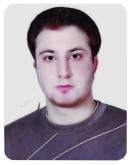

Effects of high temperature and drought stress around anthesis on wheat

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Background and Methodology

Introduction

- Crop yields are very sensitive to heat and drought, little is known on the combined impact of these stressors.
- Here we investigate individual and combined effects of heat and drought on different wheat cultivars.

Material and methods

- Pot experiment with four replications and four treatments: control (C), heat (H), drought (D) and heat and drought combined (H+D),
- One winter wheat cultivar (Batis) and two spring wheat cultivars (Kohdasht and Scirocco) were grown in years 2014 and 2015,
- Drought was imposed ten days before the expected begin of flowering (Figure 1).

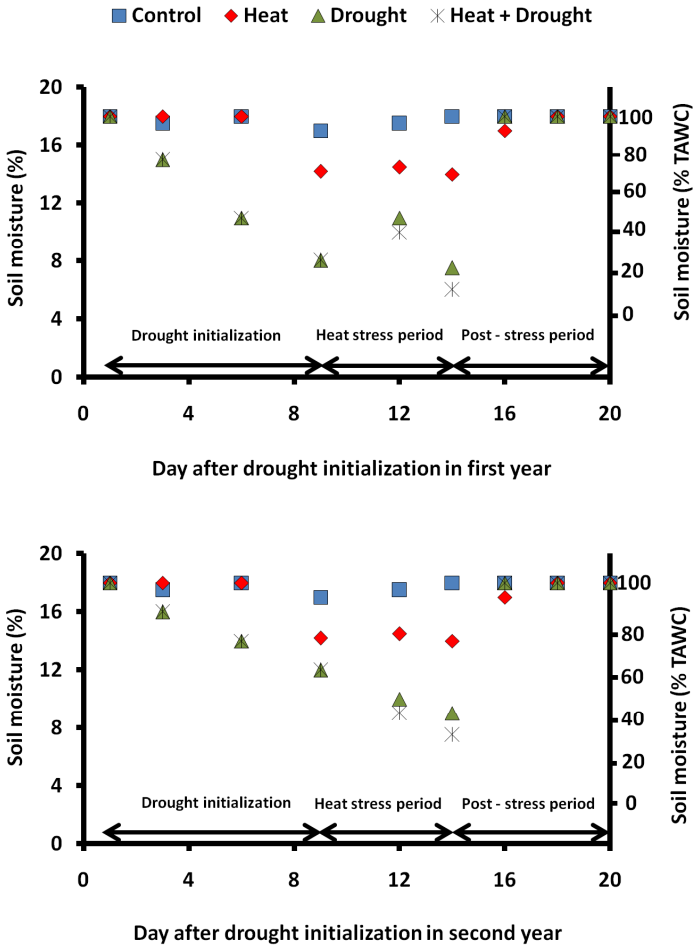

Figure 1. *Soil moisture content (Vol %; % of plant available water capacity) during the drought treatment, the heat treatment, and the post-stress period calculated as the mean of the pots planted with the three cultivars (TAWC: total available water capacity). Drought stress in year 2014 was more severe because of higher air temperature in the drought initialization period.*

- When begin of flowering was observed, heat was imposed to H and H+D,
- Heating period was five days, total stress thermal time STT (accumulated temperature sum above 31 ˚C) of 12000 °C min,
- At maturity, grain number per main stem, single grain weight and grain yield were measured after manually harvesting the plants.

Results

Effect of heat and drought on yield components

- Single grain weight was significantly lower for D (13-27% in 2014, 11-34% in 2015) and H+D treatments (43-83% in 2014, 27-41% in 2015).
- Heat stress significantly decreased grain number by 14–28% in 2014 and 10–22% in 2015 (Figure 2).
- Grain yield reduced significantly for all treatments and both years (Table 1).

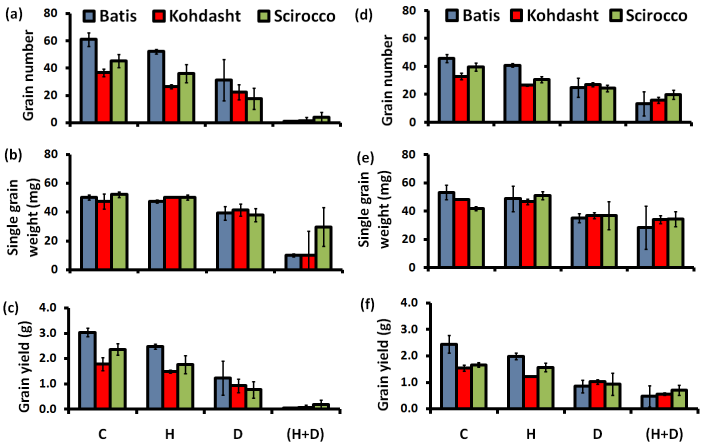

Figure 2. *Effects of heat, drought, and combined stressors on grain number, single grain weight and grain yield. Data are shown for year 2014 (a, b, c) and 2015 (d, e, f).*

Table 1. *Significance of differences in grain number, single grain weight, and grain yield for cultivars (CU), heat stress around anthesis (H), drought (D), combined heat and drought (H+D) as well as interactions between cultivars and the stressors tested for both years by an analysis of variance.*

Source of variation	First year			Second year		
	Grain number	Single grain weight (mg)	Grain yield (g)	Grain number	Single grain weight (mg)	Grain yield (g)
CU	ns	ns	ns	***	ns	*
H	***	ns	***	***	ns	**
D	***	***	***	***	***	***
H+D	***	***	***	***	***	***
CU×H	ns	ns	ns	ns	*	ns
CU×D	*	ns	*	***	ns	***
CU×(H+D)	***	*	***	***	***	***

non-significant. ***,**, * significant at P ≤ 0.001, 0.01 and 0.05, respectively)

- Drought caused earlier senescence of leaves in D and H+D treatments, therefore detrimental effects on growth and yield traits were stronger than in H treatment (Figure 3).

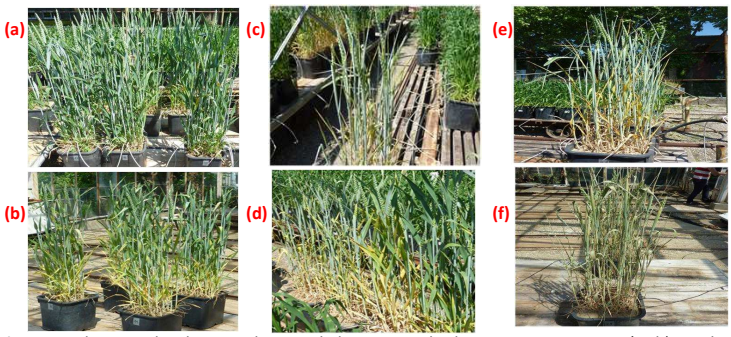

Figure 3. *Photographs showing the pots belonging to the heat stress treatment (a, b), to the drought stress treatment (c, d), and to the combined heat + drought treatment (e, f) before the application of the stress (a, c, e) and immediately after the heat stress period (b, d, f).*

Sensitivity of cultivars to heat and drought

- Differences of the cultivars in their sensitivity to heat and drought were mainly found for the combined H+D treatment (Figure 2, Table 1).

Conclusion

- Heat and drought stress affect different processes and sink-source relationships resulting in distinct impacts on yield components.
- Combined heat and drought affected yield components stronger than individual stresses, cultivar effects were mainly detected for combined H+D treatment.

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