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Original Research Article

Evaluation of Wheat (*Triticum aestivum* L.) Varieties for Heat Tolerance at Grain Growth Stage by Physio-Molecular Approaches

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Keywords

Heat stress, MSI, CSI, CTD, Molecular marker, Tolerance and Wheat

A B S T R A C T

An experiment was conducted with six wheat varieties K 911, PBW 343, Raj 3765, K 9006, AAU 11 and HD 2733 for evaluation for heat tolerance at grain growth stage. Heat treatment was given by delayed sowing of 60 days from normal date (15 November) so that wheat varieties could experience severs heat stress (37-39^{oC}) at reproductive stage. Agronomic practices were followed as per recommendation for wheat crops. Wheat varieties were screened on the basis of membrane stability index (MSI), chlorophyll stability index (CSI) and canopy temperature depression (CTD) at grain growth stage. K 911, Raj 3765 and AAU 11 had high MSI, CSI, and CTD and also showed less percent reduction in yield and yield components over PBW 343, K 9006 and HD 2733. Fifteen RAPD markers were tested for genetic variability for heat tolerance. Out of fifteen markers only three molecular markers showed variation for heat tolerance. Therefore, MSI, CSI and CTD can be used as major criteria for heat tolerance in wheat.

Introduction

Wheat (*Triticum aestivum* L.) is the important crop of India. It is consists second position in both area and production after rice in India as well as world after china. The Northern and Western part of India has maximum area and production under wheat cultivation. There are number of constraints which affect the wheat production and decrease the nutritive value of the wheat. Now a day's heat stress in wheat is becoming major constrain in wheat at grain filling stage. Heat stress is often defined as the rise in temperature beyond a threshold level (26^{0}C) for a period of time sufficient to cause irreversible damage to plant growth and development. In general, a transient elevation in temperature, usually 10-15^{0}C ambient is considered heat stress. However heat stress is a complex function of intensity (temperature in degree) duration and rate of increase in temperature. According to a report of the Intergovernmental Panel on climatic change (IPCC) global mean temperature will rise 0.3^{0}C per decade (Jones *et al.*, 1999) reaching to approximately 1 and 3^{0}C above the present value by years 2025 and 2100, respectively and leading to global warming.

Grain development begins the process of double fertilization. It is perhaps superfluous to emphasize now important is that the process leading to the development of the male and female gametes and those ensuring the fusion of the gametes and the development of the embryo and endosperm should take place undisturbed the effects of various kinds of a biotic stress on those processes are different but in all cases negative and their influence always results in a decline in yield quantity (Mahajan and Tuteja, 2005). Heat stress disrupts water ion organic solute movement across cell membrane which interferes with Photosynthesis and respiration (Christiansen, 1978) Heat stress affects metabolic process and reduces length of life cycle which is strongly associated with total biomass production in hot environment (Reynold *et al.,* 2000).

The use of DNA markers for characterization and identification of genotypes is essential for the early detection of true inter and intra specific hybrids percentage of a cultivar and patent protection DNA markers not only allow the easy and reliable identification of clones (Devarumath *et al.,* 2002) breeding lines, hybrids (Bastia *et al.,* 2001) and cultivars but also facilitate the monitoring of Introgression and the assessment of genetic diversity and relatedness among germplasm (Milligan; 2003).

Materials and Methods

An experiment was conducted with six wheat varieties K 911, PBW 343, Raj 3765, K 9006, AAU 11 and HD 2733 for evaluation for heat tolerance at grain growth stage. Heat treatment was given by delayed sowing of 60 days from normal date (15 November) so that wheat varieties could experience severs heat stress (37-39^{oC}) at reproductive stage. Agronomic practices were followed as per recommendation for wheat crops. Membrane stability index was measured according to method of Sadalla *et al.,* 1990. Total chlorophyll content was measured by chlorophyll meter as SPAD value and chlorophyll stability index was calculated by the formula of chlorophyll content in heat stress / Chlorophyll in control x 100. Canopy temperature depression is recorded by infra-red thermometer of the canopy of each variety in three replication. DNA was isolated by CTAB method (Murray and Thompson, 1980). Five plants were randomly selected and their seeds collected at 12 % level and average out as grain yield per plant.

Results and Discussion

Wheat varieties have genetic variability for membrane stability index (Fig. 1). High me membrane stability was recorded in K 911, Raj 3765 and AAU 11 over other varieties.

Membrane stability is an indication of heat tolerance. Membrane cells and its organelles is made up of lipid and protein. Under Heat stress, membrane of cells is highly affected and reduced the the metabolic acivites and finally yield of the plant (Saadala *et al.,* 1990).

Chlorophyll stability index decrease under heat stress condition irrespective of wheat varieties (Fig. 2). High CSI was noted in Raj 3765, AAU 11, and K 911 while less in PBW 343 and K 9006. Heat stress at reproductive stage enhanced the senescence process.

Tolerance varieties stay long at reproductive stage due to high MSI and formation of HSPs. Stay green varieties produce photosynthates for longer duration and increase the yield (Wang *et al.,* 2008)

Fig.1 Effect of heat stress on membrane stability index (%) of the wheat varieties at reproductive stage

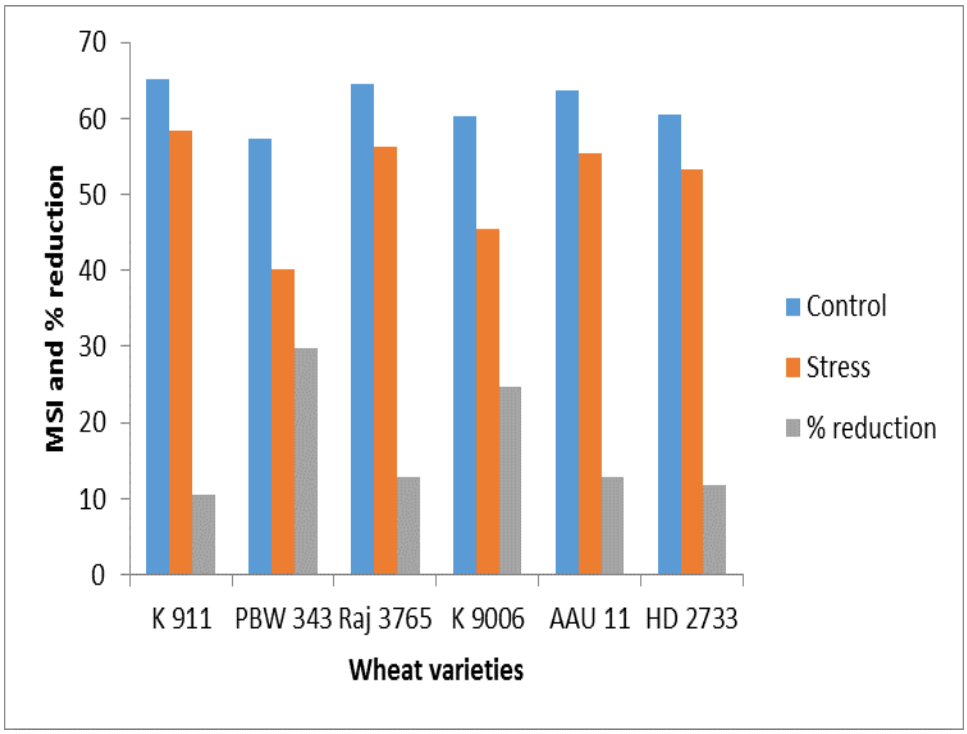

Fig.2 Effect of heat stress on chlorophyll stability Index (%) of the wheat varieties at reproductive stage

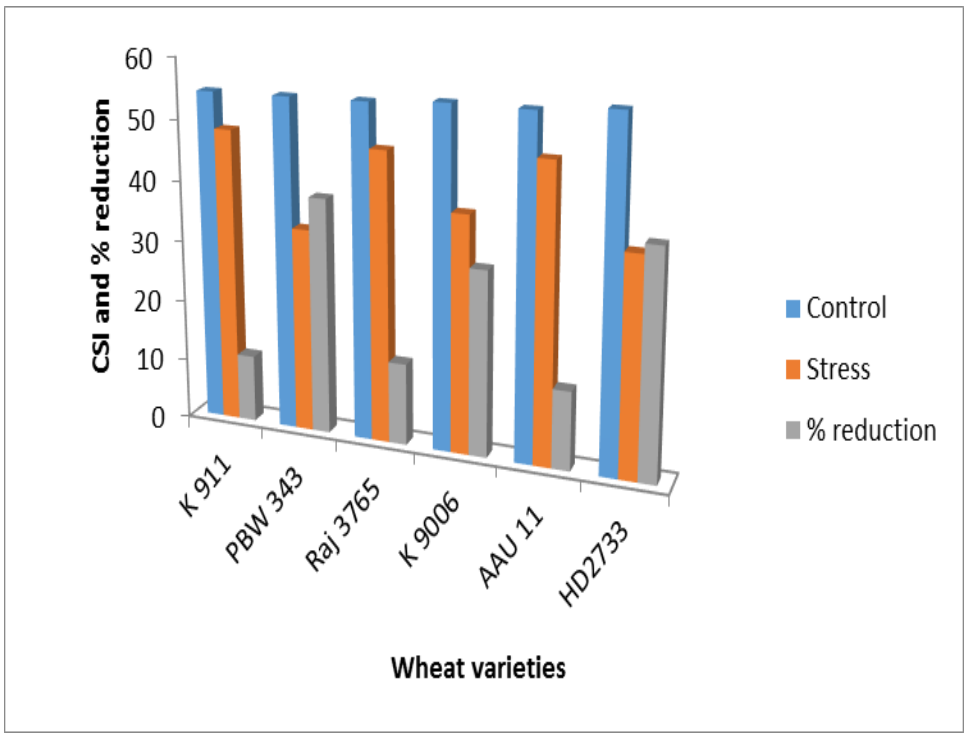

Fig.3 Effect of heat stress on canopy temperature depression (%) of the wheat varieties at reproductive stage

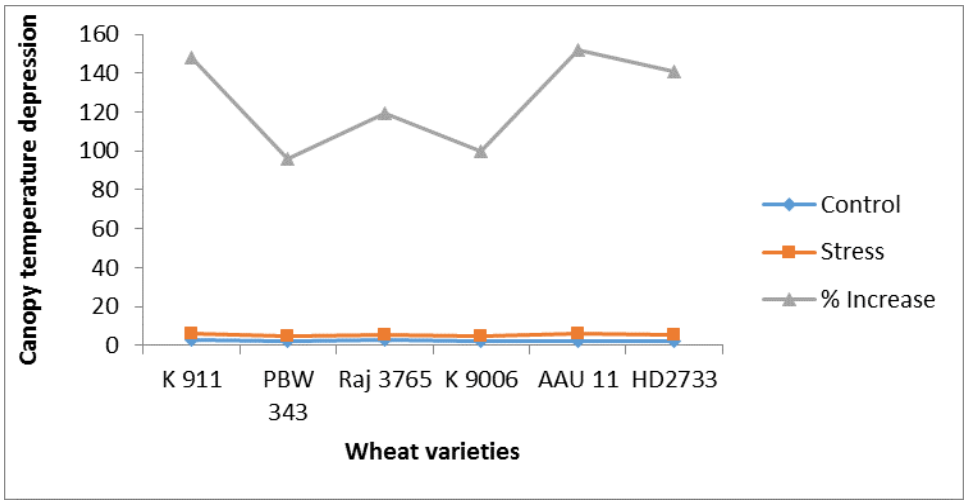

Fig.4 Effect of heat stress on gain yield (g) of the wheat varieties at reproductive stage

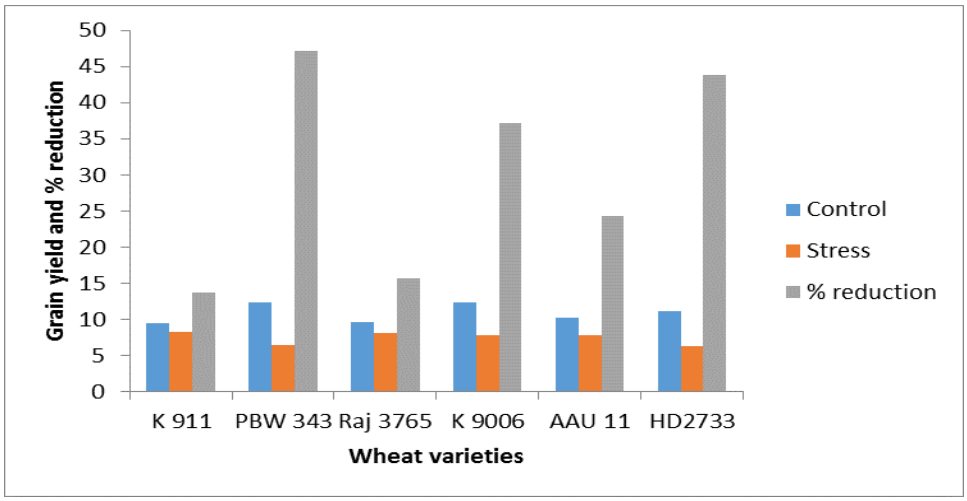

Fig.5 S 32 marker showed polymorphism for heat tolerance in wheat varieties

Canopy temperature of wheat varieties highly affected under reproductive stage heat stress condition (fig.3). High CTD was recorded in AAU 11, K 911 and Raj 3765 while less in PBW 343 and K 9006 under grain filling stage. High CTD make heat sensitive enzymes functional under heat stress regimes and less reduction in yield and yield components (Amani *et al.,* 1996).

Wheat varieties varied in grain yield under control and heat stress condition (fig. 4.). High grain under control condition was recorded in PBW 343, K 9006 and HD 2733 but these varieties also showed high yield reduction under heat stress condition in comparison to K 911, Raj 3765 and AAU 11.

Yield is resultant effects many cumulative metabolic activities. Stable grain attain due high MSI, CSI, stay green duration and CTD under heat stress condition (Ruwali and Bhawsar, 1998).

Wheat varieties showed variability for RAPD markers linked to MSI (fig.5). S32 and S 127 markers showed polymorphism for heat tolerance in wheat varieties (Lin *et al.,* (2006; Malik *et al.,* 2000).

Wheat varieties K 911, Raj 3765 and AAU 11 had high MSI, CSI and CTD showed stability in yield under heat stress.

Even PBW 343, K 9006 and HD 2733 had more yield in control condition but highly sensitive to heat stress and showed high percent reduction.

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