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Unraveling heat tolerance in bread wheat (*Triticum aestivum* L.) using physiology and proteomics approaches

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Abstract

Heat stress significantly impacts global bread wheat productivity. Our study aimed to identify underlying mechanisms of heat tolerance in wheat flag leaves and spike tissues. We compared physiology, yield, and protein abundance changes of wheat genotypes with contrasting heat tolerance (two tolerant [RAJ3765 and HD2932] and two susceptible [HD2329 and HD2733]) under short- and long-term heat stress (32°C) at ear peep. This experiment revealed that heat tolerant genotypes maintained grain yield under short-term heat exposure by maintaining photosynthesis, membrane stability, chlorophyll content, pollen viability, and redox homeostasis. Heat stress during ear peep reduced grain number, above-ground biomass, harvest index less in heat-tolerant than -susceptible genotypes while increased thousand grain weight and grain protein content, with significant genotype x treatment interactions. Notably, long-term heat stress reduced thousand grain weight more in heat-susceptible than -tolerant genotypes. We identified 31 and 60 changes in protein abundances in flag leaves and spike tissues, respectively. Key pathways in flag leaves included photosynthesis, RNA processing, heat shock proteins, redox homeostasis, carbohydrate metabolism, chromatin organisation, and protein breakdown, translation, and translocation. In spikes, prominent pathways included carbohydrate, lipid, and secondary metabolism, cell wall and chromatin organisation, redox homeostasis, membrane transport, methylation, protein folding, breakdown and translocation, RNA processing, lipid transfer, cell morphogenesis, heat shock proteins, and reproduction.

Co-expression analysis revealed proteins correlated with important agronomic traits. These proteins provided insights into mechanisms of heat tolerance associated wheat physiology and yield.

Keywords: Heat-stress, physiology, protein abundance, protein biomarkers, tolerance, wheat

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