THE EFFECT OF WATER-DEFICIT STRESS ON THE BIOCHEMISTRY OF THE COTTON FLOWER

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Abstract

Water deficit is a major abiotic factor limiting crop productivity around the world. Even though cotton is considered to be relatively tolerant to drought, plant growth and yield reduction still occur when water supply is limited or interrupted. However, little is known about metabolic responses to water deficit in the cotton flower. Research is needed to elucidate the metabolic responses of cotton reproductive units under conditions of water stress in order to facilitate methods of amelioration. The objectives were to document the physiological and biochemical changes that take place in cotton flowers and their subtending leaves when subjected to limited water supply. It was hypothesized that water-deficit stress would severely impair gas exchange functions which consequently would result in perturbation of carbohydrates of cotton reproductive units. To investigate this hypothesis growth room studies as well as field studies were conducted. Growth chamber experiments were conducted in 2009-2010 at the Altheimer Laboratory in Fayetteville, University of Arkansas. Cotton (*Gossypium hirsutum* L.) cultivar ST5288B2F was planted into 1L pots with Sun-Gro horticulture mix and growth chambers were set for normal conditions of 32/24°C (day/night), ±60% relative humidity, and 12h photoperiods. Plants were arranged in a completely randomized block design with 15 replications and half-strength Hoagland's nutrient solution was applied daily. The water-deficit treatments consisted of: (1) Untreated control and, (2) Water-deficit stress during flowering. Measurements of stomatal conductance, water potential, photosynthesis and respiration were taken from the fourth main-stem leaf. White flowers for water potential estimates, as well as carbohydrate and antioxidant content were sampled whenever they were available. Field studies were conducted in 2010 in four locations in Fayetteville and Marianna, AR, Corpus Christi, TX, and Fresno, CA. Cotton cultivar ST5288B2F was planted in all locations and treatments consisted of: (1) Untreated control and, (2) Water-deficit stress during flowering. The experimental design was a split-block and measurements of stomatal conductance were taken weekly. White flowers for carbohydrate, antioxidant and polyamine content were collected weekly, along with their subtending leaves. Seed set efficiency was estimated as seed number per boll. Results showed that water-deficit stress significantly decreased leaf stomatal conductance, photosynthesis, respiration and water potential, whereas pistil water potential remained unaffected. Sucrose content of water-stressed pistils was significantly higher compared to the control, while pistil hexose concentration remained unaffected. The opposite pattern was observed in leaf carbohydrate content, where leaf hexose concentration of water-stressed plants was significantly higher compared to the control, whereas leaf sucrose content was at the same levels as the control. Glutathione reductase activity in the pistil was increased under conditions of limited water supply, while in the leaf it remained at the same levels as the control. Concerning polyamine content of the pistils, putrescine levels in both the style and the ovary remained unaffected under water-deficit stress, however both spermidine and spermine concentrations were significantly decreased under water-deficit stress. Seed set efficiency was not significantly affected at Arkansas location, however at Texas location there was a dramatic decrease. In general, water-deficit stress during flowering significantly decreased leaf physiological functions, while pistils appeared to be more tolerant. However, biochemical functions of the pistils appeared to be more sensitive compared to the leaf with significant compromises in carbohydrate, antioxidant and polyamine metabolism. Those compromises resulted in a significant decrease of seed set efficiency at one location.