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Title: **Investigation of Heat-Induced Changes in the Grain Yield and Grains Metabolites, with Molecular Insights on the Candidate Genes in Barley**

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Abstract

Heat stress is one of the abiotic stresses that cause a significant reduction in barley yield. Climate change will increase the number of heat waves, which will result in more deterioration in the agricultural sector. Therefore, understanding the physiological changes that occur in the plant to tolerate heat stress is very important. A collection of 60 Egyptian spring barley genotypes has been tested for heat stress under field conditions. To quantify the changes in yield-related traits and the grain-reserve parameters as indicators for heat tolerance, several traits were scored. The causative genes that regulate the variation of all traits of interest were identified via single-marker analysis using 16,966 single nucleotide polymorphisms (SNP). Heat stress reduced yield-related traits, while some physiological traits (chlorophyll index, soluble carbohydrates, amino acids, and proline contents) increased. The genotypes were classified into four classes, A, B, C, and D, based on a reduction in grain yield per spike (GYPS) of 10%, 20%, 30%, and 40%, respectively. The physiological aspects were extensively studied in each group. The tolerant genotypes (class A) retained high yield-related traits as well as high reserved metabolites relative to the sensitive class D. The single-marker analysis and gene annotations revealed that the most effective markers and genes resided on chromosomes 1H and 4H. One of these markers, S4_250499621, was found to be associated with increased proline content, increased chlorophyll content, and decreased reduction in grain yield per spike and thousand kernel weight. This study is a part of our extended evaluation of this collection under various abiotic stresses at different developmental stages to develop climate-resilient crops.

Keywords: barley; grain metabolites; heat stress; single marker analysis; yield