Inheritance of important Properties in Half Diallel Hybrids of some Glandless Cotton (*Gossypium hirsutum* L.) Cultivars

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ABSTRACT

This study was carried out in 1992-93 under South Eastern Anatolian Project (GAP) region conditions to investigate inheritance of yield, yield components and fiber properties in a population containing parents and half diallel hybrids of ten glandless cotton cultivars. Data were analyzed according to 1) Jones (1965), 2) Griffing (1956) method 2, model 1 and 2 and 3) Hayman (1954) type half diallel analysis. For investigated characteristics, the narrow sense heritabilities varied between 0.07 and 0.48. For seed cotton yield the best four parents proved to be M11, LA-G-77-45, LA-G-75-26 and LA-G-70-18 and the best four combinations of hybrids were LA-G-70-18 x LA-G-75-72, LA-G-70-18 x TX-GN-8-76, M11 x RDC-10 and LY1372 x REX. For seed oil percentage, the best parent were RDC-10, for seed protein percentage the best parent was LA-G-77-45 and the best combinations of hybrids were TX-GN-8-76 x REX and M11 x LA-G-75-26.

Introduction

The cotton plant is one of the most important raw material for the textile industry because of fibers; the food and feed industry because of the 17-24% oil content of the seeds and 40-43% protein content of the meal (Incekara, 1979). However, many economic problems arise in the food and feed industry because of an alkaloid, gossypol that is present throughout the plant except roots and is toxic to humans, monogastric livestock and poultry. Gao *et al.* (1984), noted that oil content of glandless cultivars was 1.8 times higher than oil content of soybean and average protein content of glandless cultivars was 41-45% higher than protein content of soybean. Recently, glandless cultivars have gained importance as food as well as fiber plants because of imp0rovements in glandless cotton cultivars (Bourely and Hau, 1991).

This study aimed at investigating the inheritance of yield and yield components in parents and hybrid populations obtained by half diallel crossing of 10 glandless cotton cultivars.

Materials and Methods

This study involved 10 glandless cotton cultivars (*Gossypium hirsutum*) L (LY 1372, M 11, LA-G-75-21, LA-G-75-26, LA-G-70-18, TX-GN-8-76, LA-G-75-72, REX, LA-G-77-45, RDC-10). Seeds were provided through Cukurova University, Cotton Research and Application Centre from CIRAD-CA (formerly IRCT) in France. There were two sowing dates at the Centre in the first year, (23.04.1992 and 08.05.1992. Cultivars grown under normal conditions were crossed (Poelhman, 1959) as a half diallel according to Griffing (1956) and were also inbreed. In the second year, a trial was established in three randomized blocks in the same experiment field, using seeds of 45 F_1 hybrids and parents.

Seed cotton yield, yield components and fiber properties were measured. Data collected were analyzed in half diallel mating design according to a) Jones (1965), b) Griffing (1956), method II, model 1 and 2 and c) Hayman (1954). In diallel analyses, the statistical package PRODIANc 1.0 (Efe and Bek, 1994) developed for half diallel tables (parents + one set of F1s) was used.

Results and Discussion

Analysis for the half diallel table according to Jones (1965) and for general and specific combining ability (GCA and SCA) according to Griffing (1956) are given in Table 1. Prediction of additive variance and general combining ability: (a) was significant for all characters except fiber length, seed oil and seed protein percent. Variance of dominance; (b) was not significant for the any of the characters investigated. While one of the components of dominance variance (b_1), that determines average variance of dominance and heterosis, was significant for seed cotton yield, seed cotton weight per boll and boll weight but was not significant for the other characteristics, a second component (b_2) determines that dominance alleles are collected in one parent and (b_3) indicates that dominance alleles are dispersed to the parents and, at the same time, determines specific combining ability, were not significant statistically for any characters investigated. Many researchers had similar results (Konoplya, 1984; Thombre *et al.*, 1987; Jagtap and Kolhe, 1987).

Variance of GCA was only significant for seed cotton weight per boll, boll weight, carpel number per boll, 100-seed weight, plant height, ginning percentage and

fiber length, whereas both variance of GCA and variance of SCA were significant for seed cotton yield, number of bolls per plant, fiber fineness and fiber strength. Luckett (1989), Subrahmanyam *et al.* (1989) and Ji and Zhu (1988) found similar results.

Calculated genetic parameters and their proportions to each other (according to Hayman, 1954) are given in Table 2. Variance of dominance (H_1) was only statistically significant for seed cotton weight per boll, boll weight, fiber length and seed oil percentage. For the other characteristics both additive variance (D) and dominance variance were significant. The parameter H_2 indicates corrected dominance variance and was significant for all characteristics investigated except seed protein percentage. The parameter E that indicates environmental variance was significant for all characteristics investigated. Negative F values for seed cotton weight per boll, boll weight, carpal number per boll, 100-seed weight, fiber strength, seed oil and seed protein percentage indicate that recessive alleles may exceed dominance alleles for these characteristics in the parents. Conversely, positive F values for the other characteristics indicate that dominance alleles may exceed recessive alleles for these characteristics in the parents. Some researchers reported similar results (Gencer, 1982; Selim *et al.*, 1984; Isroilov, 1990).

The $(H_1/D)1/2$ gives average degree of dominance and shows that partial-dominance was determined for carpel number per boll, 100-seed weight, plant height and ginning percentage while over-dominance was determined for the other characteristics except seed protein percentage. Gencer (1980) and Gesos and Toroev (1990) noted similar results. This proportion couldn't be calculated for seed protein percentage since the parameter D was found negative. According to the value $K=h_2/H_2$ that indicates the number of effective genes for the characteristics investigated in parent; it was estimated that seed cotton weight per boll, boll weight, 100-seed weight were determined by one pair of gene, number of gene pairs which determine the other characteristics investigated couldn't be estimated because the K value calculated was very small or couldn't be calculated since the parameter D was negative (Demir and Forkman, 1975; Yildirim, 1975: Jinks, 1954; Baker and Verhalen, 1973).

Narrow sense heritability varied from 0.07 to 0.48 for the all characters except seed protein percentage. Sinde and Desmukh (1985) and Gencer (1982a) reported similar heritability. Seed protein percentage heritability couldn't be estimated because the parameter D was negative.

Conclusions

As a result of these findings, selection for seed cotton weight, carpel number per boll, 100-seed weight, plant height, boll number per plant, ginning percentage, fiber strength, fiber fineness, was recommended in early generations since heritabilities were higher and the additive variances were statistically significant. However, for seed cotton weight per boll, boll weight, fiber strength and seed oil percentage bulk selection was recommended since the dominance variances were statistically significant. The best parents and combinations of hybrids were determined regarding the effects of GCA for parents and the effects of SCA for hybrids for each of the investigated characteristics (Table 3).

References

Bourely, J. and B. Hau. (1991): Glandless cotton plants. A source of oil and protein for human consumption. Report on Five Years Research. Cotton et Fibers Tropicales. 37-66.

Demir, I. and G. Forkman. (1975): Studies on inheritance of flower colour in *Mathiola incana* plant. Ege Univ., Issue of Agricultural Faculty. No:281.

Efe, E. and Y. Bek. (1994): Half diallel analysis and a computer program: PRODIANc. Symposium on Computer Applications in Agriculture, Izmir.

Gao, Z. C., J.F. Li and Y. X. Jiang. (1984): Glandless cotton seeds are high quality protein sources. Zhongguo Mianhua (China Cotton). No:6:19-21.

Gencer, O. (1980): Studies on inheritance of yield and fiber properties in diallel hybrids of eight cotton cultivars of the species *Gossypium hirsutum* and *Gossypium barbadense*. Symp. Plant Breeding, 1979. Agricultural Research Institute of Ege Region. Num:17/41(1):31-48. Menemen, Izmir.

Gencer, O. (1982): A study on genetic structure of yield and yield components in diallel hybrids of some cultivars of the two cotton species. TUBITAK 7th Congress of Science, Ankara No:552(115):251-264.

Gencer, O. (1982a): A study on heterosis and heritabilities of yield and yield components in interspecific cotton hybrids. TUBITAK 7th Congress of Science, Ankara. No:552(115):281-293.

Gesos, K. and D. Toroev. (1990): Regional breeding/genetic evaluation of characters. Khlopok. No:1: 36-38.

Griffing, B. (1956): Concept of general and specific combining ability in relation to diallel crossing systems. Austr. Jour. Biol. Sci. 9:463-493.

Hayman, B.I. (1954): The theory and analysis of diallel crosses. Genetics. 39:789-809.

Incekara, F. (1979): Industrial Plants and Their Breeding. Fiber Plants and Their Breeding. 3rd Ed., Ege Univ. Press, Izmir.

Isroilov, M.Z.H. (1990): Breeding value of cotton varieties and lines for fiber length in a system of diallel crosses. (Tashkent, Uzbek) Plant Breeding Abstracts (1991), vol:61, No:12, Abstract No:11363, Pp. 1450."

Jagtab, D.R. and A.K Kolhe. (1987): Graphical and combining ability analysis in Upland cotton. Indian Jour. Agric. Sci. 57(7):456-464.

Ji, D.F. and J. Zhu. (1988): Genetic analysis of oil and amino acid content in shelled seed of Upland cotton hybrids. Acta Agronomica Sinica. 14(1):1-6.

Jones, R.M. (1965): Analysis of variance of the half diallel table. Heredity. 20:117-121.

Konoplya, S.P. (1984): Analysis of quantitative characters of *Gossypium barbadense* in diallel crosses. Turkmenistan SSR Ylymlar Akademijasynyn Habarlary, Biologik Ylymlaryn. No:2: 40-46.

Lucket, D.J. (1989): Diallel analysis of yield components, fiber quality and bacterial blight resistance using spaced plants of cotton. Euphytica. 44(1-2):11-21.

Poelhman, J.M., 1959. Breeding Field Crops. Holt, Rinehart and Winston Inc., New York, USA.

Selim, A.K.A., M.A. Megahead and A.E. El-Nazer, 1984. Heterosis and genetic variance components for seed cotton yield in crosses between Egyptian and Russian cultivars. Agr. Res. Review. 59(9):83-95.

Sinde, V.K. and M.D Desmukh, 1985. Genetic variability for yield and character association in Deshi cotton. Jour. of Maharashtra Agr. Univ. 10(1):21-22.

Subrahmanyam, Y., N.P. Mehta, J.C. Patel, M.C. Bhalod, J.K. Iyer. and V.G. Munshi. (1989): Genetic studies of fiber fineness in Asiatic cotton. J. Indian Soc. Cotton Improvement. 14(2):153-158.

Thombre, M.V., S.D. Pathade and F.B. Patil. (1987): Genetic analysis for boll number, boll weight and seed cotton yield. Jour. of Maharashtra Agr. Univ. 12(3):306-308.

Yildirim, M.B. (1975) Analysis of population of some agronomic characteristics in diallel hybrid progenies of five wheat cultivars. Plant. 2:204-220.

Table 1. F tests for diallel table (Jones, 1965) and for general and specific combining ability (Griffing, 1956) in 10x10 half diallel hybrid population).

Characteristics	Source of variation						
	a	b	b1	b2	b3	GCA	SCA
Seed cotton yield (kg/da)	5.04**	0.55	4.15*	0.76	0.40	15.12**	1.66*
Seed cotton weight per boll (g)	2.25*	0.49	5.56*	0.26	0.40	6.74**	1.46
Boll weight (g)	3.00**	0.45	5.49*	0.26	0.35	9.00**	1.34
Carpal number per boll	5.97**	0.29	0.03	0.11	0.35	17.89**	0.87
100-seed weight (g)	6.69**	0.31	1.23	0.22	0.30	20.07**	0.92
Plant height (cm)	6.35**	0.46	0.28	0.63	0.42	19.04**	1.38
Boll number per plant	2.16*	0.62	2.71	1.59	0.32	6.49**	1.87**
Ginning percentage (%)	7.87**	0.41	1.93	0.41	0.36	23.62**	1.22
Fiber length (mm)	1.25	0.32	0.89	0.24	0.32	3.75**	0.95
Fiber strength (Pres.)	2.31*	0.51	0.05	0.37	0.56	6.93**	1.53*
Micronaire Value	3.63**	0.62	1.19	0.87	0.54	10.90**	1.87**
Seed oil percentage (%)	0.58	0.37	0.76	0.35	0.36	1.16	0.74
Seed protein percentage (%)	0.78	0.41	0.01	0.27	0.46	1.57	0.82

* and ** Significant at 0.05 and 0.01

Table 3. Selected parents and selected hybrids for investigated characteristics in 10x10 half diallel hybrid population.

Character	Selected parents	Selected hybrids	Character	Selected parents	Selected hybrids
Seed cotton yield	M 11 LA-G-77-45 LA-G-75-26 LA-G-70-18	LA-G-70-18 x LA-G-75-72 LA-G-70-18 x TX-GN-8-76 M 11 x RDC-10 LY 1372 x REX LA-G-75-21 x LA-G-75-26	GOT %	LA-G-75-26 LA-G-70-18 LY 1372 LA-G-75-72	LY 1372 x LA-G-70-18 LA-G-75-21 x LA-G-77-45
Boll Weight S/C	M 11 REX RDC-10	M 11 x REX REX x RDC-10 LA-G-75-21 x TX-GN-8-76 LA-G-75-26 x REX	Fiber length	LA-G-70-18 LA-G-75-21	------
Boll weight Lint	M 11 REX	M 11 x REX LA-G-75-21 x TX-GN-8-76 REX x RDC-10 LA-G-75-21 x LA-G-77-45	Fiber strength	LA-G-75-21 TX-GN-8-76 LA-G-70-18 LA-G-75-72	M 11 x LA-G-75-21 M 11 x LA-G-77-45 M 11 x LA-G-75-26
Carpal number per boll	TX-GN-8-76 LY 1372 RDC-10 REX	LA-G-75-26 x REX M 11 x LA-G-75-72	Micron-aire	LA-G-77-45 RDC-10 M 11 LA-G-75-26	LA-G-75-21 x LA-G-77-45 M 11 x REX REX x RDC-10 M 11 x LA-G-77-45
Seed Index	M 11 LA-G-75-21 LA-G-77-45	M 11 x REX	Seed oil %	RDC-10	------
Plant height	LA-G-70-18 LA-G-75-26 M 11 LA-G-75-21	LY 1372 x REX LA-G-75-21 x LA-G-75-26 LA-G-75-26 x REX LA-G-77-45 x RDC-10 M 11 x RDC-10	Seed protein %	LA-G-77-45	TX-GN-8-76 x REX M 11 x LA-G-75-26
Bolls per plant	M 11 LA-G-70-18	LA-G-75-21 x LA-G-75-26 LY 1372 x REX M 11 x LA-G-75-26			

Table 2. Genetic parameters and their proportion to the others (Hayman, 1954) for investigated characteristics in 10x10 half diallel hybrid population.

Parameters	Seed cotton yield (kg/da)	Boll Weight S/C (g)	Boll weight Lint (g)	Carpal number per boll	100-seed weight (g)
D	2297±407**	0.0219±0.0268	0.0638±0.0379	0.0358±0.0056**	1.0395±0.1311**
F	40±939	-0.1303±0.0619*	-0.1934±0.0874*	-0.0115±0.0130	-0.1702±0.3024
H_1	37423±8656**	0.2439±0.0571**	0.3182±0.0807**	0.0287±0.0120*	0.7921±0.2790*
H_2	3176±736**	0.2704±0.0486**	0.3515±0.0686**	0.0343±0.0102**	0.6473±0.2371*
h_2	1909±493**	0.3709±0.0325**	0.5553±0.0459**	0.0066±0.0068	1.1586±0.1587**
E	1322±123**	0.1382±0.0081**	0.1936±0.0114**	0.0211±0.0017**	0.5602±0.0395**
$(H_1/D)_{1/2}$	1.2763	3.3377	2.2338	0.8955	0.8729
$H_2/4\ H_1$	0.2122	0.2772	0.2761	0.2985	0.2043
KD/KR	1.2449	0.0575	0.1913	0.6961	0.8285
$K=h_2/\ H_2$	0.6010	1.3713	1.5798	0.1913	1.7901
Heritability (Narrow)	0.35	0.23	0.29	0.41	0.48
Heritability (Broad)	0.59	0.49	0.51	0.58	0.60

(* and ** Significant at 0.05 and 0.01)

Table 2. (Continued)

Parameters	Plant height (cm)	Bolls per plant	GOT (%)	Fiber length (mm)	Fiber strength (Pressley)	Micronaire Value	Seed oil %	Seed protein %
D	109±16**	10.0±1.05**	5.3±0.48**	0.2245±0.1218	11.44±5.9*	0.0829±0.0235**	0.4175±6.2532	-0.9315±2.0338
F	48±36	13.02.4**	2.56±1.11*	0.1412±0.2811	-2.43±13.6	0.0252±0.0542	-4.8568±14.4281	-2.3936±4.6925
H_1	107±34**	15.5±2.2**	3.13±1.03**	1.0110±0.2593**	43.28±12.55**	0.2245±0.0500**	32.8889±13.3106*	5.4842±4.3291
H_2	85±29**	9.24±1.9**	2.20±0.873*	0.8325±0.2204**	43.23±10.66**	0.1750±0.0425**	32.7788±11.3125**	5.9469±3.6792
h_2	-5±19	3.3±1.3*	1.61±0.59*	0.1481±0.1475	-5.39±7.14	0.0084±0.0285	-0.9439±7.5722	-1.4399±2.4627
E	40±5**	4.1±0.3**	1.44±0.15**	0.5556±0.0367**	17.64±1.78**	0.0735±0.0071**	29.0838±1.8854**	4.0569±0.6132**
$(H_1/D)_{1/2}$	0.9919	1.2701	0.7667	2.1220	1.9448	1.6450	8.8752	----
$H_2/4\ H_1$	0.1995	0.1492	0.1754	0.2059	0.2497	0.1949	0.2492	----
KD/KR	1.5762	3.2906	1.9102	1.3479	0.8965	1.2032	0.2082	----
$K=h_2/\ H_2$	-0.0622	0.3588	0.7318	0.1779	-0.1248	0.0482	-0.0288	----
Heritab. (N)	0.40	0.18	0.48	0.15	0.20	0.31	0.07	----
Heritab. (B)	0.61	0.47	0.63	0.38	0.50	0.57	0.27	----