GENOTYPIC THERMOTOLERANCE IS ASSOCIATED WITH ELEVATED PRE-STRESS ANTIOXIDANT ENZYME ACTIVITY IN COTTON LEAVES AND PISTILS

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Abstract

Numerous studies have illustrated the need for antioxidant enzymes in acquired photosynthetic thermotolerance, but information on their possible role in promoting innate thermotolerance in either leaves or reproductive tissues is limited for cotton. We investigated the hypothesis that genotypic differences in subtending leaf photosynthetic thermostability and fertilization thermostability of the subtended flower would be dependent upon pre-stress antioxidant enzyme activity. To test this hypothesis, thermosensitive (cv. ST4554) and reportedly thermotolerant (cv. VH260) cotton plants were exposed to control (30/20°C) or high-day temperature (38/20°C) conditions during flowering. Source leaf photosynthesis was measured for each treatment, and the relationship between source leaf thermostability and pre-stress antioxidant enzyme activity was quantified by monitoring the actual quantum yield response of photosystem II (PSII) (Φ_{PSII}) to a range of temperatures for both cultivars grown under the control temperature regime and measuring antioxidant enzyme activity for those same leaves. Under both temperature regimes, measured pistil parameters included fertilization efficiency, glutathione reductase (GR), and superoxide dismutase (SOD). VH260 was more thermotolerant than ST4554 as evidenced by photosynthesis and fertilization efficiency being significantly lower under high temperature for ST4554 but unchanged for VH260. Under identical growth conditions, VH260 had significantly higher optimal and threshold temperatures for Φ_{PSII} than ST4554, and both photosynthetic and reproductive thermotolerance were associated with elevated pre-stress GR and SOD activity. It was concluded that maintaining a sufficient antioxidant enzyme pool prior to heat stress may be an important determinant of innate photosynthetic and reproductive thermotolerance in cotton.