WATER-DEFICIT STRESS AND REPRODUCTIVE DEVELOPMENT IN COTTON

D.A. Loka
D.M. Oosterhuis
University of Arkansas
Fayetteville, AR
B.L. McMichael
Texas Tech University
Lubbock, TX
C.J. Fernandez
Texas A&M University
Corpus Christi, TX

Abstract

Water deficit is a major abiotic factor limiting plant growth and crop productivity around the world. Cotton (*Gossypium hirsutum* L.) is considered to be relatively tolerant to drought, i.e. by osmotic adjustment however, previous research has indicated that water-deficit stress resulted in decreases in leaf photosynthesis, water potential, and osmotic adjustment, variable results in carbohydrate content and no effect on glutathione reductase. Boll water potential has been reported to remain unaffected under conditions of limited water supply and a similar pattern has been observed for boll carbohydrate content and respiration. However no research exists to our knowledge on the alterations in the physiology and biochemistry of the cotton flower under conditions of water-deficit stress. 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 objective of this study was to observe and evaluate the alterations caused by water-deficit stress during reproductive development in carbohydrate production and metabolic pathways of cotton flowers and their subtending leaf as well as their implications in plant seed set efficiency. 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, field studies were conducted in 2011 in three locations: Fayetteville, AR, Lubbock, TX, and Corpus Christi, TX. Cotton cultivar ST5288B2F was planted in all locations in a split-block design arrangement and treatments consisted of: (1) Untreated control and, (2) Water-deficit stress during flowering. Water-deficit stress was imposed by discontinuing irrigation in the water-stressed plots when 50% of the field had reached the white flower stage. Irrigation was discontinued for a total of two weeks. Measurements of soil water content and stomatal conductance were conducted weekly, while a total of 200 white flowers and their subtending leaves were sampled each week from control and water-stressed plots for carbohydrate and antioxidant content analysis. Results indicated that water-deficit stress resulted in a significant decrease in stomatal conductance rates compared to the control. In addition, leaf glucose, fructose and sucrose concentrations were increased under conditions of limited water supply, while starch concentrations were decreased compared to the control. Water-stressed pistils contained significantly higher sucrose concentrations compared to the control, while pistil glucose and fructose content remained unaffected. Pistil starch levels were decreased under conditions of water-deficit stress. Lastly, leaf and pistil glutathione reductase content remained unaltered under conditions of limited water supply. In summary, water-deficit stress during flowering had a significant effect on carbohydrate metabolism of the pistils and their subtending leaves in all locations, possibly due to the inability of antioxidant mechanism to provide sufficient protection against oxidative damage. As a result total soluble carbohydrates of the subtending leaves were significantly increased under conditions of water stress compared to the control, while glucose and fructose concentrations of the pistils remained unaffected of the water regime. However, pistil sucrose levels were significantly increased indicating a perturbation in carbohydrate cleaving enzymes that could potentially have as a consequence a compromise in fertilization and seed set efficiency.