Pre-anthesis high-temperature acclimation alleviates damage to the flag leaf caused by post-anthesis heat stress in wheat

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Introduction

Background: Heat stress severely restricts plant growth and productivity and is classified as one of the major abiotic adversities for many crops, particularly when it occurs during reproductive stages, which may lead to substantial yield loss in wheat.

The ability of plant species to acclimate to high temperatures has been found to be closely associated with the acclimation capacity at the photosynthesis level. In addition, in vivo chlorophyll fluorescence measurement has been used for detection and quantification of temperature-induced damages to the photosynthetic apparatus.

The underlying mechanisms of high temperature acclimation and their effects on subsequent heat tolerance

in wheat plants remain largely unknown.

Objective: Investigate the effect of pre-anthesis high temperature acclimation on leaf physiology of winter wheat in response to post-anthesis heat stress.

Results

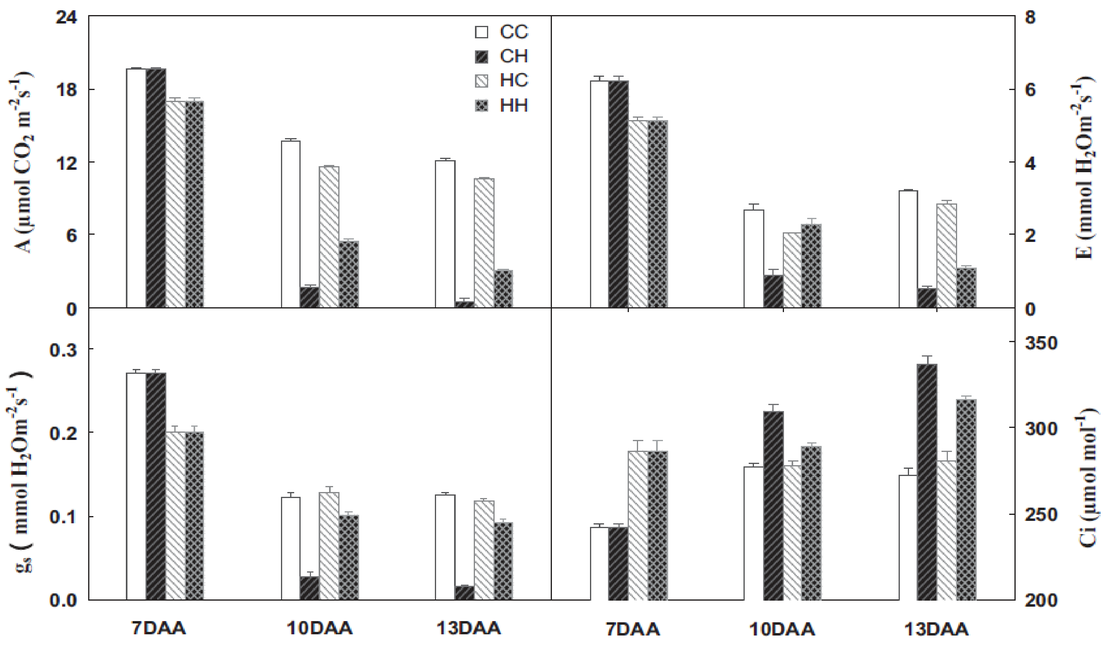

Fig. 1 Effect of pre-high temperature on photosynthesis rate (A), transpiration rate (E), stomatal conductance (g_s), and intercellular CO_2 concentration (C_i) of wheat flag leave under grain filling stage heat stress.

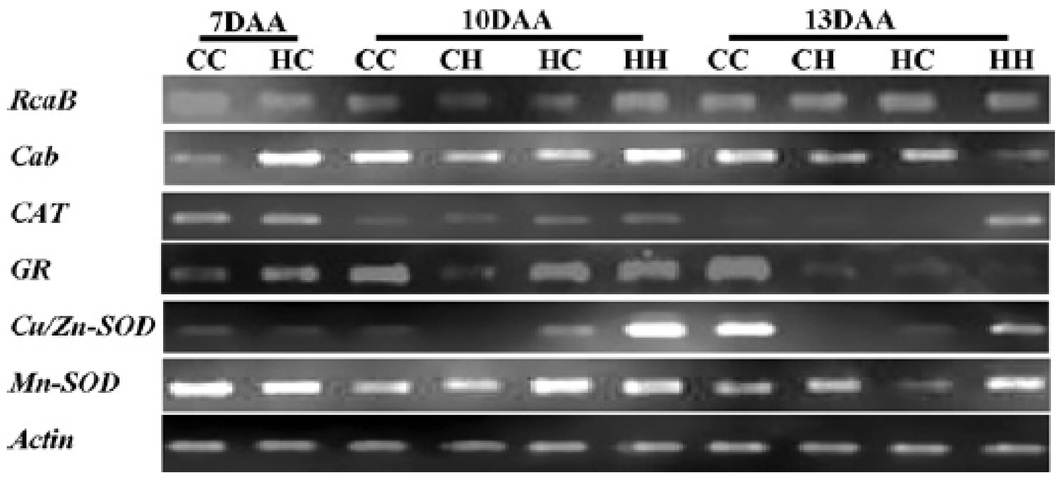

Fig.3 Effect of pre-anthesis heat acclimation on the expression of photosynthesisresponsive and antioxidant enzymes related genes under post-anthesis heat. *RcaB* – encoding the rubisco activase B, *Cab* – encoding the major chlorophyll a/b-binding protein, *CAT* – encoding catalase, *GR* – encoding cytosolic glutathione reductase, *Cu/Zn-SOD* – encoding chloroplastic Cu/Zn superoxide dismutase, *Mn-SOD* – encoding the mitochondrial manganese superoxide dismutase.

Materials and methods

An experiment with Winter wheat (*Triticum aestivum* L. cv. Yangmai 9) was made at Nanjing Agricultural University (China). Before anthesis, plants were divided into control treatment (ambient temp.), and heat treatment (exposure to high-temperature of 32 °C twice for 2 days each). The plants were subjected to another heat stress at 35°C for seven days during grain filling stage (7 day after anthesis).

Thus, in total four treatments were established, i.e. no high temperature hardening (control, CC); non- early high-temperature hardening + heat stress later (CH); early high-temperature hardening + no heat stress later (HC); early high-temperature hardening + later heat stress (HH).

Conclusions

The results indicated that pre-anthesis hightemperature acclimation improved post-anthesis heat tolerance of wheat plants in terms of improvement in photosynthesis, enhancement in the activities of anti-oxidative enzymes, and which were seemingly controlled at transcription level as indicated by the changes in the expression of photosynthesis-responsive and antioxidant-related genes in the flag leaf.

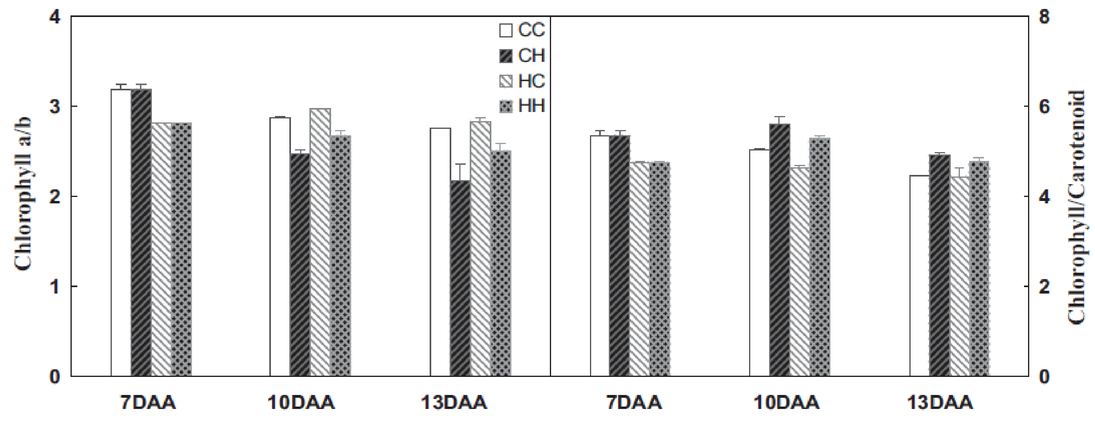

Fig. 2 Chlorophyll a/b ratio and chlorophyll/carotenoid ratio in the leaves under post-anthesis heat stress.

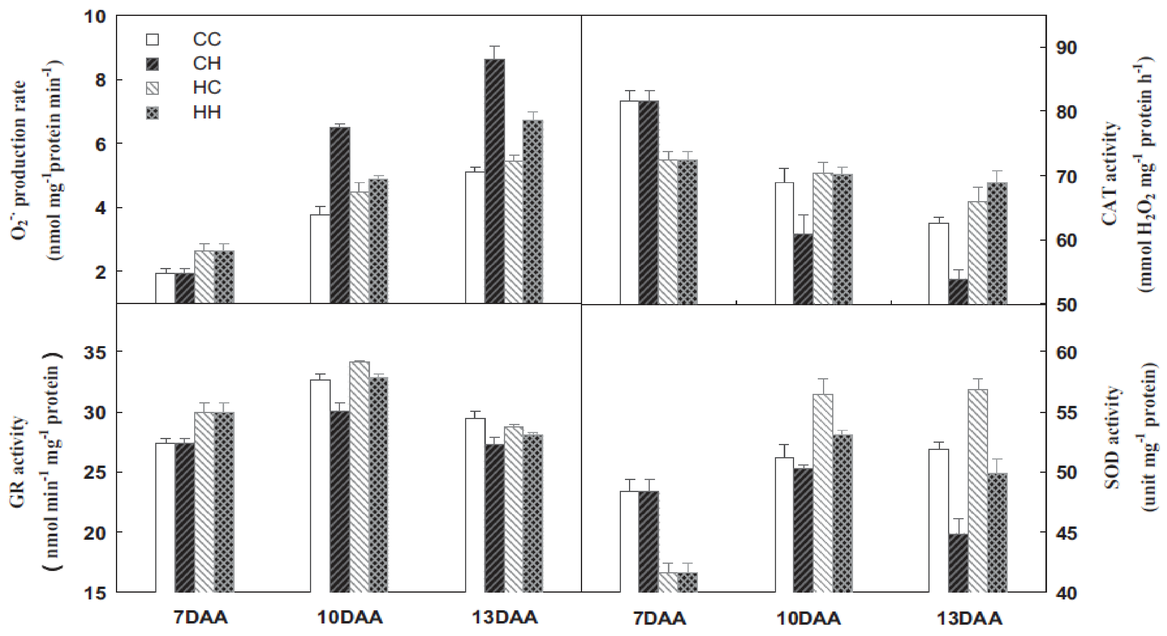

Fig. 4 Effect of pre-high temperature hardening on $O_2^{-\cdot}$ release rate, activities of catalase (CAT), glutathione reeducates (GR) superoxide dismutase (SOD) in wheat flag leave under later heat stress.

References

Wollenweber, B., et al. (2003). Journal of Agronomy and Crop Science 189(3): 142-150.

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