SUB-OPTIMAL GROWTH TEMPERATURE ALTERS THERMOTOLERANCE OF THYLAKOID COMPONENT PROCESSES IN COTTON SEEDLINGS

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Abstract

Cotton (*Gossypium hirsutum*) is often planted under sub-optimal early season temperatures, yet it is unknown whether this increases susceptibility to acute high temperature exposure. To address this, cotton seedlings were grown under optimal (30/20°C) and sub-optimal (20/15°C) growth temperature regimes, and comprehensive fluorescence analysis was conducted for cotyledons from both temperature regimes in response to incubation temperatures ranging from 30 to 50 °C. Results indicated that low growth temperature did not alter reaction center density (RC/CS_0), but increased antenna size (ratio of antenna chlorophyll to reaction center chlorophyll; ABS/RC) and decreased the amplitude of the I to P phase of the fluorescence transient [" V_{IP}; associated with the photosystem (PS) I content]. Photosynthetic performance indices (PI_{total} and PI_{ABS}), quantum yield of energy trapping (Æ$_{Po}$), the contribution of the thylakoid reactions to PI_{ABS} (F_v/F_0), electron transport to intersystem electron acceptors (Æ$_{E0}$) and reduction of PSI end electron acceptors (Æ$_{Ro}$) were all substantially lower in plants grown under sub-optimal temperature than in plants grown at optimal temperature. Furthermore, thermotolerance of all the aforementioned parameters was significantly reduced by low early season growth temperatures. Among different OJIP-derived parameters, PI_{ABS} and PI_{total} were more heat sensitive than other fluorescence-based parameters, and Æ$_{Po}$ and Æ$_{Ro}$ were the most heat tolerant. In addition, thermotolerance of PI_{total} (overall photosynthetic thermotolerance) was significantly correlated with thermotolerance of all other OJIP-derived parameters. Regression analysis indicated that heat tolerance trends for Æ$_{E0}$ were more consistent with the changes in thermotolerance of PI_{total}. We conclude that 1) low growth temperature in the seedling phase of cotton results in decreased photosynthetic thermotolerance and 2) overall photosynthetic thermotolerance is primarily constrained by the ability of intersystem electron transport to acclimate to growth environment.