# Pima Cotton Genetics

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## ABSTRACT

*In an investigation of the genetic diversity and structure of Gossypium barbadense L. it was determined that northwestern South America was the species' center of variability and probably the species' center of origin. Cultivars of the species were found to possess as much genetic variability as the center of variability. Cultivar variability was due in large part to introgression with G. hirsutum. Studies of interspecific hybrid performance revealed that development of G. barbadense parents could significantly affect the plant height, earliness, and yield of the resulting hybrids. Environment significantly affected hybrid performance and could enhance or obscure any beneficial effects of hybrid parent selection. A conversion program to convert photoperiodic short-day flowering tropical accessions to day neutrality continues. Preliminary results from inheritance and linkage studies of a male sterility factor and a foliar mutant indicate that both are single gene, recessive traits. No linkages between the male sterility factor and 21 marker traits were found.*

## 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; 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 investigation of the genetic diversity and structure of the *Gossypium barbadense* L. species, conducted jointly with Jonathan Wendel of Iowa State University, was completed in 1989. An allozyme analysis was performed on 153 accessions of the germ plasm collection to ascertain the geographic origin of the species, its pattern of diffusion, and to reveal infra-specific relationships. Fifty-nine loci were examined, 24 of which were polymorphic. Data were analyzed using principal component analysis, cluster analysis, apportioning of genetic variation, and computation of regional gene frequencies.

A performance evaluation of interspecific hybrid (ISH) cottons was completed in 1989. Hybrids were evaluated at Maricopa and Safford, AZ, in 1988 and at Safford, AZ, and Las Cruces, NM, in 1989. The ISH tested in both years had as one parent short-statured, early-maturing Pima strains specifically developed for hybrid use. Four Upland cotton varieties were used as the other parent in crosses to produce $F_1$ hybrid seed. Hybrids and their parents were evaluated in replicated field tests using a splitplot design in 1988 and a randomized block design in 1989. Yield, earliness, plant height, and fiber data were obtained from three of the four tests. Earliness measurements were not made at the Safford location in 1988. In 1989 early season bloom count data were obtained at the Las Cruces location. Data were analyzed using ANOVA GLM procedures.

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. Crosses of tropical accessions with a commercial Pima cultivar are made in the greenhouse at Maricopa, $F_1$ populations are 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 germ plasm accessions are recouped in day-neutral flowering plants.

Genetic traits presently under investigation in genome mapping efforts include a male sterility factor and a mutant leaf trait. In 1989 $F_2$ populations segregating for the male sterility factor and 21 genetic marker traits were grown in the field at Maricopa, AZ, and scored to determine the inheritance and linkage relationships of the sterility factor. Crosses of the mutant leaf trait with 32 genetic markers made in 1988 were grown to produce seed for segregating $F_2$ populations. Four new mutant phenotypes were identified in fields at Maricopa and Safford, AZ, in 1989, and preliminary crosses were made to the PS-6 cultivar to determine their inheritance.

## RESULTS

An allozyme investigation of the *G. barbadense* species completed in 1989 revealed that northwestern South America was the center of variability of the species and was probably the species' center of origin. Several diffusion pathways from the postulated center of origin could be discerned. Separate diffusion pathways from the center of origin into northern South America east of the Andes and into Argentina and Paraguay were evident. Caribbean and Central American accessions appeared to derive from northeastern forms and not directly from the northwestern forms of the center of origin. Modern and obsolete cultivars of *G. barbadense* appeared to derive largely from northwestern South American materials. Genetic variability in cultivars was found to be equivalent to that observed in accessions from the species' center of variability. Variation in cultivars was due in large part to introgression from the species *G. hirsutum*.

Evaluation of interspecific hybrids at three locations over two years indicated that selected *G. barbadense* parent strains significantly affected hybrid performance. Hybrid plant heights were significantly influenced by the *G. barbadense* parent in two of four tests, with the non-selected PS-6 commercial cultivar producing the tallest hybrids. Significant differences in parental contribution to hybrid earliness were also noted in two tests, with the later PS-6 parent producing later maturing hybrids than the early maturing Pima strains. *G. barbadense* parents significantly affected hybrid yields in all four tests. Selected parental strains produced hybrids which out yielded PS-6 hybrids in three of four tests. Hybrid yields exceeded parent yields in 3 of the 4 tests. Best hybrid yields exceeded best parent yields by 29.1%, 49.1%, and 87.5% at Safford in 1989, Safford in 1988, and Las Cruces in 1989, respectively. Environment was a strong factor in hybrid performance. At the low-elevation Maricopa location, which experiences seasonal temperature extremes, hybrids were twice as tall as at the Safford and Las Cruces locations. Hybrids did not outyield parent strains at Maricopa, but did at the higher-elevation Safford and Las Cruces locations.

In the backcross program to convert tropical cottons to day neutrality in 1989, 102 accessions were advanced a generation at Tecoman, Mexico. Fifty-eight new accessions were introduced into the conversion program through crossing at Tecoman. Sixty-one accessions were successfully backcrossed to their tropical parent accessions in the greenhouse at Maricopa.

Preliminary genetic investigation of a male sterility factor in 1989 indicated that it is inherited as a single gene recessive trait. No linkage relationships between the male sterility gene and 21 marker traits were found. A foliar mutant was observed to segregate in a manner consistent with a single gene trait. Expression of heterozygotes of the foliar mutant often could not be readily discerned from homozygous normal leaf expression. For the above reason, the foliar mutant has been tentatively designated as a single gene recessive trait. Linkage data for the foliar mutant will be collected in 1990.

# PUBLICATIONS

**Percy, R.G. and J.F. Wendel - 1990.** Allozyme evidence for the origin and diversification of *Gossypium barbadense* L. Theor. Appl. Genet.: accepted for pub.

**Percy, R.G. and E.L. Turcotte - 1990.** Effect of *Gossypium barbadense* parental selection upon $F_1$ interspecific hybrid plant height, earliness, and yield. Beltwide Cotton Prod. Conf., Proc. 41st Cotton Imp. Conf. accepted for pub. (abs.).

**Turcotte, E.L. and R.G. Percy - 1989.** The genetics of kidney seed in *Gossypium barbadense* L. Crop Sci.: accepted for pub.