Volume 1 of 2
Pages 1 – 722

1995 PROCEEDINGS BELTWIDE COTTON CONFERENCES

January 4 – 7
San Antonio, TX

National Cotton Council of America

Post Office Box 12285 · Memphis, TN 38182 · (901) 274-9030

The Cotton Foundation

Printed in cooperation with
The Cotton Foundation

Analysis of variance mean squares for yield and yield components.

	df	Lint percentage	100 seed weight	Boll weight	Yield
	2	3.4850	0.1052	0.4007	1425813.284	
	2	19.1771	0.4847	1.4670	2506028.659	
	4	8.7835	0.9112	0.7788	549043.712	
	9	22.0957	2.8763	1.3129	986179.092	
	18	3.9470	1.1352	0.3033	353806.199	
	45	5.5265	0.7716	0.4369	462285.610	
	2	24.7805	1.3981	1.3909	956400.719	
	9	29.8224	2.6713	0.5850	321605.174	
	17	24.9812	1.2833	0.4997	244179.410	
	2	9.7359	0.2652	0.1441	198046.516	
	9	10.9025	2.1128	0.8385	340411.249	
	13	15.1750	0.4328	0.1808	381871.797	
	2	3.2203	0.2019	0.2365	1494034.057	
	9	7.8772	0.9269	0.5466	1009602.560	

GENETIC ASSOCIATION AMONG YIELD AND FIBER TRAITS IN F_2 HYBRID COTTON

Bing Tang[1], J. N. Jenkins[2], J. C. McCarty[2] and R. G. Creech[1]
[1]Mississippi State University and [2]USDA-ARS, Mississippi State, MS

Abstract

...rid cultivars continue to occupy a portion of the cotton (*Gossypium hirsutum*) ...duction areas in the United States and other countries. This study was ...ducted to determine the genetic relationship between traits and heritabilities ...aracteristics in F_2 hybrid population. Sixty-four F_2 hybrids resulted from ...s of 4 commercial cultivars and 16 pest-resistant germplasm lines were ...ated for 5 fiber and 4 yielding traits in four environments at Mississippi ... MS. An additive-dominance model was employed for these traits with ...ent genetic background in different environments. MINQUE(1) method ...sed for estimating genetic variance and covariance components and pre-...g the genetic correlation.

...ults indicated that dominant variance was the major portion of the pheno-... variances for lint yield, lint percentage and boll size. A smaller proportion ...e additive variance for fiber traits and the significance on additive x environment ...ance components suggested that lack of substantial genetic variability for fiber ...s within these F_2 hybrids. However, relatively high values of narrow-sense ...abilities for lint yield and yield component indicated that a sufficient pro-...on of additive genetic variance might be available in F_2 hybrids for effective ...ction. The estimates of the genetic and phenotypic coefficients of correlation ...e pairs of characters, for the most part, seem to be of comparable magni-... Fiber strength was positive-addictively correlated with boll weight, and ...paired dominant correlations between these traits with elongation and 2.5% ...n length were also significant positive. Based on the analysis of heritability ...genetic correlation, the indirect selection for yield improvement only by lint ...entage were expected to be as effective as by lint yield itself for these F_2 ...pulations; however, indirect selection for yield improvement by other traits, ...h as boll number, fiber elongation and micronaire, would be 66%, 79% and ...less effective than selection for lint yield itself, respectively.

INTROGRESSION OF GLANDED-PLANT AND GLANDLESS-SEED TRAIT FROM *G. STURTIANUM* WILLIS INTO TETRAPLOID COTTON PLANTS.

G. Mergeai, V. Bi Irié, P. Dujardin, J.P. Baudoin
Faculté des Sciences agronomiques de Gembloux
Gembloux, Belgium

Abstract

Two trispecific synthetic allotetraploids have been obtained using the Australian diploid species *G. sturtianum*, the main cultivated amphidiploid, *G. hirsutum*, and two American wild diploid species : *G. thurberi* and *G. raimondii*. Observation in the progeny of these trispecific hybrids revealed the expression of the gossypol glands morphogenesis repressive mechanism of *G. sturtianum* in a rather high proportion of the BC1 seeds (6 on 41). In these materials, the glandless-seed and glanded-plant trait seems to be linked to a lethal factor. Only one of the six totally glandless BC1 seeds gave an adult plant. *In vitro* culture of the seed and grafting of the plantlet at a early stage on *G. hirsutum* were necessary to obtain a normal development of this genotype. All the other glandless materials died just after germination or never germinated. The survival plant will be used in a backcrossing programme to obtain the introgression of the glanded-plant and glandless-seed character into *G. hirsutum*.

Introduction

The introgression of the glandless-seed and glanded-plant character from the Australian wild diploid species into upland cotton would transform it in a true food crop whilst preserving one of its natural defence mechanism. Either bispecific or trispecific hybrids can be used to reach this goal (Mergeai, 1993). To date, the main efforts have concerned the exploitation of bispecific hybrids issued from direct crosses between *G. hirsutum* and different Australian species. Most of the hexaploids and pentaploids obtained from those initial crosses are characterised by lower seed gossypol contents than the cultivated parent and a normal gossypol concentration in the other parts of the plant (Muramato, 1969; Dilday, 1986; Koto, 1989). The addition families produced by back... ...sing the pentaploids with *G. hirsutum* show varying gossypol glands density in the seeds and leaves. The only glanded plants issued from glandless seeds produced by this way are multiple addition materials of *G. sturtianum* or *G. australe* on *G. hirsutum* (Altman *et al.*, 1987, Koto, 1989). No monosomic addition line express the glandless seed and glanded-plant trait (Koto, 1989; Rooney *et al.* 1991). Another way to achieve the introgression is to create trispecific hybrids combining *G. hirsutum* with an Australian species and either a D or a A diploid species. Shujing and Biling (1993) followed this last scheme. They crossed *G. bickii* with *G. arboreum* to obtain a sterile diploid hybrid whose fertility was partially restored by chromosome doubling. The resulting allotetraploid was then crossed with *G. hirsutum* to produce a fertile trispecific hybrid. The bispecific and trispecific allotetraploids showed differences in the expression of the glandless seeds-glanded plant trait. All plants of each hybrid showed glands in their aerial parts but only the kernels of the bispecific allotetraploid seeds were totally glandless. A similar observation was made by Mergeai (1992) on an (*G. arboreum* x *G. australe*) allotetraploid. All the seeds of the *bickii-arboreum-hirsutum* triple hybrid showed a few small and light coloured glands on the edges of the cotyledons. No details are available on the glands distribution of the seeds produced from the backross of the *arboreum-bickii-hirsutum* trispecific hybrid. From the literature (Shujing and Biling, 1993) it appears that no plant expressing the glandless seed-glanded plant trait has been produced yet through this method. Cytogenetics observations on the trispecific hybrid showed an extremely low number of bivalents in Metaphase I. This result questions the actual possibilities to exploit AADC or AADG trispecific hybrids in an hybridization programme aiming at the introgression of the glanded-plant and glandless-seed trait into *G. hirsutum*. The phyletic distance between D and G genomes seems to be too large to allow the introgression of the concerned character in the D subgenome of *G. hirsutum*. Given the closer phyletic relations existing between A and C species, it is expected to obtain better results using ACDD trispecific hybrids. We decided therefore to develop this kind of material and to check its potentialities for the introgression of this character.

Material and methods

Two trispecific allotetraploid hybrids including an Australian diploid species have been created within the cotton collection maintained at the Tropical Crop Husbandry Department of the Faculty of Agricultural Sciences of Gembloux (Marechal, 1983). The first trispecific allotetraploid was obtained according to the method developed by Beasley (1940). In a first step, a fertile bispecific allotetraploid was created by doubling the chromosome number of the allodiploid

hybrid resulting from the cross : *G. thurberi* x *G. sturtianum*. This synthetic allotetraploid was then backcrossed by *G. hirsutum* to give the trispecific hybrid *G. thurberi* - *G. sturtianum* - *G. hirsutum* (C1D1AhDh) (designated by the initials TSH). The second trispecific allotetraploid was obtained following the scheme developed by Deodikar (1949). The first step was to create an allohexaploid which resulted from colchidiploidization of the triploid hybrid issued from the cross *G. hirsutum* x *G. raimondii*. In a second step, this allohexaploid was crossed by *G. sturtianum* to develop the trispecific hybrid *G. hirsutum* - *G. raimondii* - *G. sturtianum* (AhDhD5C1) (designated by the initials HRS).

Both trispecific hybrids have been backcrossed by C2 and NC8 *G. hirsutum* varieties originating from Zaire. To increase the rate of success in the backcrosses, we applied a growth regulator solution (50 mg/l NOA - 100 mg/l GA) on the ovaries according to the formula proposed by Altman (1988). To evaluate glands density of all the hybrids obtained, the seeds were soaked for one hour in water after removal of their integuments. The glands density of the hybrid seeds was assessed under a binocular microscope according to a visual scale ranging from 0, for totally glandless, to 10, for totally glanded.

After assessment of their glands density the seeds were either planted directly in jiffy-pots containing a mixture of sand, peat and compost in equal proportion, or transferred on the *in vitro* culture media developed by Stewart & Hsu (1977) for cotton germinated embryos. Adult plants were cultivated in greenhouses at Gembloux.

Results and discussion

Among the material created in Gembloux, the expression of the glanded plant-glandless seed trait has been assessed in all hybrids including the Australian species *G. sturtianum* i.e. the bispecific allotetraploid *G. sturtianum* x *G. thurberi*, the trispecific allotetraploid hybrids TSH and HRS and their BC1 progenies. A similar expression of the character is observed in the bispecific allotetraploid and the two trispecific hybrids : the seeds have a reduced number of glands that are mainly located on the edges of the cotyledons. After germination, the number of glands increases to reach a normal density on the aerial parts of the plant. The trispecific hybrid seeds produced by Shuijing & Biling (1993) from the backcross of the bispecific allotetraploid *G. arboreum* x *G. bickii* with *G. hirsutum* showed a similar glands density. These results confirm data obtained by Mergeai (1992) : the later pointed out a better expression of the repressive mechanism if an Asian diploid species (genome A) was associated with an Australian cotton species in a synthetic bispecific allotetraploid.

Thanks to the application of growth regulators, 41 viable seeds were obtained from the two trispecific allotetraploids (Table 1). For each hybrid, the backcross success rate is similar and very low. In our conditions, about 17 crosses are necessary to obtain one seed. Whitout application of growth regulators, we could not obtain BC1 seeds from the TSH trispecific hybrid while very few seeds were collected from the HRS hybrid (1 seed for more than 100 crosses).

The glands distribution of the BC1 seeds is very variable (Table 2). It ranges from "0" (totally glandless) to 9 (almost similar to *G. hirsutum* glanding pattern). The proportion of totally glandless seeds was relatively high (6 on 41). The distribution of the glands density frequencies of the rest of the seeds is characterised by an asymmetric bell shape.

In the BC1 population, the glandless trait appears to be linked with a lethal factor. Only one of the six glandless BC1 seeds gave rise to a viable plant. In order to facilitate the development of this plant, it was necessary to cultivate the seed *in vitro* for three weeks and then to graft the plantlet on a vigorous *G. hirsutum* seedling. All the other materials issued from glandless BC1 seeds ceased to grow before the spreading of the cotyledons. The only surviving plant from the six BC1 glandless seeds flowers abundantly and shows a normal density of gossypol glands on its aerial parts. This plant will be used in a backcrossing programme to obtain the introgression of the glanded-plant and glandless-seed character of *G. sturtianum* into *G. hirsutum*.

References

Altman, D.W., D.M. Stelly and R.J. Kohel. 1987. Introgression of the glanded-plant and glandless-seed trait from *Gossypium sturtianum* Willis into cultivated upland cotton using ovule culture. Crop Sci. 27:880-884.

Altman, D.W. 1988. Exogenous hormone applications at pollination for in vitro and in vivo production of cotton interspecific hybrids. Plant Cell Rep. 7:257-261.

Beasley, J.O. 1940. The production of polyploids in *Gossypium*. J. Hered. 31:39-48.

Deodikar, G.B. 1949. Cytogenetic studies on crosses of Gossypium anomalum with cultivated cottons. I. (G. hirsutum x G. anomalum)doubled x G. hirsutum. Ind. J. Agric. Sci. 19:389-399.

Dilday, R.H. 1986. Development of cotton plant with glandless seeds and glanded foliage and fruiting forms. Crop Sci. 26: 639-641.

Koto, E. 1989. Tentative de transfert du caractère "retard à la morphogénèse des glandes à gossypol"I. Caractéristiques des hexaploides G. hirsutum x G. sturtianum et G. hirsutum x G. australe. 1re Conférence de la recherche cotonnière africaine, Lomé, Togo, 31 janv.-2 fév., 1989, IRCT, Montpellier, Tome I. 167-173.

Maréchal, R. 1983. A collection of interspecific hybrids of genus *Gossypium*. Coton Fibres Trop. 38:240-246.

Mergeai, G. 1992. New perspectives concerning the methodology to be used for introgression of the glanded-plant and glandless-seed character in cultivated cotton (*Gossypium hirsutum* L.). Coton Fibres Trop. 47: 113-119.

Mergeai G. 1994. Interspecific hybridization for cotton improvement. *In* : Cotton biotechnology. FAO regional office for Europe technical series 32. FAO, Rome, Italy. 23-28.

Muramato, H. 1969. Hexaploid cotton : some plant and fiber properties. Crop Sci. 9:27-29.

Rooney, W.L., D.M. Stelly and D.W. Altman. 1991. Identification of four *Gossypium sturtianum* monosomic alien addition derivatives form a backcrossing program with *G. hirsutum*. Crop. Sci. 31:337-341.

Stewart J. McD. and C.L. Hsu. 1977. In-ovulo embryo culture and seedling development of cotton (*Gossypium hirsutum* L.) Planta 137:113-117.

Shujing, Z and L. Biling. 1993. Studies of the "glandless seeds-glanded plant" trait from *Gossypium bickii* into cultivated upland cotton (*G. hirsutum*). Coton fibres Trop. 48:195-199.

Table 1. Production of BC1 seeds by HRS and STH trispecific hybrids.

Hybrids	Number of seeds produced	Number of crosses	Average numbers of crosses for one seed
HRS x NC8	5	175	35
HRS x C2	12	157	13
TSH x NC8	12	205	17
TSH x C2	12	150	13
Total	41	687	17

Table 2. Assessment of the gossypol glands density in trispecific BC1 seeds.

Glanding classes	Hybrids				Cumulated frequencies (%)
	HRS x C2	HRS x NC8	TSH x C2	TSH x NC8	
0	2	0	2	2	6(15)
1	0	0	1	0	1(2)
2	2	0	0	0	2(5)
3	1	1	0	2	4(10)
4	1	1	3	0	5(12)
5	0	1	0	3	4(10)
6	1	2	2	3	8(19)
7	2	0	2	2	6(15)
8	1	0	2	0	3(7)
9	2	0	0	0	2(5)
10	0	0	0	0	0(0)
Total	12	5	12	12	41 (100)