LEAF ONTOGENY STRONGLY INFLUENCES PHOTOSYNTHETIC TOLERANCE TO DROUGHT AND HIGH TEMPERATURE IN GOSSYPIUM HIRSUTUM

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Abstract

Previous research has shown that young leaves and are less responsive to temperatures above the accepted thermal optimum in cotton, when compared to fully expanded leaves. Much of this research relies heavily chlorophyll fluorometry. Briefly, efficiency of electron flow through photosystem II (PSII) has been shown to be less responsive to heat extremes in young leaves, when compared to more expanded leaves; however, little information downstream of the light reactions has been reported. While this phenomenon is interesting, it may be of little biological relevance as leaf temperatures above 35°C are rarely seen under ideal growing conditions. Conversely, when leaf temperatures increase as a result of abiotic stress (such as air temperature extremes or drought), enhanced thermotolerance becomes germane to crop performance. To investigate the effect that drought-induced leaf temperature extremes have on carbon assimilation in both young and fully-expanded leaves, cotton grown in Southern Georgia over two years was irrigated according to the University of Georgia's checkbook recommendation; as well as by three distinct irrigation thresholds based on predawn leaf water potential (-0.5, -0.7, -0.9 MPa). Plants were then sampled multiple times during a long dry-down period. Observational data was collected throughout the growing season and included: leaf characteristics and pigments, plant water status, chlorophyll fluorometry, leaf temperature, and gas exchange. Temperature response was also evaluated by monitoring PSII efficiency as leaf temperatures were increased from 30 to 50°C. Results indicate 1) a strong relationship between plant water status, and stomatal conductance to water vapor with leaf temperature 2) for well watered cotton, PSII thermotolerance is greater in young leaves throughout the growing season, whereas this trend is lost as drought progresses 3) young leaf net photosynthesis is relatively unresponsive to high leaf temperatures, when compared to mature leaves.