PIMA COTTON GENETICS

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Abstract

A Pima cotton genetics program was initiated in the 1950's by the Cotton Branch of the USDA-ARS. The program was part of a combined breeding and genetics project located at Phoenix, Arizona, and concerned with the improvement of Pima cotton for the southwestern U.S.

Publications on genetics studies of *G. barbadense* L. including primitive or "dooryard" cottons, Sea Island types, Egyptian, and Pima cottons, began 80 years ago with a description of crinkle leaf in Sea Island cotton by S. C. Harland in 1971. Since then, 44 simply inherited genetic traits have been described in *G. barbadense*. Eighteen of these were contributed by the Pima genetics program. Genes conditioning these traits account for approximately 25% of the genes described in tetraploid cotton. Morphological characteristics, plant and flower color, and genes affecting reproductive processes are included. Several qualitative traits have been transferred to *G. barbadense* from *G. hirsutum*. These include genes conditioning glandless seed, nectariless, genetic-cytoplasmic male sterility, and frego bract. These simply inherited genes have been used for linkage studies to form multiple-marker stocks and to develop lines containing genes with potential economic value for use in cotton breeding programs.

Several mutants have occurred independently in *G. hirsutum* and *G. barbadense*, and others are members of complementary gene pairs conditioning a single trait.

Pima S-1 and related materials were found to be unique in their relatively high frequency of haploid plants in the field. Two or three haploids per acre were common, in contrast to unrelated *G. barbadense* and *G. hirsutum* in which haploids were much less frequent.

Availability of numerous haploids provided a basis for in-depth studies of haploids and their potential uses. One hundred and sixty haploids were located in field plantings of Pima cotton and transplanted to a greenhouse from 1965 through 1960. Forty-nine of these were doubled with colchicine and evaluated for agronomic performance and fiber quality. Results of these and other studies showed that doubled haploids of advanced generation materials were equal to or inferior in agronomic performance and fiber quality when compared with the strains from which they were derived. Doubled haploids showed no deleterious effects of homozygosity. It was concluded that large numbers of doubled haploids would have to be screened to locate those with enhanced yield and fiber quality. Boll and fiber properties of 234 doubled haploids have been described.

Another potential source of haploids we investigated were twin seedlings from germinated seed. These studies resulted in one haploid each of obsolete cultivar ''ima 32' and experimental strain 3-79. Both haploids were doubled with colchicine. Doubled haploid 3-79 has been designated as a genetic standard for *G. barbadense*.

The scarcity of haploids from twin seedlings as opposed to the frequency of haploids in field plantings led us to speculate that haploids in the field were coming from single-embryo seed. We began our investigations on the origin of haploids using a doubled haploid from Pima S-1, doubled haploid 57-4 (DH 57-4). DH 57-4 was producing a high frequency of haploids in greenhouse and field plantings. In greenhouse plantings, we confirmed that the haploids were from single-embryo seed. To determine if the haploids were from egg or sperm cells, DH 57-4 was crossed, as female, with 'A-44' (*G. hirsutum*). Haploids from egg cells would be *G. barbadense*, and haploids from sperm cells would be *G. hirsutum*. Four haploids were obtained from crossed seed. Two were *G. barbadense* and thus from egg cells. The other two haploids were sectored or chimeral for *G. barbadense* and *G. hirsutum* tissue. The chimeral nature of the two haploids was detected at flowering when it was observed that some fruiting branches on each plant were *G. barbadense* and some were *G. hirsutum*.

Two additional crosses were made using DH 57-4 as female and the virscent plant color marker, v7, or the glandless plant marker, gl2gl2gl3gl3, as male. Seed from each cross contained plants sectored for green and virescent or glanded and glandless tissue. The chimeral plants were composed of distinct areas of tissue involving maternal or paternal chromosome complements. No areas of tissue of obvious hybrid origin were observed.

The phenotypes of the chimeral plants were consistent with an explanation of their origin via semigamy, a form of apomictic reproduction in which a sperm cell enters an egg cell but does not fuse with the egg nucleus. Each nucleus divides independently resulting in embryos and resulting plants sectored for maternal and paternal tissue.

Inheritance studies showed that semigamy was conditioned by one dominant gene. Semigamy has proven useful to produce haploids, and by chromosome double, true breeding lines from male gametes of selected parents.

Other studies with DH 57-4 resulted in plants that were trichimeral. Polyspermy, the presence of more than two sperm nuclei in the embryo sac at the time of fertilization

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was considered the most likely explanation for the trichimeral plants.

Primitive, obsolete cultivar, and non-Pima *G. barbadense* germplasm has been an important part of the Pima genetics program since the 1950's. The Cotton Winter Nursery in Mexico has been used extensively for *G. barbadense* germplasm research. Seed increases of short-day photoperiod germplasm, crosses to transfer day-neutral photoperiod to short-day material, and seed increases of genetic stocks and doubled haploids have been made at the Cotton Winter Nursery. Studies with the kidney seed trait found in many *G. barbadense* germplasm accessions showed that kidney seed was inherited as a monogenic recessive, and also resulted in an expanded list of descriptors for *G. barbadense* var. *braziliense*. Seed of *G. barbadense* germplasm stocks has been stored in the USDA-ARS National Cotton Germplasm Collection at College Station, Texas.

The Pima genetics program also has developed and released germplasm lines to breeders and geneticists that incorporated various genetic traits with potential economic value, lines with enhanced fiber, and lines for use in producing hybrid cotton.

The USDA-ARS cultivar development portion of the Pima project was terminated in 1993. The genetics portion of the project has continued and germplasm enhancement has received greater emphasis. Recent efforts have included the distribution of advanced generation materials from the discontinued Pima breeding program to private Pima cotton breeders and other interested parties.