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A field experiment to test interactive effects of elevated CO_2 concentration (FACE) and elevated canopy temperature (FATE) on wheat

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Abstract

Among the parameters of global climate change the increases of the atmospheric CO_2 concentration and of temperature, both of which affect plant growth and development, are of prime importance. However, with respect to the importance of these climate changes for global food security little is known on the possible interactions of these prominent changes on crop growth. This is holds also true for anticipated increases in mean temperatures as well as for short-term high temperature events (i.e. heat stress). Form previous studies it is known that wheat is particularly sensitive to temperatures of 30°C and above during the anthesis and early grain filling. Short-term heat stress may decrease yield by impairing grain set. Higher average temperatures during grain filling may influence yield by reducing grain filling duration. If and to what extend elevated CO_2 may affect crop responses to heat stresses remains a matter of debate, particularly because of a lack of suitable experiments. While there are a few model projections addressing the interactive impacts of these climate change elements on crops, these models nearly exclusively rely on data from non-field experiments. At the Thünen-Institute of Biodiversity (Braunschweig, Germany) for the first time field experiments with winter wheat were conducted, in which elevated canopy temperature treatments (free-air temperature enrichment = FATE) were applied to the plants in 2013 and combined with free-air CO_2 enrichment (FACE, 600 µmol mol^{-1}) in 2014 and 2015. The temperature treatments comprised 1.) at anthesis a short-term heat stress treatment (5 or 12 h d^{-1} for 5 days, maximum increase up to +6°C) and 2.) during grain filling a long-term increase (24h d^{-1} for 28 days, average increase up to

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+3°C). Here we present details of the experimental set-up, the system performance and among others results of heat stress effects at anthesis on yield components.

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Keywords: Winter Wheat; Grain Filling; Anthesis; Grain Number; Thousand Kernel Weight; Carbon Dioxide; Heat Stress; Temperature Increase; Climate Change; Experimental Technique