Pima Cotton Genetics

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Abstract

An isozyme study of the diversity and structure of Gossypium darwinii revealed levels of genetic variation within the species which were high for an island endemic. Infraspecific diversity of G. darwinii was observed among populations of the various Galapagos Islands. Evidence of introgression of other Gossypium species into G. darwinii was noted. An investigation into the effects of altered Pima (G. barbadense) fiber genotypes on interspecific hybrid fiber characteristics indicated that parent genotype could significantly affect hybrid fiber length, strength, uniformity, and micronaire. However, hybrid heterosis for fiber length and micronaire greatly exceeded the influence of parent genotype. Hybrid fiber characteristics were unique, fitting within neither the extra-long staple nor long staple classifications. A conversion program to convert photoperiodic short-day accessions of a Gossypium barbadense germplasm collection to day neutrality continues.

INTRODUCTION

The Pima genetics program is a long-term project with numerous objectives that include: characterizing and evaluating a collection of primitive *Gossypium barbadense* L. cottons for potentially useful agronomic traits; investigating the genetic and geographic variability of the species; converting the *G. barbadense* germplasm from a short-day to a day-neutral flowering habit to make variability in the collection available to genetic investigations and improvement efforts; transferring genetic traits that confer tolerance to environmental and biological stresses to Pima breeding lines; and investigating genetic systems in *G. barbadense* to provide information on the inheritance and relationships of genetic systems in cotton.

MATERIALS AND METHODS

An allozyme investigation of the diversity, geographic structure, introgressive status, and taxonomic standing of the Galapagos Islands endemic cotton species *G. darwinii* Watt was completed in 1990. In the investigation, conducted jointly with J. Wendel of Iowa State University, allozyme analysis was performed on 58 accessions from six island using 17 enzymes collectively encoded by 59 loci. Data were analyzed using principal component analysis, cluster analysis, apportioning of genetic variation, and computation of island gene frequencies.

An investigation to determine the effects of altered Pima (*G. barbadense)* parental fiber traits upon interspecific hybrid cotton fiber characteristics was also concluded in 1990. Four extra-long staple Pima cotton strains bred for short, coarse fiber and the cultivar Pima S-6 were crossed to the upland (*G. hirsutum*) cultivars McNair 235, Stoneville 506, SP21 S, and AZ 107 to produce F_1 hybrids. Hybrids and their parents were grown in replicated tests at Maricopa, AZ (1988); Safford, AZ (1988 and 1989); and Las Cruces, NM (1989). Handpicked 100 boll fiber samples from the above tests were analyzed in the USDA-ARS fiber laboratory at Maricopa, AZ in 1989 and 1990. In 1990, fiber samples from the Safford and Las Cruces locations were sent to STARLAB, INC for microspin testing. Data were analyzed using ANOVA GLM procedures on a split-plot design in 1989 and on a randomized block design in 1990.

A program to convert photoperiodic short-day flowering cottons to a day neutral flowering habit using a

backcross scheme has been conducted at the Tecoman, Mexico winter nursery and the Maricopa research center for several years. In the backcross scheme, initial crosses of tropical accessions to a commercial Pima cultivar are made in the greenhouse at Maricopa to transfer the day neutrality factor. The F_1 populations are then grown in Mexico, and segregating F_2 populations are grown in the field at Maricopa. Flowering segregants from the field at Maricopa are transferred to the greenhouse where they are backcrossed to their tropical short-day parent. The procedure is repeated until the genotypes of the tropical germplasm accessions are recouped in day-neutral flowering plants. The above procedure was used in 1990. However, due to lack of space or difficulty in producing backcross populations in the greenhouse in 1989, 39 BC_F_3 populations and their corresponding short-day parents have been grown and crossed at Tecoman, Mexico to advance these accessions by one backcross generation.

RESULTS

Allozyme evidence from *G. darwinii* indicated that levels of genetic variation in the species were high for an island endemic. The mean number of alleles per locus was 1.34 and the average panmictic heterozygousity was 0.062. Principal component analysis revealed clustering of accessions by island of origin. Significant introgression of *G. hirsutum* alleles was detected in *G. darwinii*. However, there is no historical record of *G. hirsutum* introduction onto the Galapagos Islands and morphological evidence supports introgression of *G. barbadense* into *G. darwinii*. It is proposed that the occurance of *G. hirsutum* alleles in *G. darwinii* is the result of a mediated transfer of *G. hirsutum* alleles into *G. darwinii* by means of a *G. hirsutum* introgressed *G. barbadense* source.

Although Nei's genetic identity for *G. darwinii* and *G. barbadense* was high (0.949); the two species were nearly fixed for alternative alleles at four loci (*Adh2, Arg2, Aco3,* and *Leu1*), and both species exhibited a large number of unique alleles (*G. darwinii* - 12, *G. barbadense* - 21). Allozyme data supports geographical and morphological evidence suggesting that *G. darwinii's* specific rank is warranted. Further, allozyme data suggested that *G. barbadense* and *G. darwinii* may be descendants of a common ancestor, rather than a progenitor-derivative pair.

In an evaluation of parental effect upon hybrid fiber characteristics, *G. barbadense* parent contributions to hybrid fiber length, uniformity, strength, and micronaire were significant in three of four tests. A linear regression of hybrid on parent fiber lengths was significant (R^2 = 0.95). A 0.76 mm change in hybrid fiber length was observed for every change of 2.54 mm in the parental fiber. Linear regression of hybrid on parent micronaire was smaller but significant (R^2 = 0.52). Hybrid micronaire changed by 0.03 units for every 0.1 unit of change in parent micronaire. Positive hybrid heterosis for fiber length and negative heterosis for micronaire were observed at all locations. Heterotic effects of hybridization exceeded and opposed the desired direction of parental effects for both fiber length and micronaire. A negative heterosis for uniformity was noted at Maricopa, AZ in 1988 and a positive heterosis was observed for strength at Safford, AZ in 1989, but these observations were not repeated in the other three tests. Contrary to some previous reports, fiber uniformity in hybrids was within acceptible limits and reflected the higher uniformity of the *G. barbadense* parents. Hybrid fiber strengths, though less than the Pima parent strengths, were quite high (262-288 $kNmkg^{-1}$). Alteration of parental traits resulted in unique hybrid fibers which possess traits within both the extra-long staple and long staple classifications.

In the 1990 backcross program to convert tropical cottons to day neutrality, 80 populations were successfully backcrossed to their tropical parent accessions and 50 BC_F_1 populations were advanced to the F_2 generation. At Tecoman, Mexico, 58 BC_F_1 populations were advanced to the F_2 generation and 36 populations were successfully backcrossed to their short-day tropical parent.

PUBLICATIONS

Percy, R.G. and E.L. Turcotte. 1991. Parental effect of selected early, short-statured American Pima cotton strains upon agronomic traits of interspecific hybrids. Crop Sci.: accepted for pub.

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Wendel, J.F. and R.G. Percy. 1991. Allozyme diversity and introgression in the Galapagos Islands endemic *Gossypium darwinii* and its relationship to continental *G. barbadense*. Biochemical Sys. and Ecol.: accepted for pub.