Pima Cotton Genetics

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Abstract

An investigation was conducted to determine the inheritance, allelism, and linkage associations of a spontaneous, male-sterile mutant found in plants of American Pima (Gossypium barbadense L.) cotton. Analyses of F_1, F_2 and BC populations of the mutant indicated that it was inherited as a single, recessive gene. Tests for allelism of the new gene with three previously described recessive male-sterility genes (ms_1, ms_2 and ms_3) were negative. Analyses of F_2 population segregation from crosses to 23 mutant marker stocks produced no evidence of linkage associations. We have proposed that the male sterility mutant be designated male-sterile-13 and be given the gene symbol ms_{13}.

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

A spontaneous male sterility mutant was observed segregating in the Pima breeding nursery in 1986 and was given the experimental designation 86ms. Open-pollinated (OP) seed were collected from individual fertile and sterile plants, and a single sterile plant was transplanted to the greenhouse for crossing. Two progeny rows of plants originating from OP seed of individual fertile plants segregated for fertility and sterility. The above segregating progeny rows were rogued to purity for sterility; and the remaining sterile progeny and the sterile individual maintained in the greenhouse were used for crossing. Sterile plants were crossed as the female parent to two lines with normal phenotypes, PS-6 and P65, to determine inheritance; and to 23 mutant marker stocks representing 10 linkage groups for linkage studies. Segregating F_2 populations were planted in replicated progeny rows in two years,1989 and 1990, and scored as to phenotype. To test for allelism between 86ms and the *G. hirsutum*-derived ms_1, ms_2, and ms_3 genes, marker stocks of ms_1, ms_2 and ms_3 were crossed to the *G. hirsutum* cultivar 'SP21-S' to produce heterozygous F_1 progeny, which were subsequently crossed to an F_1 population of the cross 86ms X PS-6. Progeny of the above crosses were scored for sterility. Chi-square analyses were used to estimate the fit of observed to expected genetic ratios and for detection of linkage. Recombination values were calculated by the maximum likelihood method (Allard, 1956).

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.

Results

In an investigation of the spontaneous mutant 86ms, a good fit to a 3:1 segregation ratio for fertile:sterile plants in three F_2 populations and to a 1:1 segregation ratio in a backcross to 86ms were consistent with the hypothesis of monogenic, recessive inheritance. As expected for a recessive gene, F_1 populations and a backcross to the normal genotype PS-6 cultivar produced only fertile plants. In tests for allelism with ms_1, ms_2, and ms_3, crosses of heterozygous parents would be expected to produce segregating progeny if allelism is present, but only fertile progeny if there is non-allelism. Results indicated that 86ms is non-allelic to the three documented recessive male sterility systems ms_1, ms_2, and ms_3. No linkage associations were detected between 86ms and 23 marker loci in segregating F_2 populations. The lack of linkage of 86ms with R_1 was further evidence that 86ms is non-allelic with ms_3, in that R_1 and ms_3 are about 25 cM apart.

We have proposed that the 86ms sterility mutant be designated male-sterile-13 and be given the gene symbol ms_{13}. The ms_{13} mutant is the first recessive gene for sterility described in *G. barbadense*. Unlike ms_1 and ms_3, the ms_{13} gene has displayed strong environmental stability in both the field and greenhouse at Maricopa. Despite the lack of linkage associations observed in this investigation, the strong unambiguous expression of ms_{13} should make it a useful addition in *Gossypium* spp. mapping efforts. The gene also may have potential in cotton breeding efforts.

In the 1991 backcross program to convert tropical cottons to day neutrality, 97 BC_F_1 populations were advanced to BC_F_2 in the field at Maricopa and 80 BC_F_2 populations were successfully backcrossed to their tropical parent accessions in the greenhouse. At Tecoman, Mexico, 80 backcross populations were grown to produce BC_F_1 seed.

Publications

Percy, R.G. and E.L. Turcotte.1991. Early-maturing, short-statured American Pima cotton parents improve agronomic traits of interspecific hybrids. Crop Sci. 31:709-712.

Percy, R.G. and E.L. Turcotte.1991. Inheritance of male-sterile mutant ms_{13} in American Pima cotton. Crop Sci. 31:1520-1521.