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HETEROSIS AND COMBINING ABILITY FOR AGRONOMIC AND FIBER QUALITY TRAITS IN INTRA-AND INTERSPECIFIC CROSSES OF COTTON

BY

El-Marakby, A.M.*; Afaf, M.Tolba* and Heba, H. Hamed**

* Agron. Dept., Fac. Of Agric., Ain Shams Univ., Cairo, Egypt
** Cotton Res. Institute, Agric. Res. Center, Giza, Egypt

ABSTRACT

Seven cotton genotypes involving three Upland (*G. hirsutum*, L.) varieties, namely; Deltapine, Tamcot C.E and Australian 6100 and four varieties of *G. barbadense*, L. viz., Giza 70, Giza 83, Giza 89 and Sea Island were crossed in 2003 season in a half-diallel mating system, excluding reciprocals. The seven parents and their 21 F_1s were evaluated in 2004 for 13 agronomic and fiber traits.

The results indicated that mean squares due to parents and crosses were highly significant denoting the presence of reasonable degrees of variability for all, 13 traits studied. Some crosses between *G. hirsutum* x *G.barbadense* varieties exhibited good performance, for instance Tamcot C. E x Giza 83 produced essentially the same yield as Tamcot C. E and possessed higher yield, early maturing, equal fiber strength, longer and finer fibers than the Egyptian long–staple cv. Giza 83, thus can be used for hybrid cotton production. Significant desirable positive or negative better parent heterosis was observed in some F_1s for the majority of traits.

General combining ability (GCA) was significant for all traits, except for boll weight, seed index, No. loculi/boll and micronaire value. Specific combining ability (SCA) was significant for all traits, except for seed cotton yield and some of its components, micronaire value and yellowness. The GCA/SCA ratio exceeded unity for 11 characters indicating predominance of additive and additive x additive types of gene action in the inheritance of these traits, while the ratio was less than unity for seed index and lint% revealing more importance of non-additive. Based on GCA effects, each of the 7 parents proved to be good general combiner for some traits. Some F_1 combinations were characterized by significant SCA effects and involved at least one parent as good general combiner in all traits, therefore it could be useful in a pedigree program for varietial improvement purposes.

Key words: *G.hirsutum, G.barbadencse, Diallel, Heterosis, Combining ability, Yield components, Fiber quality*

INTRODUCTION

The frequent crossing between Egyptian cotton cultivars followed by rigid selections resulted in exhausting the genetic variability and narrowing the genetic base, hence reducing the chances for further effective selection. It is imperative for this reason to use other genotypes belonging to barbadense species such as Sea Island or genotypes belonging to the American hirsutum species for intra and interspecific crossing with Egyptian cultivars hoping to generate new recombinants amenable to effective selection in a program for pedigree breeding. However, for "hybrid cotton breeding" heterotic effects in interspecific cotton hybrids between *G. barbadense*, L x *G. hirsutum*, L offer possibility for achieving progress in cotton production, this is because data on previous experiments investigating interspecific hybrids indicated an overall tendency for F_1s to possess the high yielding ability of the *G. hirsutum*, L. parents and a close resemblance in fiber properties of *G. barbadense*, L. (Davis, 1979; Weaver *et al.*, 1984; Hassan *et al.*, 2005; Sultan, 2008). In this respect, Potdar *et al.* (1999) stated that, among the cotton growing countries, India ranks first in area (9.16 million ha) which produced about 17.15 million bales of cotton. They added that, from this 9.16 million ha, an area of about 40% was cultivated with hybrid cotton. However, the cost of producing hybrid cotton seed could be the deciding factor in determining if hybrid cotton is to be planted on a large scale. In India, the conventional hand emasculation and pollination method was used for the development of a number of intra-specific and inter-specific hybrids released for commercial cultivation on a large acreage, depending upon that manual labor in India is abundant and inexpensive. Singh *et al.* (1980) reported that the first hybrid which ushered in the "Hybrid Cotton Era" in India was an intraspecific cross between two *G. hirsutum* strains. This hybrid was released in 1968 under the name of "Hybrid - 4"; followed by a successful extra–long staple interspecific (*G. hirsutum* L x *G.barbadense* L) hybrid popularly known as "Varalaxmi". The technique used in India is impractical in many other cotton producing regions especially where labor costs are high. However, with the achieved development of a complete cytoplasmic male-sterile and a dependable genetic fertility restorer system in cotton (Meyer, 1975); commercial production of F_1 hybrid seed is feasible. However, the technique used in India for development of cotton hybrids between *G. hirsutum* x *G. barbadense* seems to be practical in Egypt since manual labor is abundant and inexpensive. Some isolated regions, such as "Toshki" or others can be prospective areas for "hybrid cotton production" where large acreage can be devoted for this purpose.

The diallel-cross technique provides information about general (GCA) and specific combining ability (SCA) effects of parents and is helpful in estimating various types of gene action. In addition, the diallel analysis is a systematic method for identifying those parents and hybrids that have superior combinations of the characters of interest. GCA involves mostly additive and additive × additive gene effects. SCA, on the other hand, depends upon non-additive gene effects, which involves dominance and epistatic components of genetic variation. Knowledge of the relative magnitude of additive and non-additive effects would be very useful in designing an efficient breeding program. Mid- and better parent desirable heterotic effects were found for earliness, yield components and fiber quality properties in intra - or inter-specific cotton crosses (Soomro *et al.*, 1995; Awad, 2001; El-Helw, 2002; Hassan *et al.*, 2005; Rabie *et al.*, 2007 and Sultan, 2008).

Several workers reported contradicting results with respect to the role and importance of GCA and SCA effects in the inheritance of agronomic traits in their diallel crosses (Jagtab and Kohle, 1987; Meredith, 1990; Hendawy, 1994; Nassar *et al.*, 1995; Patiel *et al.*, 1997; Rady *et al.*, 1999; Hassan *et al.*, 2005; Rabie *et al.*, 2007 and Sultan, 2008). The predominance of additive genetic effects in the inheritance of fiber technological properties was reported by Abo El-Zahab (1983) and El-Feki *et al.* (1994) while Lasheen (2003) found that non-additive effects were predominant in the case of fiber strength and 2.5% span length.

The present study was designed to determine heterosis and general and specific combining ability for earliness index, yield and its components and fiber quality properties in a 7-parent half diallel cross involving 3 varieties of American Upland cotton (*G. hirsutum*, L.) and four varieties belonging to *G. barbadense*, L.

MATERIALS AND METHODS

The present investigation was carried out during the two successive seasons 2003 and 2004. In the first season, all possible crosses were made, excluding reciprocals, in a diallel mating design involving seven divergent parental cotton genotypes at Giza Agric. Res. Station, Agric. Res. Center. The genotypes included four varieties belonging to *G.*

barbadense, L., namely; the Egyptian cvs. Giza 83, Giza 89 (long-staple) and Giza 70 (extra-long staple) as well as the exotic extra-long variety Sea Island. The other three genotypes belong to *G. hirsutum*, L., involving the American Upland varieties; Deltapine, Tamcot C.E and Australian 6100. The pure seed of the parental genotypes were supplied by Cotton Breeding Section, Cotton Res. Institute, ARC. In the 2nd season 2004, the seven parents along with their 21 F_1's were sown on 4th April in complete randomized block design with four replications. The experimental plot consisted of 4 rows, 3.5 m long and 60 cm apart. Hills were spaced at 25 cm within rows and seedlings were later thinned to two plants/hill. All cultural practices were followed throughout the growing season as usually done with ordinary cotton culture. Data were recorded for the following traits:

1- Earliness index; determined as percent of seed cotton yield of first pick to total seed cotton yield/plot collected from two picks.
2- Seed cotton yield; estimated as weight of seed cotton yield/plot, then converted to yield per fed. (Ken/fed).
3- Lint parentage (lint %); ratio of lint to seed cotton sample expressed as percentage.
4- Number of bolls per plant; the average number of open bolls/plant of 10 plants picked at random from each plot.
5- Boll weight; the average boll weight in grams of 50 fully developed bolls picked from each plot.
6- Number of loculi/boll; determined as average of 50 bolls from each plot.
7- Number of seeds/boll; average number of seeds per boll from 5 bolls from each plot.
8- Seed index; determined as weight of 100 seeds in grams from each plot.

Fiber quality properties were measured by using the High Volume Instrument (HVI) according to A.S.T.M. (1984): D-4605-86, as follows:

9- Fiber length; expressed as upper half mean length in (mm).
10- Fiber strength; expressed as gram/tex.
11- Micronaire reading (Mic.); this value determines fineness and maturity in combination.
12- Lint color "reflectance" (Rd %).
13- Lint color "yellowness degree" (+b).

The obtained data were statistically analyzed as randomized complete blocks design according to Snedecor and Cochran (1981). L.S.D was used to compare differences among means at 5% and 1% levels. Heterosis was determined as percentage of better parent (BP) values of each cross as follows:

$$\text{Heterosis } (\%) = \left[\left(\overline{F_1} - \overline{BP}\right)/\overline{BP}\right] \times 100$$

General and specific combining ability estimates were obtained by employing Griffing's (1956) diallel cross analysis designated as method 2 model 1.

RESULTS AND DISCUSSION

A-Analysis of variance and mean performance:

Analysis of variance presented in Table (1) indicate that mean squares due to genotypes; parents and crosses were highly significant for earliness index, yield and its components and fiber technological traits indicating the presence of sufficient genetic variability in the population and the validity to proceed for further analysis.

The mean performance of seven parental varieties and their crosses is presented in Table (2). Concerning earliness index, the results show that the Upland varieties (*G. hirsutum*, L.) tended to be earlier in maturity as they gave the highest ratio of 1st pick with Tamcot C.E. was the earliest variety giving 76.15%, while in the Egyptian cultivars along with Sea Island (*G. barbdense*, L.) gave the lowest earliness index. Giza 89 cv. was the latest giving a ratio of 54.75%. With regard to F_1's, earlier crosses tended to be produced from crossing between parents belonging to *G. hirsutum*, L for instance, Deltapine × Tamcot C.E. (78.75%) and Australian 6100 × Tamcot C.E. (77.75%). The interspecific crosses tended to give moderate earliness such as Australian 6100 × Giza 83 (71.68%) followed by Sea Isalnd x Australian 6100 (70.98%) and so on. The intra-specific crosses within *G. barbadese*, L. tended to give the lowest ratios of 1st pick such as Giza 70 × Giza 89 which was the latest with a ratio of 58.75%.

Concerning yield and its component traits, the American Upland variety Tamcot C.E possessed the highest desirable values of boll weight (4.67g), number of loculi/boll (4.79), number of seeds/boll (32.19), lint percentage (39.87%), seed cotton yield/fed. (10.62 ken.), while the Egyptian cv. Giza 89 attained the lowest values of seed cotton yield per fed (7.15 Ken.). Generally, the *barbadese* varieties gave highest number of bolls/plant, with Giza 83 being the highest (16.88) and each variety consistently produced 3 loculi/boll. Also, the *barbadense* varieties tend to give lower values of either boll weight or number of seeds/boll due to their small number of loculi per boll as compared to the Upland varieties. The heaviest 100-seed weight of 11.15 g was obtained from Australian 6100 while the lowest value of 9.76 g was obtained from Giza 70.

The best performing F_1 in number of bolls/plant was the interspecific cross Sea Isalnd × Australian 6100 giving 19.99 bolls, followed by the three intra-specific crosses *G. barbadense*, Giza 83 × Giza 89, Sea Island × Giza 83 and Giza 70 × Giza 89 giving values of 19.00, 18.14 and 18.00 bolls, respectively. The F_1's between Upland varieties exhibited the highest seed cotton yield namely; Deltapine × Tamcot C.E, Australian 6100 × Tamcot C.E and Deltapine × Australian 6100, giving 10.91, 10.76 and 10.40 ken/fed. Such result is attributable to that Upland crosses attained the heaviest boll weight, higher number of loculi/boll and higher number of seeds/boll. It is worthy to note that the interspecific cross; Tamcot C.E. × Giza 83 produced high seed cotton yield of 10.27 ken/fed. comparable but did not differ significantly from that obtained from the intervarietal Upland crosses.

Concerning fiber quality traits, the data presented in Table (3) indicate that the Egyptian extra-long staple cv. Giza 70 possessed the longest, strongest and finest fibers among the other *G. barbadense* varieties. On the other hand, the Upland varieties exhibited as expected, the poorest quality fibers since they were short, weak and coarse as compared to the *G. barbadense* varieties, this inferior quality of Upland cotton fibers was possed along to the three crosses among them. The intra-specific crosses within *G. barbadense* species exhibited good fiber properties.

It is interesting to note that most interspecific crosses involving *G. hirsutum* × *G. barbadease* varieties showed better fiber characteristics, such as the cross Tamcot C.E. × Giza 70 which gave longer, stronger and finer fibers of 36.28 mm, 46.00 g/tex and 3.39 micronaire units, respectively, indicating that some F_1's between Egyptian x American Upland produced high quality fibers which fell in the Egyptian category in addition to that these F_1's produced high yield which resembles the high yielding Upland varieties.

With regard to lint color reflectance (Rd %), data in Table (3) indicate that Giza 89 followed by Tamcot C.E. gave the highest Rd % values toward bright white color, while Giza 83 gave the lowest value toward creamy color. The values of yellowness degree (+b) emphasized this trend, since +b value was high for Giza 83 toward creamy color, while +b values for Giza 89 and Tamcot C.E. were low showing tendency toward whiteness. Concerning F_1 hybrids, the two Upland crosses; Dellapine × Australian 6100 and Tamcot C.E. × Australian 6100 gave the highest Rd% values accompanied by low +b values, showing tendency toward whiteness, while the dark creamy crosses were those involving Giza 83, namely; Sea Island × Giza 83 and Giza 70 × Giza 83.

These results concerning performance of hybrids are in agreement with those reported by Davis (1979), Weaver *et al.* (1984) and Hassan *et al.* (2005) who found that the crosses between *G. hirsutum* × *G. barbadense* varieties possessed high yielding ability similar to the high yielding varieties of the former species coupled with the best fiber quality of the *G. barnadense* ones. Moreover, Sultan (2008) found that some crosses, such as, Giza 70 × Okra leaf greatly surpassed the Upland Okra leaf in yield and attained longer and finer fibers than the Egyptian cv. Giza 70.

Table (1): Mean squares for earliness index yield and yield components and fiber properties in a seven parent half diallel cross of cotton.

Source of variation	d.f	Earliness index (%)	No. of bolls/ Plant	Boll weight (g)	Seed index (g)	No. of loculi / boll	No. of seeds / boll	Lint (%)	Seed cotton yield (Ken/fed.)	Upper half mean length (mm)	Fiber strength (g/tex.)	Mic. reading unit	Color	
													Reflectance (Rd %)	Yellownes (+b)
Replication	3	1.22	9.28	0.06	0.25	0.02	0.48	0.58	1.42	1.330	0.241	0.025	0.277	0.882**
Genotypes	27	173.86**	15.04**	1.90**	3.90**	1.43**	107.74**	22.28**	3.32**	17.179**	59.868**	0.660**	34.401**	2.899**
Parents (P)	6	323.29**	10.29**	3.59**	0.71**	2.92**	214.16**	22.60**	5.95**	28.524**	112.647**	0.333**	27.627**	3.008**
Crosses (C)	20	127.90**	15.42*	1.36**	3.61**	1.05**	72.19**	15.93**	2.69**	10.981**	40.945**	0.689**	32.921**	2.755**
P vs. C	1	196.33**	35.73*	2.62**	28.88**	0.02	180.11**	147.29**	0.23	73.073**	121.667**	2.047**	104.658**	5.143**
Error	81	0.75	5.42	0.02	0.12	0.04	0.92	1.09	0.63	0.790	0.872	0.050	0.828	0.148

*,** denote significant at 5 % and 1% levels of probability, respectively.

Table (2): Mean performance of seven cotton parents and their F_1 crosses for earliness index and yield and yield components.

Parents and crosses	Earliness index (%)	No. of bolls/ plant	Boll weight (g)	Seed index (g)	No. of loculi/ boll	No. of seeds/ boll	Lint (%)	Seed cotton yield (Ken/fed.)
Deltapine (P_1)	69.30	13.44	3.78	10.38	4.18	28.75	39.86	9.66
Sea Island (P_2)	55.50	15.44	2.40	10.54	3.00	14.75	38.26	8.39
Australian 6100 (P_3)	73.08	13.20	4.16	11.15	4.71	27.44	35.43	10.33
Tamcot C. E. (P_4)	76.15	12.52	4.67	10.70	4.79	32.19	39.87	10.62
Giza 70 (P_5)	56.80	15.98	2.50	9.76	3.00	19.63	34.33	8.47
Giza 83 (P_6)	59.63	16.88	2.61	10.72	3.00	16.00	37.45	9.38
Giza 89 (P_7)	54.75	14.48	2.49	10.52	3.00	15.06	34.51	7.15
Mean	63.60	14.56	3.23	10.54	3.67	21.97	37.10	9.14
P_1xP_2	65.35	15.34	2.73	12.09	3.82	20.75	33.78	8.54
P_1xP_3	69.03	13.90	3.86	10.86	4.66	29.13	37.09	10.40
P_1xP_4	78.75	14.56	3.77	11.25	4.39	26.13	36.35	10.91
P_1xP_5	70.09	15.06	2.94	12.21	3.50	15.75	32.32	8.94
P_1xP_6	65.18	15.46	2.98	12.49	3.60	16.19	32.56	9.43
P_1xP_7	66.25	14.66	2.90	11.81	3.96	20.50	32.78	8.48
P_2xP_3	70.98	19.99	2.79	12.43	3.68	16.56	34.82	9.07
P_2xP_4	70.30	16.35	2.83	12.34	3.84	18.31	31.39	9.61
P_2xP_5	67.48	17.37	2.24	10.52	3.00	14.63	35.30	8.89
P_2xP_6	65.18	18.14	2.43	10.60	3.00	15.44	37.56	9.66
P_2xP_7	69.58	16.46	2.46	10.48	3.00	16.00	35.59	8.54
P_3xP_4	77.75	12.80	4.56	11.41	4.49	28.00	36.87	10.76
P_3xP_5	64.30	16.82	2.67	12.60	3.70	18.44	32.97	9.55
P_3xP_6	71.68	16.34	2.84	13.28	3.41	20.94	33.35	9.75
P_3xP_7	59.05	15.52	2.73	12.76	3.76	19.00	32.87	8.70
P_4xP_5	59.13	15.10	3.01	12.59	3.88	17.44	32.30	9.20
P_4xP_6	67.85	16.38	2.98	12.23	4.00	18.81	35.24	10.27
P_4xP_7	60.83	13.81	2.82	12.60	3.70	21.56	32.06	8.24
P_5xP_6	62.63	12.14	2.58	10.32	3.00	16.00	38.03	8.70
P_5xP_7	58.78	18.00	2.27	10.34	3.00	16.69	35.14	8.24
P_6xP_7	59.85	19.00	1.97	10.78	3.00	13.69	35.15	8.34
Mean	**66.67**	**15.87**	**2.87**	**11.71**	**3.64**	**19.05**	**34.45**	**9.25**
LSD at 0.05	**1.218**	**3.276**	**0.199**	**0.487**	**0.281**	**1.350**	**1.469**	**1.117**
0.01	**1.613**	**4.338**	**0.264**	**0.645**	**0.373**	**1.787**	**1.945**	**1.479**

B-Expression of heterosis:

Analysis of variance presented in Table (1) showed that parents vs. crosses mean squares, as an indication to average heterosis over all hybrids, was highly significant for earliness index, number of bolls/plant, boll weight, seed index, number of seeds/boll, lint %, upper half mean length, fiber strength, micronaire value, color reflectance (Rd%) and yellowness (+b), indicating that average heterosis was exhibited for these traits, while parents vs. crosses mean squares for No. of loculi/boll and seed cotton yield per fed. were insignificant, revealing that heterotic effect was not pronounced for both traits.

Better parent heterotic values for all traits are presented in Table (4). Earliness index showed that 7 hybrids exhibited tendency for earliness (desirable positive heterosis) relative to the better parent, ranging from 2.10% for Australian 6100 × Tamcot C.E. to 25.37% for Sea Isalnd × Giza 89, while 12 F_1's exhibited tendency for lateness and gave significant negative heterotic effect ranging from -22.35% for Tamcot C.E. × Giza 70 hybrid up to -1.92% for Australian 6100 × Giza 83 hybrid. In this respect, Awad *et al.* (1986), El-Helw (2002), Hassan *et al.* (2005), Rabie *et al.* (2007) and Sultan (2008) have obtained similar desirable better parent heterotic effects for earliness in their intra-or inter-specific crosses of cotton.

With regard to number of bolls/plant, desirable positive and significant heterosis of 29.47% was obtained for the interspecific hybrid Sea Island × Australian 6100, while 11 F_1's exhibited positive values relative to their better parents but did not reach the level of significance. Hassan *et al.* (2005) and Sultan (2008) have also obtained high positive better parent heterosis in the majority of their crosses for this trait especially in crosses between *G. hirsutum* × *G. barbadense*.

Table (3): Mean performance of seven cotton parents and their F_1 crosses for fiber properties.

Parents and crosses	Upper half mean length (mm)	Fiber strength (g/tex.)	Mic. reading units	Color: Reflectance(Rd %)	Color: Yellownes (+b)
Deltapine (P_1)	31.27	34.57	5.02	72.47	9.50
Sea Island (P_2)	34.69	40.07	4.23	73.10	8.77
Australian 6100 (P_3)	29.63	35.80	4.16	73.77	7.97
Tamcot C. E. (P_4)	27.29	32.13	4.41	75.87	7.87
Giza 70 (P_5)	36.60	51.10	4.13	71.30	9.07
Giza 83 (P_6)	31.58	37.67	4.78	67.20	10.50
Giza 89 (P_7)	32.41	38.20	4.43	76.13	7.80
Mean	**31.92**	**38.51**	**4.45**	**72.83**	**8.78**
$P_1 x P_2$	34.64	39.00	3.53	66.53	10.77
$P_1 x P_3$	29.99	35.77	4.49	77.40	8.37
$P_1 x P_4$	30.43	35.70	4.24	74.80	8.93
$P_1 x P_5$	34.41	38.87	3.76	69.30	8.77
$P_1 x P_6$	34.76	40.90	4.24	72.77	9.30
$P_1 x P_7$	34.32	45.33	4.22	67.57	8.37
$P_2 x P_3$	36.42	38.80	3.61	66.27	10.23
$P_2 x P_4$	33.67	43.60	3.45	68.60	10.03
$P_2 x P_5$	34.92	42.60	4.27	66.23	10.23
$P_2 x P_6$	33.31	41.80	4.79	67.30	11.77
$P_2 x P_7$	33.46	47.10	4.45	70.57	9.10
$P_3 x P_4$	29.73	35.10	4.07	77.07	7.80
$P_3 x P_5$	35.96	41.40	3.61	69.20	9.57
$P_3 x P_6$	35.54	37.67	3.68	67.00	9.50
$P_3 x P_7$	35.75	41.03	3.74	70.80	8.43
$P_4 x P_5$	36.28	46.00	3.39	68.00	9.10
$P_4 x P_6$	33.96	37.50	3.94	70.00	9.37
$P_4 x P_7$	35.55	44.53	4.06	73.33	8.23
$P_5 x P_6$	33.88	45.73	4.67	70.20	10.43
$P_5 x P_7$	34.75	44.63	4.56	71.90	9.03
$P_6 x P_7$	33.93	43.90	5.12	70.53	9.07
Mean	**34.08**	**41.28**	**4.09**	**70.26**	**9.35**
L.S.D at 0.05	**1.455**	**1.529**	**0.366**	**1.490**	**0.630**
0.01	**1.938**	**2.036**	**0.487**	**1.984**	**0.839**

Table (4): Heterosis as percentage of better parent (B.P) for earliness index and yield and yield components in a seven parent half diallel cross of cotton.

Crosses	Earliness Index (%)	No. of bolls/ plant	Boll Weight (g)	Seed Index (g)	No. of loculi/ boll	No. of seeds/ boll	Lint (%)	Seed cotton yield (Ken/fed.)
Deltapine x Sea Island	-5.70**	-0.65	-27.78**	16.47**	-8.61*	-27.83**	-15.25**	-11.59*
Deltapine x Australian 6100	-5.54**	3.42	-7.21**	4.62*	-1.06	1.32	-6.95**	0.68
Deltapine x Tamcot C. E	3.41**	8.33	-19.27**	8.38**	-8.35**	-18.83**	-8.83**	2.73
Deltapine x Giza 70	1.14	-5.76	-22.22**	25.10**	-16.27**	-45.22**	-18.92**	-7.45
Deltapine x Giza 83	-5.95**	-8.41	-21.16**	20.33**	-13.88**	-43.69**	-18.31**	-2.38
Deltapine x Giza 89	-4.40**	1.24	-23.28**	13.78**	-5.26*	-28.70**	-17.76**	-12.22**
Sea Island x Australian 6100	-2.87**	29.47**	-32.93**	17.93**	-21.87**	-39.65**	-8.99**	-12.20*
Sea Island x Tamcot C. E	-7.68**	5.89	-39.40**	17.08**	-19.83**	-43.12**	-21.27**	-9.51
Sea Island x Giza 70	18.80**	8.70	-10.40**	7.79**	0.00	-25.47**	-7.74	4.96
Sea Island x Giza 83	9.31**	7.46	-6.90	0.57	0.00	-3.50	-1.83**	2.99
Sea Island x Giza 89	25.37**	6.61	-1.20	-0.57	0.00	6.24	-6.98**	1.79
Australian 6100 x Tamcot C.E	2.10*	-3.03	-2.36	6.64**	-6.26*	-13.02**	-7.52**	1.32
Australian 6100 x Giza 70	-12.01**	5.26	-35.82**	29.10**	-21.44**	-32.80**	-6.94**	-7.55
Australian 6100 x Giza 83	-1.92*	-3.20	-31.73**	23.88**	-27.60**	-23.69**	-10.95**	-5.61
Australian 6100 x Giza 89	-19.20**	7.18	-34.38**	21.29**	-20.17**	-30.76**	-7.23**	-15.78**
Tamcot C. E. x Giza 70	-22.35**	-5.51	-35.55**	29.00**	-19.00**	-45.82**	-18.99**	-13.37*
Tamcot C. E. x Giza 83	-10.90**	-2.96	-36.19**	14.30**	-16.49**	-41.57**	-11.61**	-3.30
Tamcot C. E. x Giza 89	-20.12**	-4.63	-39.61**	19.77**	-22.76**	-33.02**	-19.59**	-22.41**
Giza 70 x Giza 83	5.03**	-28.08**	-1.15	5.74*	0.00	-18.49**	1.55	-7.25
Giza 70 x Giza 89	3.49**	12.64	-9.20*	5.94*	0.00	-14.98**	1.83	-2.72
Giza 83 x Giza 89	0.37	12.56	-24.52**	2.47	0.00	-14.44**	-6.14*	-11.09

As for boll weight, number of loculi/ boll, number of seeds/boll and lint%, none of the hybrids exhibited significant positive heterosis relative to better parent in the four traits which agree with the data obtained by Weaver *et al.* (1984), Hassan *et al.* (2005) and Sultan (2008). In the case of seed index, 18 out of 21 F_1's exhibited positive significant heterosis relative to better parents which reached 29.10% for the interspecific hybrid Australian 6100 × Giza 70.

Concerning seed cotton yield, data in Table (4) indicate that none of the hybrids exhibited significant positive heterosis relative to better parent for this trait. On the other hand, six F1 crosses gave insignificant positive heterotic values ranging from 0.68% for Dellapine × Australian 6100 to 4.96% for Sea Island × Giza 70, indicating that yield of these crosses was equal or very close to their better parents.

Positive as well as negative heterotic effects relative to better parents were reported by many workers on seed cotton yield in both intra-or interspcific crosses of cotton. Their values differed according to the parents involved in the F_1 hybrids (Weaver *et al.*, 1984; Hendawy, 1994; Soomro *et al.*, 1995; El-Helw, 2002; Hassan *et al.*, 2005; Rabie *et al.*, 2007 and Sultan, 2008).

With respect to fiber quality properties, data in Table (5) indicate that 6 interspecific crosses expressed significantly positive heterotic effect for fiber length relative to the better parent, ranging from 4.99% for Sea Island × Australian 6100 to 12.54% for Australian 6100 × Giza 83, indicating that the six interspecific crosses exhibited longer fibers than their better *barbadense* parents. Only the intervarietal cross Giza 83 × Giza 89 gave a significant value of 4.69% more than the better parent Giza 89.

For fiber strength, 4 interspecific crosses between *G. hirsutum* x *G. barbadense* and 5 crosses within *barbadense*, L. possessed stronger fibers than the better *G. barbadenese*, L parents, ranging from 4.32% for Sea Island × Giza 89 to 18.66% for Deltapine × Giza 89.

Concerning micronaire value, the data show that 10 interspecific F_1's exhibited significant negative heterosis relative to better parent (low micronaire) ranging from -10.10% for Australian 6100 × Giza 89 to -18.44 for

Sea Island × Tamcot C.E. while, 5 hybrids within *G. barbadense*, L. exhibited significant positive heterosis.

The results reported herein concerning heterosis of fiber length, strength and fineness are in general agreement with those obtained by Meredith (1990), Percy and Turcotto (1992), Hendawy (1994), El-Debaby *et al.* (1997), El-Helw (2002) and Abd El-Maksoud *et al.* (2003) who reported positive or negative heterosis for these traits in their intra- and interspecific crosses.

Moreover, Weaver *et al.* (1984) and Sultan (2008) have obtained longer, stronger and finer fibers than the best fiber quality of the *G. barbadense* varieties involved in their interspecific crosses which agree with the present results.

With regard to color reflectance (Rd%), data in Table (5) show that the hybrid Deltapine × Australian 6100 was the only one exhibiting significant positive heterosis toward white color with a value of 4.92%, while 16 F_1's exhibited significant negative heterosis for reflectance toward creamy color. As for yellowness (+b), 14 F_1's showed significant positive heterosis toward creamy color. Most of the intra-and interspecific crosses obtained by Sultan (2008) manifested undesirable heterotic effects toward creamy color which agree with our results.

Table (5): Heterosis as percentage of better parent (B.P) for fiber properties in a seven parent half diallel cross of cotton.

Crosses	Upper half mean length (mm)	Fiber strength (g/tex.)	Mic. reading units	Color	
				Reflectance (Rd %)	Yellownes (+b)
Deltapine x Sea Island	-0.14	-2.67	-16.55*	-8.99**	22.81**
Deltapine x Australian 6100	-4.09	-0.08	7.93	4.92**	5.02
Deltapine x Tamcot C. E	-2.69	3.27	-3.85	-1.41	13.47**
Deltapine x Giza 70	-5.98**	-23.93**	-8.96*	-4.37**	-3.31
Deltapine x Giza 83	10.07**	8.57**	-11.30**	0.41	-2.11
Deltapine x Giza 89	5.89	18.66**	-4.74	-11.24**	7.31
Sea Island x Australian 6100	4.99*	-3.17	-13.22**	-10.17**	28.36**
Sea Island x Tamcot C. E	-2.94	8.81**	-18.44**	-9.58**	27.45**
Sea Island x Giza 70	-4.59*	6.31**	3.39	-9.40**	16.65**
Sea Island x Giza 83	-3.98	4.32*	13.24**	-7.93**	34.21*
Sea Island x Giza 89	-3.55	17.54**	5.20*	-7.30**	16.67**
Australian 6100 x Tamcot C.E	0.34	-1.96	-2.16	1.58	-0.89
Australian 6100 x Giza 70	-1.75	-18.98**	-12.59**	-6.19**	20.08**
Australian 6100 x Giza 83	12.54**	0.00	-11.54**	-9.18**	19.20**
Australian 6100 x Giza 89	10.31**	7.41**	-10.10*	-7.00**	8.08
Tamcot C. E. x Giza 70	-0.87	-9.98**	-17.92**	-10.37**	15.63**
Tamcot C. E. x Giza 83	7.54**	-1.83	-10.66*	-7.74**	19.06**
Tamcot C. E. x Giza 89	9.69**	18.21**	-7.94	-3.68**	5.51
Giza 70 x Giza 83	-7.43**	-10.51**	13.08**	-1.54	14.99**
Giza 70 x Giza 89	-5.05*	-12.66**	10.41*	-5.56**	15.77**
Giza 83 x Giza 89	4.69*	14.92**	15.58**	-7.36**	16.28**

*, **: denote significant at 5 % and 1% levels of probability, respectively.

C-Combining ability:

Partitioning of genetic variance into general combining ability (GCA) and specific combining ability (SCA) shown in Table (6) indicate that both GCA and SCA were highly significant for earliness index, No. of bolls/plant, No. of seeds/boll, lint%, upper half mean length, fiber strength and fiber reflectance (Rd%), revealing the important role of both additive and non-additive gene effects in the expression of these traits. Data also revealed that GCA variance was significant for seed cotton yield and fiber yellowness (+b), indicating that the nature of gene effect was predominantly additive for both traits. It could therefore be concluded that selection based on accumulation of additive effects would be successful in improving both traits. The GCA/SCA ratio was calculated to clarify the nature of genetic variance involved and to determine the relative importance of both genetic portions (Table 6). The ratio of GCA/SCA was found to be greater than unity for earliness index, all fiber quality traits and most yield components, indicating that additive and additive × additive types of gene action were of grater importance in the inheritance of these traits, while low ratio of GCA/SCA was found for seed index and lint % indicating that non-additive effect was more important for such traits. The obtained results are in harmony with those obtained by Jagtab and Kohle (1987), Meredith (1990), Hendawy (1994), Nassar *et al.* (1995), Patiel *et al.* (1997), Rady *et al.* (1999), Hassan *et al.* (2005), Rabie *et al.* (2007), and sultan (2008) who found that both additive and non-additive gene effects were involved in the inheritance of the studied traits, while Ismail *et al.* (2005) found that non-additive effects were important in the case of boll number, boll weight and seed cotton yield. The predominance of additive genetic effects obtained in the present study in the inheritance of fiber traits was in harmony with those reported by Abo El-Zahab (1983), El-Feki *et al.* (1994), Hassan *et al.* (2005) and Sultan (2008), while Lasheen (2003) found that GCA/SCA ratio was less than unity for fiber strength and 2.5% span length.

Table (6): Mean squares for general (GCA) and specific (SCA) combining ability in a half diallel cross of cotton for earliness index, yield and yield components and fiber properties.

Source of variation	d.f	Earliness index (%)	No. of bolls/ plant	Boll weight (g)	Seed index (g)	No. of loculi / boll	No. of seeds / boll	Lint (%)	Seed cotton yield (Ken/fed.)
GCA	6	118.74**	6.38**	1.81	0.76	1.53	94.63**	3.43**	3.20**
SCA	21	21.96**	3.01**	0.09	1.04	0.02	7.59**	6.18**	0.15
Error	81	0.19	1.35	0.01	0.03	0.01	0.23	0.27	0.16
GCA/SCA		5.41	2.12	20.11	0.73	76.50	12.47	0.56	21.33

Source of variation	d.f	Upper half mean length (mm)	Mic. reading Unit	Fiber strength (g/tex.)	Color: Reflectance (Rd %)	Color: Yellownes (+b)
GCA	6	10.84**	55.98**	0.33	18.98**	2.83*
SCA	21	4.27**	9.66**	0.19	9.32**	0.43
Error	81	0.26	0.29	0.02	0.28	0.05
GCA/SCA		2.53	5.80	1.02	2.04	6.58

*, **: denote significant at 5% and 1% levels of probability, respectively.

1-General combining ability effects:

Estimates of general combining ability effects (gi) for individual parental varieties evaluated in F_1 crosses are presented in Table (7). Positive and significant GCA values are desirable for earliness index, yield and its components and fiber length, strength and reflectance (Rd%) while negative and significant GCA values for micronaire value and yellowness (+b) would be useful from the breeder's point of view.

Regarding earliness index, the Upland varieties Deltapine, Australian 6100 and Tamcot C.E. exhibited positive GCA effects toward better earliness index and they are considered good combiners, while the *barbadense* varieties exhibited negative GCA effects and they were poor combiners for this trait.

Concerning yield and its components, the data revealed that Tamcot C.E. and Australian 6100 were good general combiners for all traits, except for number of bolls/plant and lint%. Also, the Upland variety Deltapine was good combiner for all traits except for number of bolls/plant, seed index and seed cotton yield. The parental *G. barbadense* variety Sea Island was good combiner for no.

of bolls/plant and lint%, Giza 70 for seed index and Giza 83 was good combiner for lint%.

With respect to fiber quality properties, the data in Table (7) revealed that Giza 70 and Sea Island are good general combiners for improvement of fiber length and fiber strength. Also, Giza 89 was good combiner for fiber strength, while the three Upland varieties had highly significant negative GCA effect, indicating that these three parents were poor combiners for fiber length and strength. As for micronaire reading, the Upland varieties Australian 6100 and Tamcot C.E. showed significant negative GCA effect and are recommended to be good combiners for developing fine fibers. With respect to fiber reflectance (Rd%), data showed that the parents Deltapine, Australian 6100, Tamcot C.E. and Giza 89 had significant positive GCA effect toward of white color, while Giza 70, Sea Island and Giza 83 exhibited negative values in toward of creamy color. Regarding yellowness (+b), the data indicate that Sea Island and Giza 83 had positive and significant GCA effect toward creamy color while Australian 6100,Tmcot C.E.and Giza 89 showed negative effect and are considered good combiners toward whiteness.

2-Specific combining ability effects:

The effects of specific combining ability (Si) for the parental combinations in F_1 crosses are given in Table (8). Regarding earliness index, the data show that 11 out of 21 F_1 crosses exhibited significant positive SCA effect toward earliness. The highest SCA values were given by Sea Island x Giza 89, Sea Island. X Giza 70, Deltapine x Tamcot C.E. and Deltapine x Giza 70, the latter two F_1's contained at least one good general combiner patent for earliness index. For boll number/plant, two hybrid combinations exhibited greatest SCA effect viz. Sea Island x Australian 6100 and Giza 83 x Giza 89. For boll weight, 5 F_1's had positive SCA effects. The highest values were manifested by Australian 6100 x Tamcot C.E., Sea Island x Tamcot C.E. and Sea Island x Giza 89. Twelve F_1's had significant positive SCA effects for seed index ranged from 0.548 for Deltapine x Giza 89 to 1.406 for Australian 6100 x Giza 83. For number of loculi/boll, the hybrids Deltapine x Australian 6100 and Deltapine x Giza 89 had significant positive SCA values. It is worthy to note that the first cross involved both good combiner parents, while the second was a result of crossing one good x one poor combiner parents.

As for number of seeds/ boll, 8 crosses had significant positive SCA effects. The highest were exhibited by Deltapine x Australian 6100, Sea Island x Tamcot C.E. and Sea Island x Giza 89.The three Upland varieties involved in some of these crosses were good general combiners. For lint%, 8 F_1's showed significant positive SCA effects. The highest values were displayed by Giza 70x Giza 83, Deltapine x Giza 70 and Australian 6100 x Giza 83.

Concerning seed cotton yield, 10 F_1's exhibited positive SCA effects but all failed to reach the level of significance. Thus it is preferable to take into account the seed cotton yield components related to seed cotton yield. As for number of seeds/ boll, 8 crosses had significant positive SCA effects. The highest were exhibited by Deltapine x Australian 6100, Sea Island x Tamcot C.E. and Sea Island x Giza 89.The three Upland varieties involved in some of these crosses were good general combiners. For lint%, 8 F_1's showed significant positive SCA effects. The highest values were displayed by Giza 70x Giza 83, Deltapine x Giza 70 and Australian 6100 x Giza 83.

With regard to fiber quality properties, data in Table (9) indicate that 9 crosses had significant positive SCA effects. The highest values were exhibited by the interspecific F_1's; Tamcot C.E. x Giza 89, Sea Island x Australian 6100 and Tamcot C.E. x Giza 70, the latter two F_1's involved at least one general good combiner parent viz. Sea Island and Giza 70. For fiber strength, the highest SCA effects were recorded by 9 crosses which varies from 1.014 for Australian 6100 x Giza 89 to 4.944 for Deltapine x Giza 89, out of the 9 crosses only three ones involved the good general combiner parent Giza 70.

Table (7): Estimation of general combining ability (GCA) effects for earliness index, yield and yield components and fiber properties.

Parents	Earliness index (%)	No. of bolls /plant	Boll weight (g)	Seed index (g)	No .of loculi /boll	No. of seeds / boll	Lint (%)	Seed cotton yield (Ken/fed.)	Upper half mean length (mm)	Fiber strength (g/tex.)	Mic. Reading unit	Color	
												Rflectance (Rd %)	Yellownes (+b)
Deltapine	2.892**	-0.940*	0.337**	0.011	0.347**	3.080**	0.408*	0.249	-0.804**	-2.224**	0.120	-0.020	0.678**
Sea Island	-0.806**	1.133*	0.379**	-0.202**	-0.314**	-3.003**	0.447*	-0.298	0.832**	0.924**	-0.099	0.666**	-1.722**
Australian 6100	3.525**	-0.284	0.451**	0.476**	0.441**	3.191**	-0.231	0.568**	-0.631**	-2.594**	-0.214**	-0.427**	0.896**
Tamcot C. E.	4.411**	-1.143*	0.623**	0.275**	0.523**	4.046**	0.337	0.718**	-1.569**	-2.002**	-0.164**	-0.497**	1.815**
Giza 70	3.469**	0.236	-0.333**	0.361**	-0.343**	-2.225**	-0.689**	-0.369	1.675**	4.080**	-0.102	0.177	-1.085**
Giza 83	-1.734**	0.766	-0.301**	-0.026	-0.350**	-2.795**	0.652**	0.127	0.024	-0.209	0.285**	0.751**	-1.667**
Giza 89	-4.820**	0.232	-0.398**	-0.173*	-0.304**	-2.295**	-0.923**	-0.995**	0.472	2.024**	0.174**	-0.649**	1.085**
L.S.D at 5%	0.326	0.880	0.059	0.129	0.076	0.363	0.394	0.424	0.545	0.573	0.138	0.238	0.559
1%	0463	1.332	0.089	0.196	0.115	0.549	0.597	0.456	0.586	0.616	0.148	0.256	0.601

*, **: denote significant at 0.05 and 0.01 levels of probability, respectively

Table (8): Estimates of specific combining ability (SCA) effects for earliness index and yield and yield components of 21 cotton crosses.

Crosses	Earliness Index (%)	No. of bolls/ plant	Boll weight (g)	Seed index (g)	No. of loculi/ boll	No. of Seeds/ boll	Lint (%)	Seed cotton yield (Ken/fed.)
Deltapine x Sea Island	-2.637**	-0.393	-0.193*	0.864**	0.142	0.896*	-2.192**	-0.635
Deltapine x Australian 6100	-3.292**	-0.416	0.107	-1.046**	0.230*	3.076**	1.799**	0.362
Deltapine x Tamcot C. E	5.546**	1.103	-0.158*	-0.460**	-0.127	-0.778	0.491	0.719
Deltapine x Giza 70	4.761**	0.224	0.025	1.138**	-0.149	-4.882**	2.517**	-0.158
Deltapine x Giza 83	-1.884**	0.094	-0.018	1.080**	-0.042	-3.875**	-3.614**	-0.165
Deltapine x Giza 89	2.277**	-0.172	0.000	0.548**	0.274**	-0.063	-1.818**	0.002
Sea Island x Australian 6100	2.356**	3.600**	-0.243**	0.739**	-0.096	-3.403**	-0.510	-0.422
Sea Island x Tamcot C. E	0.795	0.815	0.375**	0.845**	-0.016	2.507**	-4.511**	-0.028
Sea Island x Giza 70	5.849**	0.461	-0.009	-0.336*	0.012	0.076	0.431	0.334
Sea Island x Giza 83	1.814**	0.700	0.147*	-0.597**	0.019	1.458**	1.342**	0.611
Sea Island x Giza 89	9.300**	-0.445	0.276**	-0.569**	-0.027	1.521**	0.947*	0.609
Australian 6100 x Tamcot C.E.	3.914**	-1.314	0.525**	-0.757**	-0.121	0.986*	1.653**	0.255
Australian 6100 x Giza 70	-1.656**	1.328	-0.411**	1.069**	-0.043	-2.306**	-1.228**	0.134
Australian 6100 x Giza 83	3.984**	0.317	-0.273**	1.406**	-0.323**	0.764	2.185**	-0.169
Australian 6100 x Giza 89	-5.555**	0.031	-0.284**	1.036**	-0.019	-1.674**	-1.090**	-0.100
Tamcot C. E. x Giza 70	-7.718**	0.467	-0.241**	1.260**	0.050	-4.160**	-2.464**	-0.368
Tamcot C. E.x Giza 83	-0.728	1.216	-0.302**	0.564**	0.182	-2.215**	-0.866	0.200
Tamcot C. E.x Giza 89	-4.666**	-0.817	-0.366**	1.082**	-0.164	0.035	-2.468**	-0.710
Giza 70 x Giza 83	1.927**	-4.402**	0.251**	-0.717**	0.047	1.243**	2.953**	-0.284
Giza 70 x Giza 89	1.163**	1.992	0.035	-0.547**	0.002	1.431**	1.641**	0.378
Giza 83 x Giza 89	0.503	2.461*	-0.299**	-0.445**	0.009	-1.000**	0.302	-0.010
L.S.D at 0.05	0.807	2.174	0.144	0.322	0.191	0.396	0.976	0.744
0.01	1.098	2.957	0.195	0.439	0.260	1.220	1.327	1.013
L.S.D at 0.05	0.948	2.225	0.168	0.379	0.225	1.055	1.144	0.874
0.01	1.290	3.472	0.229	0.515	0.306	1.435	1.557	1.189

*, **: denote significant at 0.05 and 0.01 levels of probability, respectively

Concerning micronaire values 11 crosses had significant negative SCA effects ranging from -0.670 for Deltapine x Sea Island to -0.250 for Deltapine x Giza 89. However, out of these 11 F_1's 7 contained one good general combiner parent either Australian 6100 or Tamcot C.E. As for fiber color traits, the data show that 6 crosses had desirable significant positive reflectance (Rd%) toward brightness ranging from 1.00 for Giza 70 x Giza 89 cross to 4.926 for Deltapine x Australian 6100, while in the case of yellowness (+b) only three crosses exhibited desirable negative SCA values ranging from-0.485 for Australian 6100 x Tamcot C.E to -0.641 for Deltapine x Giza 83.

Generally it could be concluded that several F_1 hybrids either intra-or interspecific exhibited good performance in one or more traits. Some crosses involving *G. hirsutum x G. barbadense* indicated an overall tendency for F_1's to possess the high yielding ability of the *hirsutum* varieties and a close resemblance or even better fiber properties than those of Egyptian varieties (*G. barbadense*, L), therefore can be practically exploited in hybrid cotton production.

Based on GCA effects, each of the seven parents studied proved to be good general combiner for some traits, thus can be effectively used as promising progenitors for high expression of the characters under consideration. Also, high SCA effects were recorded for many crosses in the majority of traits which were a result of crossing good x good or good x poor general combiner parents. In such hybrids, desirable transgressive segregants could be expected in subsequent generations, if the additive genetic system present in the good general combiner parent and the complementary epistatic effects in the F_1 acted in the same direction to maximize the desirable characters in a pedigree selection program designed for varietal improvement purposes.

Table (9): Estimation of specific combining ability (SCA) effects for fiber properties of 21 cotton crosses.

Crosses	Upper half mean Length (mm)	Fiber strength (g/ tex).	Mic. Reading unt	Color	
				Reflectance (Rd %)	Yellownes (+b)
Deltapine x Sea Island	1.071*	-0.290	-0.670**	-3.222**	0.911**
Deltapine x Australian 6100	-2.112**	-0.005	0.404**	4.926**	-0.396
Deltapine x Tamcot C. E	-0.741	-0.664	0.101	1.407**	0.241
Deltapine x Giza 70	-0.005	-3.579**	-0.438**	-1.193*	-0.600**
Deltapine x Giza 83	-1.999**	2.744**	-0.341**	2.856**	-0.641**
Deltapine x Giza 89	1.133*	4.944**	-0.250*	-5.096**	-0.174
Sea Island x Australian 6100	2.681**	-0.119	-0.260*	-3.807**	0.785**
Sea Island x Tamcot C. E	0.869	4.088**	-0.470**	-2.399**	0.656**
Sea Island x Giza 70	-1.128*	-2.994**	0.291*	-1.859**	0.181
Sea Island x Giza 83	-1.090*	0.495	0.428**	-0.211	1.141**
Sea Island x Giza 89	-1.381**	3.562**	0.192	0.304	-0.126
Australian 6100 x Tamcot C.E	-1.611**	-0.894	0.268*	3.456**	-0.485*
Australian 6100 x Giza 70	1.372**	-0.675	-0.258*	-1.511**	0.607**
Australian 6100 x Giza 83	2.603**	-0.119	-0.571**	-3.130**	-0.033
Australian 6100 x Giza 89	2.365**	1.014*	-0.397**	-2.081**	0.300
Tamcot C. E. X Giza 70	2.637**	3.332**	-0.521**	-3.630**	0.211
Tamcot C. E. X Giza 83	1.964**	-0.879	-0.358**	-1.048*	-0.096
Tamcot C. E. X Giza 89	3.107**	3.921**	-0.134	-0.467	0.170
Giza 70 x Giza 83	-1.356**	1.273*	0.303*	2.052**	0.296
Giza 70 x Giza 89	-0.940	-2.060**	0.311*	1.000*	0.296
Giza 83 x Giza 89	-0.109	1.495**	0.481**	0.215	-0.244
L.S.D at 0.05	0.959	1.008	0.241	0.979	0.414
0.01	1.305	1.369	0.328	1.333	0.563
L.S.D at 0.05	0.541	1.181	0.285	1.152	0.487
0.01	1.531	1.607	0.388	1.568	0.662

*, **: denote significant at 0.05 and 0.01 levels of probability, respectively.

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قوة الهجين والقدرة على الائتلاف للصفات المحصولية وجودة التيلة فى هجن صنفية ونوعية من القطن

عبد المقصود محروس المركبى*، عفاف محمد طلبة*، هبة حسين حامد**

* قسم المحاصيل – كلية الزراعة – جامعة عين شمس – شبرا الخيمة – القاهرة

** معهد بحوث القطن – مركز البحوث الزراعية – الجيزة – مصر

تتجه بعض الدول المنتجة للقطن في السنوات الأخيرة للإستفادة من قوة الهجين. فقد نجحت الهند في الإنتاج التجاري لبعض الهجن الصنفية والنوعية اعتمادا على الخصي والتلقيح اليدوي ووفرة الأيدى العاملة حتى اصبح القطن الهجين يزرع في حوالي ٤٠% من المساحة المنزرعة قطنا في الهند والبالغة ١٦و٩ مليون هكتار. وفي الولايات المتحدة تجرى تجارب مكثفة لإنتاج القطن الهجين اعتماداً على إدخال صفة العقم الذكرى السيتوبلازمى فى نباتات الأم. كما أن قوة الهجين تكون في أوضح صورها بين أباء متباعدة وراثيا. ومن جهة أخرى يعتمد أستنباط السلالات والأصناف الممتازة بطريقة الانتخاب المنسب المعتادة علي معرفة السلوك الوراثى للأباء والهجن من حيث قوة الهجين والقدرة العامة والخاصة على الائتلاف.

إستخدم لهذا الغرض سبعة أصناف منها ثلاثة تتبع القطن الابلند الأمريكى من نوع*G. hirsutum* وهى Australian 6100, Tamcot C.E. and Deltapine والتى تتميز بمحصولها العالى والتبكير فى النضج وأربعة أصناف تتبع النوع *G. barbadense* وهى جيزة ٧٠ وجيزة ٨٣ وجيزة ٨٩ وصنف Sea Island وتتميز جميعها بجودة الصفات التكنولوجية للتيلة. زرعت الأصناف السبعة في موسم ٢٠٠٣ بمحطة بحوث الجيزة وتم عمل دائرة تهجينات بينها مع أستبعاد الهجن العكسية للحصول على ٢١ هجين فردى.

وفى موسم ٢٠٠٤ قيمت الأباء والهجن من حيث صفات التبكير والمحصول ومكوناتة وصفات جودة التيلة في تجربة قطاعات كاملة العشوائية من أربع مكررات .وفيمايلى أهم النتائج:-

١. أظهر تحليل التباين وجود أختلافات معنوية بين الآباء وهجنها مما يعنى أن جميع التراكيب الوراثية أظهرت درجات من التباين الوراثى لكل الصفات.
٢. جمعت بعض الهجن النوعية للصفات التى يتميز بها كلاً من نوعى القطن الأبلند الأمريكى والقطن المصرى – على سبيل المثال أعطى الهجين .X Tamcot C.E فى جيزة ٨٣ محصولاً من القطن الزهر يماثل صنف .Tamcot C.E العالى المحصول بينما كان أفضل من الصنف المصرى جيزة ٨٣ فى طول التيلة والنعومة والتبكير فى النضج ويعادله فى متانة التيلة ومثل هذه الهجن يمكن إستعمالها فى إنتاج القطن الهجين .
٣. أظهرت بعض الهجن الصنفية والنوعية قوة هجين سالبة أو موجبة مرغوبة بالنسبة للأب الأفضل .
٤. أظهرت نتائج تحليل تباين القدرة العامة والخاصة على الائتلاف معنوية عالية فى معظم الصفات المدروسة مما يوضح الأهمية النسبية لكل من الجينات المضيفة وغير المضيفة فى وراثة هذه الصفات.
٥. كانت النسبة بين تباين القدرة العامة والخاصة على اللائتلاف أعلى من الواحد الصحيح فى صفة التبكير ومعظم صفات المحصول ومكوناته وصفات التيلة مما يدل على أن التباين الوراثى المضيف وكذلك المضيف x المضيف هما الأكثر أهمية فى وراثة هذه الصفات، بينما كانت النسبة أقل من الواحد الصحيح فى صفتى معامل البذرة والنسبة المئوية للشعر مما يعكس الأهمية النسبية للفعل الجينى غير المضيف فى وراثتهما .

٦. يمكن الإستفادة من أصناف الأبلند Australian 6100, Tamcot C.E. and Deltapine فـــى تحســـين صفة التبكير فى برامج تربية القطن حيث أظهرت قدرة عامة جيدة على الائتلاف للتبكير فى النضج . كما أظهرت هذه الأصناف الثلاثة قدرة عامة على الائتلاف لصفات وزن اللـــوزة وعـــدد الفصـــوص وعدد البذور باللوزة. وأظهر صنف Sea Island قدرة عامة عالية لصفات عدد اللوز بالنبات ومعـــدل الحليج والصنف جيزة ٨٣ أظهر قدرة عامـــة لصـــفة معـــدل الحلـــيج فقـــط بينمـــا أظهـــر صـــنفى الأبلند Australian 6100, Tamcot C.E. قدرة عامة جيدة على التآلف لمحصول القطن الزهر للفـــدان ولصفة نعومة التيلة. وأظهرت أصناف البربادنسى Sea Island، وجيزة ٧٠ قدرة عامة جيـــدة علـــى التآلف لصفات طول التيلة ومتانة التيلة ويشترك معهما جيزة ٨٩ لتحسين صفة المتانة. وأما أصـــناف الأبلند الثلاثة ويشترك معهم جيزة ٨٩ فقد أظهرت قدرة عامة جيدة لتحسين درجة إنعكاس لون التيلـــة نحو اللون الأبيض وتقليل درجة الإصفرار.

علاوة على ما سبق فقد أمكن تحديد بعض الهجن الصنفية والنوعية التى قد تمثل أهمية كبيرة فـــى مجال انتخاب سلالات متفوقة من نسلها حيث تميزت هذه الهجن بقدرة خاصة عالية على الائتلاف للصفات المدروسة علاوة على إحتوائها على أب واحد على الأقل يتميز بقدرة عامة جيدة على التآلف مما يزيد مـــن فرصة الحصول على بعض الإنعزالات الممتازة فى أجيالها الإنعزالية للصفة محل الإهتمام