HEAT ADAPTATION IN PIMA COTTON

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Abstract

Breeding Pima cotton for increased yield in the hot, arid southwest has resulted in progressively higher stomatal conductance levels in succeeding cultivars (Lu et al. 1994). One possible explanation for this phenomenon is that higher stomatal conductance levels have increased evaporative cooling; reducing thermal stress, and providing a heat avoidance type of heat resistance. A series of experiments have been conducted from 1992 to the present to investigate this heat resistance mechanism and to develop efficient selection methodologies. Investigations were conducted under replicated field, greenhouse, and laboratory conditions using appropriately selected or created genetic populations. Somatal conductance measurements were made using a Li-Cor LI-1600 steady state porometer. Carbon isotope samples were analyzed by the Stable Isotope Laboratory of Boston University. Supporting the hypothesis of a heat avoidance type of resistance was the observation that lint yields of Pima cultivars correlated with mid-afternoon stomatal conductance levels (r = 0.82), but not with morning stomatal conductance levels (Radin et al. 1994). Further support for heat avoidance resistance was obtained from an F_2 population in which leaf temperatures of individual plants varied over a 6 ^{0}C range and were highly correlated (r = -0.76) with stomatal conductance measurements. Photosynthetic rates of individual plants were not related to stomatal conductance over most of the stomatal conductance range of the F_2 population; indicating that photosynthesis was not CO_2 limited. Twelve F_3 populations (derived from the above F_2 population) showed a positive correlation between stomatal conductance and fruit retention (r = 0.68) and a negative correlation between leaf temperature and fruit retention (r = -0.75). In an inheritance study of stomatal conductance in *Gossypium barbadense* L., broadsense heritability estimates ranged widely between five crosses (H = 0.16-0.74) but were large enough to allow gain through selection (Percy et al. 1996). Heat adapted upland cultivars were identified as a source of genetic variation for increasing stomatal conductance levels beyond those presently available in Pima cultivars. Yield differentials between the two species were observed to be temperature dependent, with upland yields increasing from 1.5 times that of Pima yields at mean July temperture highs of 31^{0}C, to 2.5 times that of Pima yields at mean July temperature highs of 35^{0}C. Due to perceived limitatons in stomatal conductance measurements as a selective tool for heat resistance, carbon isotope discrimination measurements were investigated as a possible replacement (Lu et al. 1996) . High positive correlations between stomatal conductance and carbon isotope discrimination were obtained in a segregating F_2 population (r = 0.76) and among primitive *G. barbadense* accessions (r = 0.68). Therefore, it should be possible to use carbon isotope discrimination to select for a heat avoidance resistance under irrigation in the arid southwest.

References

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