How a 10-day heatwave impacts barley grain yield when superimposed onto future levels of temperature and CO2 as single and combined factors

Heatwaves pose a threat to crop production and are predicted to increase in frequency, length and intensity as a consequence of global warming. Future heatwaves will occur in addition to the ongoing increase of mean temperature and CO2. To test effects of heatwaves superimposed to future climate scenarios, 22 barley accessions were cultivated with elevated temperature (+5 °C) and CO2 (700 ppm) as single factors and in combination. The control treatment mimicked ambient Scandinavian early summer conditions (19/12 °C, day/night; 400 ppm CO2). Around flowering a 10-day heatwave of 33/28 °C (day/night) was superimposed to all treatments. The lowest average grain yield was observed when the heatwave was superimposed onto the combined elevated temperature and CO2 treatment. Here the yield decreased by 42% compared to no heatwave and 52% compared to ambient conditions. When the heatwave was superimposed onto ambient conditions the average grain yield decreased by 37% compared to no heatwave. There was no significant difference between the relative grain yield decrease caused by the heatwave in the ambient and future climate scenarios. In contrast, the vegetative aboveground biomass increased upon heatwave exposure, leading to a strong decline in the harvest index. Our results strongly emphasize the need to produce heatwave resilient cultivars.