CHROMOSOME SUBSTITUTION FROM *G. BARBADENSE* AND *G. TOMENTOSUM* ALTERS PHYSIOLOGY AND AGRONOMIC TRAITS IN UPLAND COTTON

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Abstract

Abiotic stresses often cause extensive damage to cotton yield and quality, thus cultivars with enhanced resilience to multiple stress conditions will be highly valued. Chromosome substitution (CS) lines provide a unique opportunity to search for and quantify genetic effects on a chromosome-by-chromosome basis for important traits. The identification of lines that are phenotypically stable under field conditions could lead to crucial cultivar improvements. This experiment was designed to develop stress response indices and identify traits that may be associated with drought, heat or reproductive tolerance among the CS lines. Eleven parameters related to physiology, pigments, photosynthesis, and reproduction were measured during mid-fruiting in eleven chromosome substitution lines of cotton containing individual chromosome substitutions from CS-B (*G. barbadense*) and CS-T (*G. tomentosum*) backcrossed into a common *G. hirsutum* (TM-1) background . The measured parameters were compared statistically to TM-1. Cell membrane thermostability (CMT), canopy temperature depression (CTD), chlorophyll stability index (CSI), and specific leaf area (SLA) were considered physiological parameters related to heat and drought. Total chlorophyll and carotenoids were used as pigment parameters; whereas, net photosynthesis and stomatal conductance were used as photosynthesis related parameters. Pollen viability (%) and pollen germination at both 30 and 38°C were used as reproductive parameters. Individual response indices were calculated in relation to parent line, TM-1, for each parameter. Four cumulative stress performance indices namely photosynthesis, pigment, membrane stability, reproductive, and temperature and drought response indices were calculated by summing up the individual response indices. The cumulative photosynthesis indices differed significantly among CS lines and values were greater than the parent, TM-1, in the B04 and B15sh lines from *G. barbadense* and the T07, T15sh, and T18 lines from *G. tomentosum*; whereas, values were lower in the B01, B07, B18, and T04 lines. The cumulative pigment response indices also varied among CS lines; the B15sh, B18, T07, and T18 lines had higher values and the B01, B04, B07, T01, and T08 lines showed slightly lower values than TM-1. Temperature stability of the cell and chloroplast membranes, expressed as the cumulative membrane stability response indices, differed significantly among CS lines; values were greater than TM-1 in the CS lines B04 and T18, suggesting greater tolerance to heat stress. On the other hand, lower membrane stability indices were observed in the CS lines B07, B15sh, B18, T04, T07, and T08. Reproductive (pollen) performance was significantly greater in all CS lines compared to TM-1; the B04 line from *G. barbadense* and T07 and T18 lines from *G. tomentosum* showed greater tolerance to high temperature stress. Values for the cumulative drought and heat response indices, calculated as the sum of several traits related to stress tolerance, were significantly greater in all the CS lines. The B04 line and the T01 and T18 lines appeared to exhibit superior drought and heat tolerance mechanisms, as compared to TM-1. Additional research will be needed to determine the relative importance of heritability of these physiological traits and indices to abiotic stress tolerance, fiber traits and yield in cotton.