GENOTYPIC DIFFERENCES IN THERMOTOLERANCE ARE DEPENDENDENT UPON PRE-STRESS CAPACITY FOR ANTIOXIDANT PROTECTION OF THE PHOTOSYNTHETIC APPARATUS IN COTTON

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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 is lacking. We investigated the hypothesis that genotypic differences in source leaf thermostability would be dependent upon pre-stress capacity for antioxidant protection of the photosynthetic apparatus in cotton. To test this hypothesis, thermosensitive (cv. ST4554) and thermotolerant (cv. VH260) cotton plants were exposed to control (30/20°C) or high day temperature (38/20°C) conditions during flowering and source leaf gas exchange, chlorophyll content, and maximum photochemical efficiency (F_v/F_m) were measured for each treatment. The relationship between source leaf thermostability and pre-stress antioxidant capacity was quantified by monitoring the actual quantum yield response of photosystem II (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. Cultivar VH260 was more thermotolerant than ST4554 as evidenced by photosynthesis and F_v/F_m being significantly lower under high temperature for ST4554 but not VH260. Under identical growth conditions, VH260 had significantly higher optimal and threshold temperatures for Φ_{PSII} and glutathione reductase (GR) activity than ST4554 and innate threshold temperature was dependent upon endogenous GR and superoxide dismutase activity. We conclude that maintaining a sufficient antioxidant enzyme pool prior to heat stress is an innate mechanism for coping with rapid leaf temperature increases that commonly occur under field conditions.