Evaluating boron efficiency associated with heat tolerance in spring wheat

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Introduction

Spring wheat covers about 80 m ha cultivated area in developing countries and produced in six meg-environments (ME1-ME6) including irrigated temperate, high rainfall, acid soils, low rainfall, high temperature and high latitude (Rehman and Reynolds 2021).
Spring wheat experiences terminal heat stress (> 25°C) during reproductive period that disrupt physiological processes, for instance, anthesis induced restricted embryo development reduces pollen viability, increased anther sterility produce less grain numbers and shortened growth cycle causes reduced grain yields (Rehman et al. 2021). Boron (B) efficient genotypes have capacity to transport B from the roots to the developing anthers and pollen in the growing spike and grain setting than B-inefficient genotypes. And the genotypic variation exists in wheat germplasm both for B efficiency and heat tolerance simultaneously (Rerkasem et al. 2004).

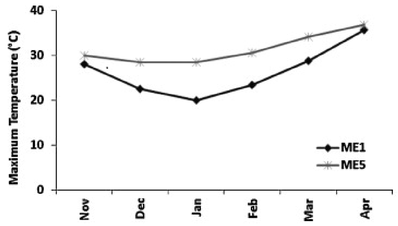


Figure: Maximum and minimum temperatures in the mega environments (ME) during wheat growing season

The present study compared performance of wheat cultivars (Bhakkar Star-19, Galaxy-13, AARI-11, Millet-11 and Jauhar-16) with Fang-60 a B-efficient and heat tolerant check under optimal and deficient B soil condition and terminal heat stress (±5°C) started from booting stage until maturity. The study will provide foundation to determine the variation among wheat genotypes for morpho-physiological basis to boron use efficiency against terminal heat stress.

Methods

Experimental treatments and details

Experiment 1: Ten seed of each wheat cultivars Fang-60 (Boron efficient), Bhakkar Star-19 (heat tolerant), Galaxy-13, AARI-11, Millet-11 and Jauhar-16 were sown in earthen filled pots with 3.5 kg soil optimum in B (2.80 mg/kg) and irrigated with distilled water to attain field capacity before sowing. The urea for N, SSP for P and SOP for K were applied following wheat recommendation. The pots were divided into two sets i.e. one kept under open wire house and other for heat stress (±5°C) from booting stage until maturity.

Experiment 2: The wheat cultivar used in the study were selected from Exp 1 based on seed yield Jauhar-16 and Galaxy-13 and Fang-60 (Boron efficient). Two sets of genotypes were grown with (+B) and without boron (-B), and one set of each was shifted to glass house after booting stage for terminal heat stress, while remaining two sets of genotypes kept under ambient condition. While all practices were kept as for Exp 1.

Phenotyping

❖ Phenotyping for canopy temperature, cell membrane permeability, pollen viability, relative water contents, SPAD-chlorophyll and stem water soluble carbohydrates was performed during anthesis. Crop phenology was also determined and morphological traits at harvest maturity

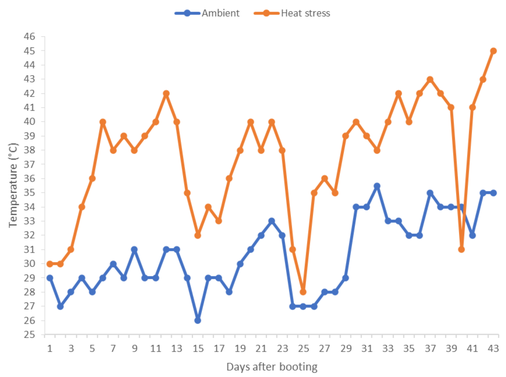
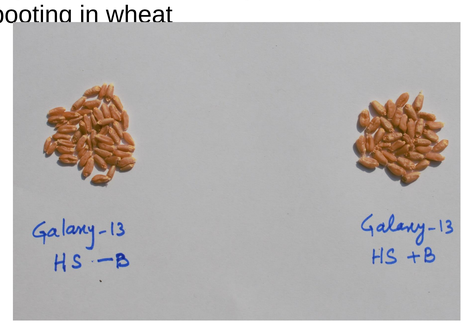
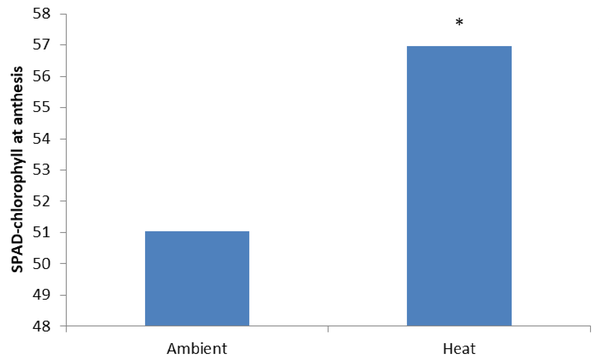


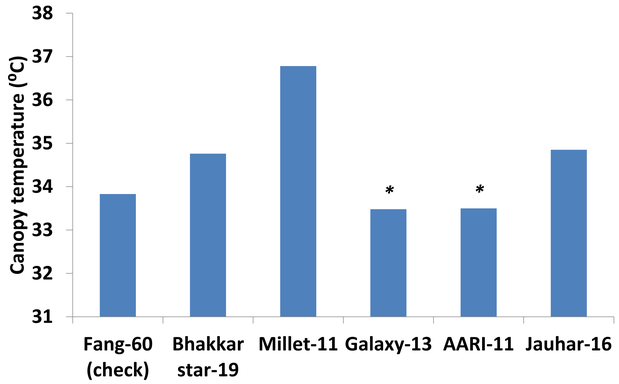
Figure: Ambient and high temperature after booting in wheat

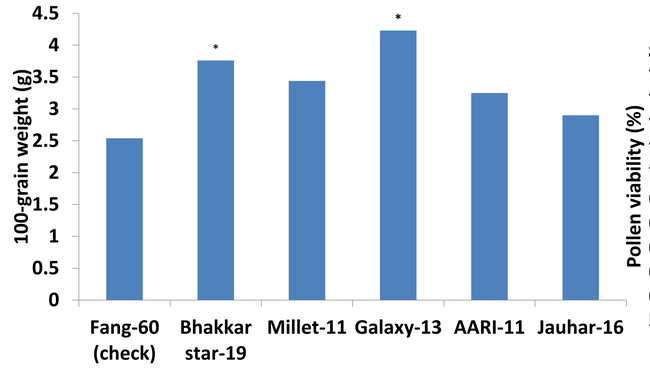


Results

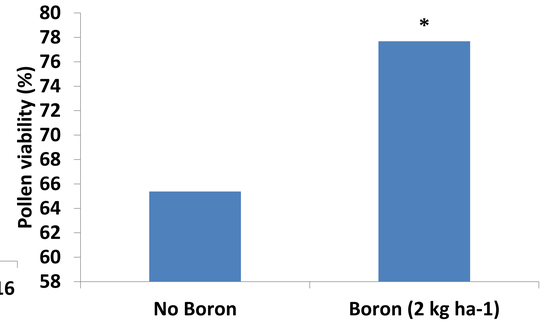
Experiment 1:

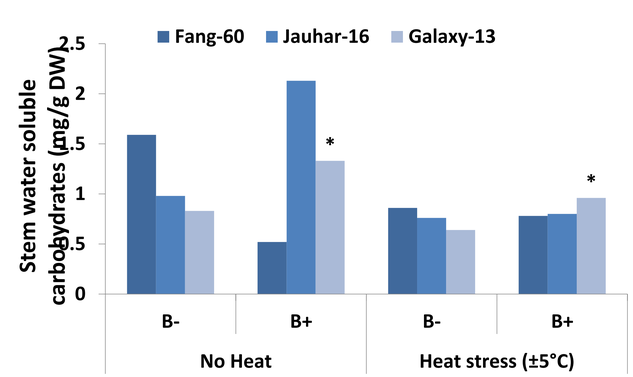


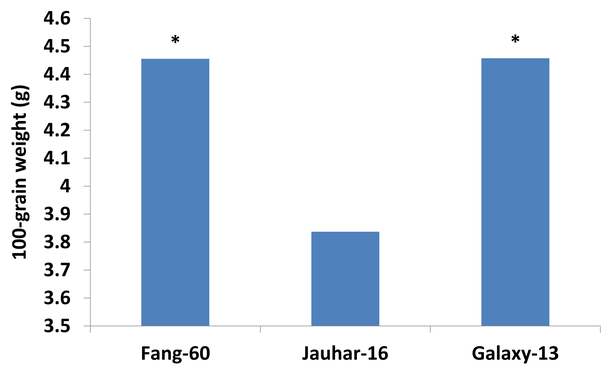




Experiment 2:







Conclusions

- ❖ Heat stress reduced plant dry biomass (20%) and spike length, spikelets and grain numbers (13.57%) that improved with +B respectively. Among genotypes increased grain numbers for Jauhar-11 (11%) and Galaxy-13 (7%) compared to Fang-60.
- ❖ Heat stress reduced 100-grain weight which improved (3%) by +B, among genotypes, Galaxy-13 produced similar 100-seed yield to Fang-13.
- ❖ High grain yield in Galaxy-13 was associated with reduced canopy temperature during anthesis and grain filling, highest SPAD-chlorophyll contents under +B and heat stress compared to –B condition during grain filling but less than Fang-60. Among genotypes Jauhar-16 expressed more pollen viability (2.7%) while Galaxy-13 expressed highest (24%) stem water soluble carbohydrates compared to Fang-60 with +B under heat stress.
- ❖ Galaxy-13 as heat tolerant and B-efficient genotype can be used for further evaluation of spring wheat for B efficiency and heat tolerance.

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