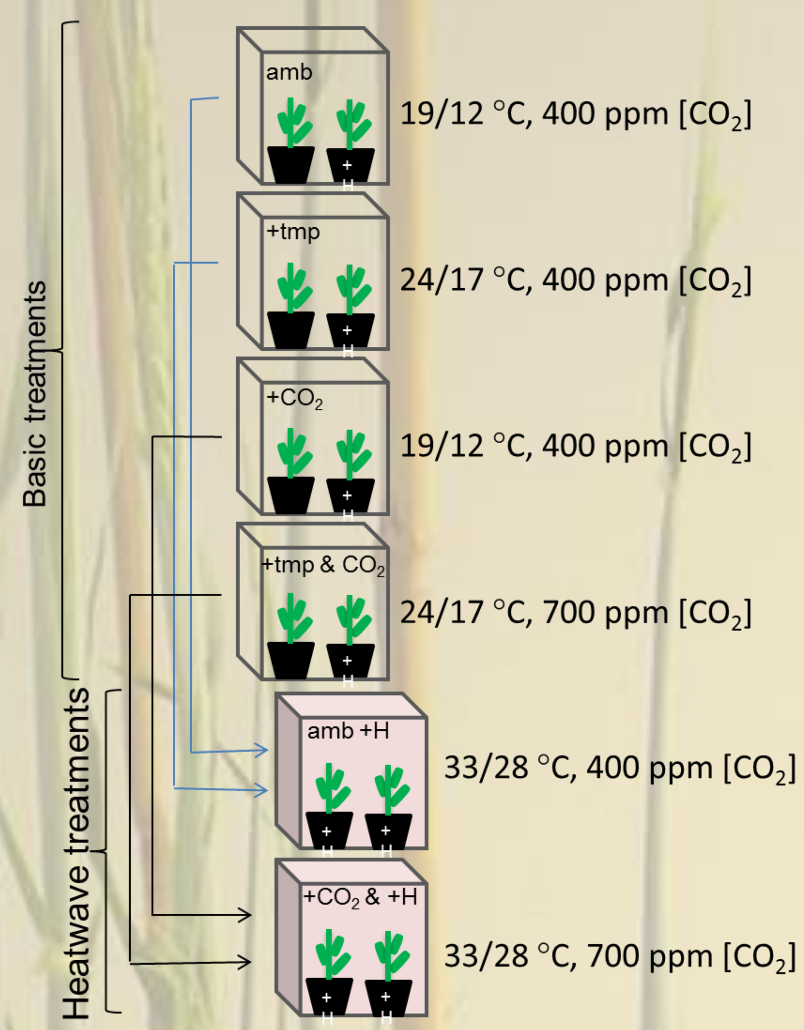

Fig. 1. Overview of the four basic treatments and the extreme heatwave treatments. For each accession half of the plants (8/16) were transferred from the basic treatment to the heatwave treatment at the appropriate developmental phase.

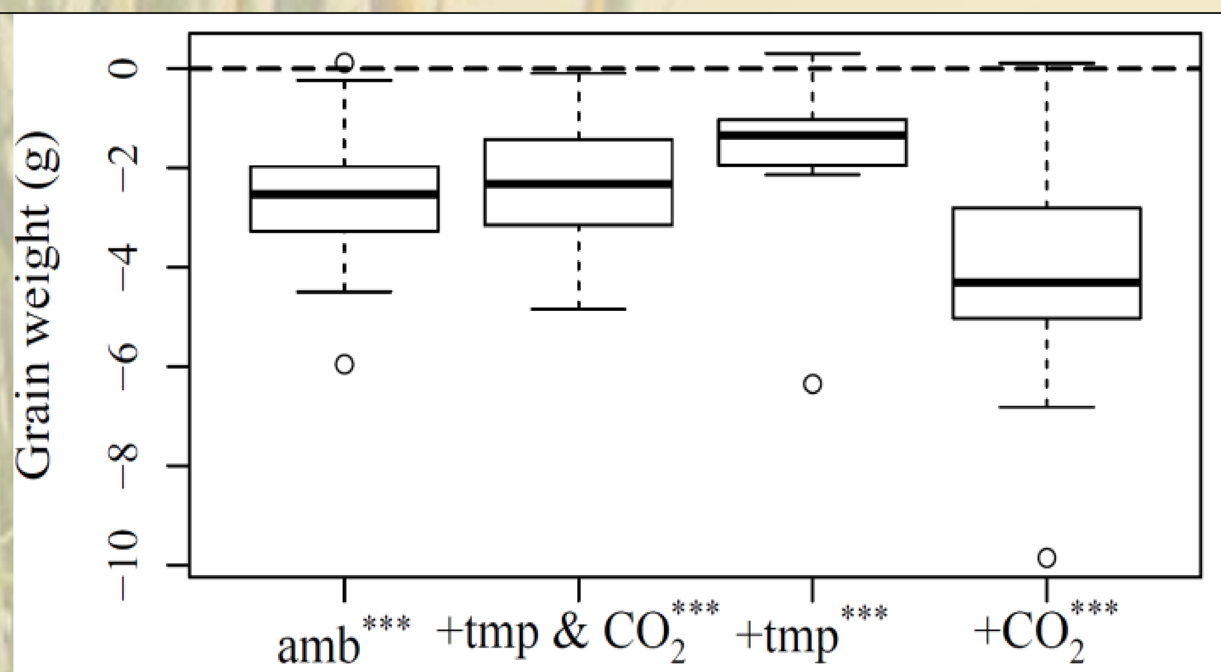

Fig. 2. Effects on grain yield of the heatwave superimposed on the four treatments, ambient (amb), elevated temperature and [CO_2] (+tmp & CO_2), elevated temperature (+tmp) and elevated [CO_2] (+CO_2). Dotted line is the production in the corresponding basic treatment (same treatment but no-heatwave). ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

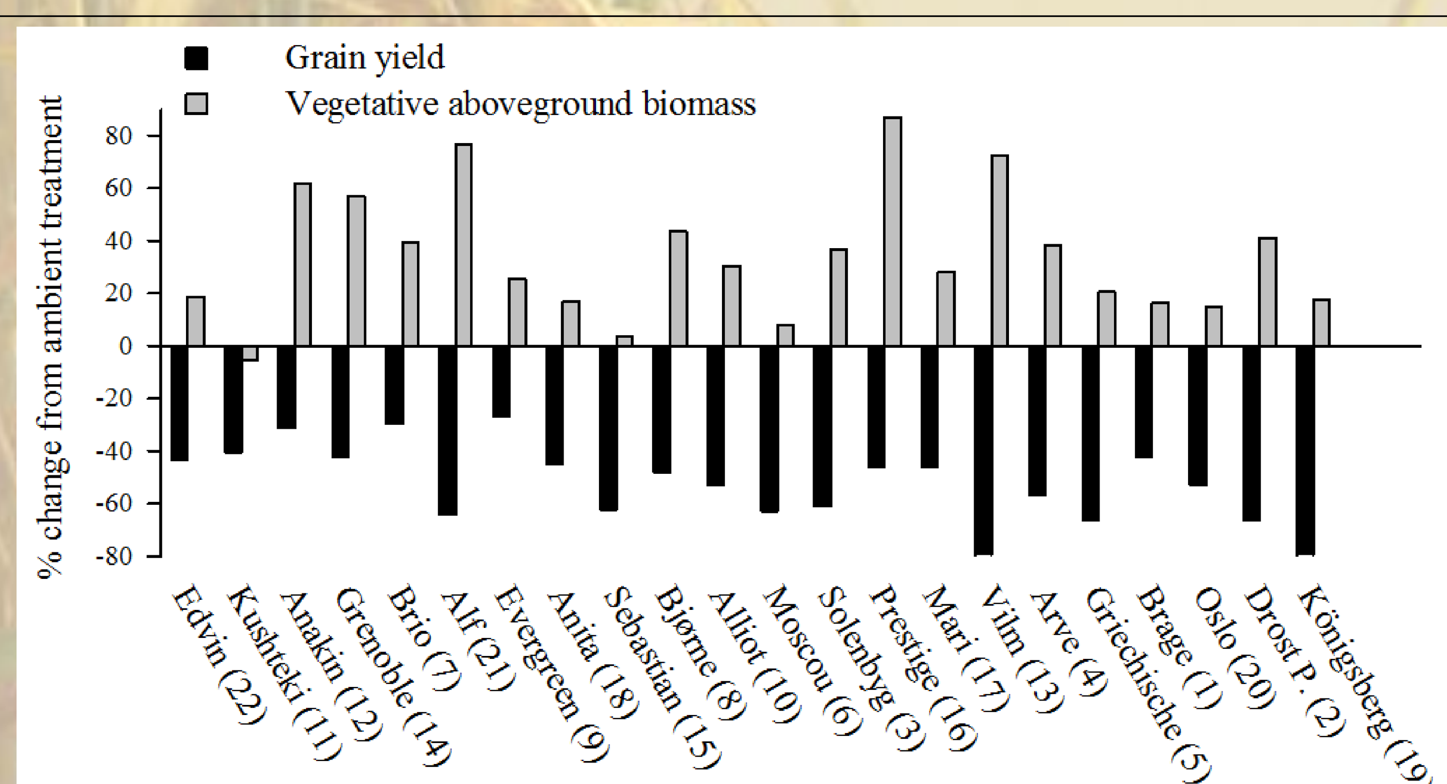

Fig. 3. Change (%) in production of the 22 barley accessions from a 10-day heatwave around flowering superimposed on the combined elevated temperature (+5 °C) and [CO_2] (+300 ppm). The values are given relative to ambient conditions with no heatwave exposure. In brackets is the rank for grain yield under basic ambient conditions.

Acknowledgements
COBRA (Core Organic II) and NordForsk ('Sustainable primary production in a changing climate')

References
Ciais P et al. 2005. Nature 437, 529–33.
Collins M et al. 2013. WG1, AR5, IPCC.
Bencze S et al. 2004. Cereal Res Commun 32, 75–82.

Contact
Rikke B. Jørgensen
rijq@kt.dtu.dk
Senior Scientist, ECO,
Technical University of Denmark