EFFECT OF WATER-DEFICIT STRESS ON REPRODUCTIVE DEVELOPMENT IN THE COTTON PISTIL

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Abstract

Water deficit is the major abiotic factor limiting plant growth and crop productivity around the world. Even though cotton is considered to be relatively tolerant to drought, i.e. by osmotic adjustment; plant growth and yield reduction still occur when water supply is limited or interrupted. Cotton reproductive units have been shown to be relatively insensitive to plant water deficits. It has been observed that both cotton flowers and bolls exhibited a consistently higher water potential compared to that of the subtending leaves and bracts, during and after anthesis and under variable water stress conditions. Investigations in other crops, such as maize, soybean, and rice have suggested that carbohydrate metabolism of reproductive units is greatly affected by water stress treatments. However, to our knowledge, the pathways of carbohydrate metabolism and subsequent energy production, as well as antioxidant metabolism of cotton flowers under water stress have received little attention. 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 of this study were to observe and quantify 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 and energy production metabolism of cotton reproductive units. Growth chamber experiments were conducted in 2009 at Altheimer Laboratory at the University of Arkansas in Fayetteville. Cotton (*Gossypium hirsutum* L.) cultivar ST5288B2F was planted into 2L pots with Sun-Gro horticulture mix and growth chambers were set for normal conditions of 30/20°C (day/night), ±60% relative humidity, and 12h photoperiods. Plants were arranged in a completely randomized block design with 20 replications and half-strength Hoagland's nutrient solution was applied daily in order to maintain adequate nutrients and water. The water-deficit treatments consisted of: (1) Untreated control, (2) Water-deficit stress during squaring, and (3) Water-deficit stress during flowering. Measurements of stomatal conductance, fluorescence, and respiration were taken from the fourth main-stem leaf and flowers for carbohydrate and antioxidant content were sampled whenever they were available. The results showed that both early (during squaring) and late (during flowering) water-deficit stresses had a detrimental impact on carbohydrate metabolism of cotton flower pistils. Late-stress caused glucose, fructose, and sucrose levels to significantly decrease, which resulted in a reduction in respiration rates. The early stress caused a similar reduction to glucose levels which was not accompanied by a corresponding reduction in respiration rates. Additionally, fructose and sucrose levels of early-stressed flowers were significantly higher than those of the late-stressed flowers indicating a perturbation in the breakdown and interconversion of carbohydrates in the flower. These responses would most likely result in a compromise of fertilization efficiency and seed set.