PHYSIOLOGICAL STUDIES OF COTTON DROUGHT TOLERANCE

R.G. McDaniel and A.K. Dobrenz

Abstract

We evaluated an array of progeny of interspecific cotton crosses in the field. Significant water stress was placed on the plants in mid-summer by withholding water supplied by drip irrigation during plant development earlier in the season. A number of physiological measurements were carried out on selected individual plants of this population during the several week period of imposed drought stress. Overall results confirm that a large degree of variation exists within the population for all traits measured. Initial carbon isotope discrimination measurements suggest this trait may prove useful in estimating transpiration efficiency of cotton genotypes.

Introduction and Results

A number of interspecific crosses were made in summer, 1990 between *Gossypium hirsutum*, cv. Deltapine 90 and *Gossypium barbadense*, cv. Pima S-6. Reciprocal hybrid seed from these crosses, along with F_2 seed from previous Deltapine 90 by Pima S-6 crosses were planted in the field in Tucson, AZ in April 1991. Plants produced from these seeds were subjected to significant but non-lethal water stress in June and early July, and leaves were sampled during this period for carbon isotope composition analyses and other measurements. At the same time, over a several week period during maximum flowering, and before significant summer rainfall, physiological measurements were made on representative plants drawn from the field population. Significant differences in transpiration rates, net photosynthetic rates and in other morphological characteristics were observed among the segregating F_2 progeny plants. Observed variation among several plants from this field for leaf stomatal density is shown in table one. Table two illustrates similar variability for transpiration rates and simultaneous measurements of leaf temperature for these same plants under field conditions. Data taken several times over a four week period are presently being analyzed. Initial heritability analyses should be possible, as both parents, F_1 hybrids, F_2 and F_3 progeny were compared under the same environmental conditions.

These data substantiate the large amount of genetic diversity inherent to these segregating interspecific cross progeny. Carbon isotope discrimination analyses run using leaf samples taken during the drought stress imposed on this population also show considerable variability, and the differences observed appear to correlate with plant transpiration efficiency. The ability to discriminate between two isotopes of carbon - C_{12} and C_{13} - during photosynthesis has been found to be an excellent predictor of stress response in several other crop plants. Field experiments we plan for 1992 are designed to test this concept with selections from these segregating cotton populations. Used judiciously, measurements of these physiological traits may improve our ability to select more drought tolerant cotton genotypes for Arizona.

Table 1. Observed Variation in Stomate Density of Selected Cotton Progeny.

	Stomates per mm^2		
Plant Number	Adaxial Surface	Abaxial Surface	Ratio
2-3-5	126	246	1.95
3-4-5	120	286	2.38
4-4-3	93	246	2.65
6-5-11	126	153	1.21
7-4-8	226	353	1.56
8-1-3	213	293	1.38

Table 2. Observed Variation in Transpiration Rate and Leaf Temperature of Selected Cotton Progeny.

Plant Number	Transpiration Rate mg cm^2s^{-1}	Leaf Temperature (°C)
2-3-5	41.7	35.0
3-4-5	29.5	35.6
4-4-3	25.2	35.5
6-5-11	29.7	34.8
7-4-8	14.0	36.4
8-1-3	25.0	35.5