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HETEROSIS AND COMBINING ABILITY FOR EARLINESS, YIELD AND FIBER QUALITY CHARACTERS IN EGYPTIAN COTTON (*GOSSYPIUM BARBADENSE* L.)

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ABSTRACT

The main objectives of this study are to determine heterosis, general and specific combining ability; broad and narrow sense heritabilies's and inbreeding depression for earliness, yield and its components and fiber quality traits of Egyptian cotton.

The genetic materials used in the present study included seven cotton varieties and their 21F1 hybrids. All seven varieties belong to *Gossypium barbadense L*. In 2015 growing season, these genotypes were evaluated in a field trial experiment at Shandwell Agric. Res. Station, Sohag Governorate for the following traits: days to first flower (DFF), days to first opened boll (DFB), seed cotton yield/plant (SCY/P), lint yield/plant (LY/P), boll weight (BW), number of bolls/ plant (B/P), lint percentage (L%), seed index (S I g), fiber fineness (FF), fiber strength (FS) and upper half mean (UHM).

The obtained results indicated that the parent Giza 90 (P2) was the earliest comparison with the other parents for DFF and DFB. However, Giza 88 (P5) was the best combiner for SCY/P, LY/P, NB/P, SI, and LI traits, and the parent Giza 80 (P1) had organized the better mean performance for L % trait. Furthermore, the results revealed that Giza 86 (P3) was the best combiner for UHM (35.6 mm), Giza 87 (P4) for Mic. (2.8 units) and Giza 93 (P7) for PI (10.2). In the same time, the cross (P3 x P6) was the earliest combination for DFF and DFB and manifested that the highest yielding cross combination was (P2 x P7) with the means of 133.8 and 45.5 for SCY/P and NB/P, and the cross (P2 x P6) was the highest yielding for the BW (g) and SI (g) with the mean of 3.1 g and 10.3. Also the combination (P1 x P4) showed the best mean performance was observed for FF (2.9 Mic), UHM (36.3 mm) and (P1 x P5) for FS (11.1g/tex). Therefore, these parental varieties could be utilized in a breeding program for improving these traits through the selection in segregating generations.

The mean squares due to all 28 genotypes parents and crosses are significant or highly significant for most studied traits. The analysis of variance for combining ability showed highly significant mean squares of specific combining ability (SCA) for all earliness traits. These results indicated the predominance of non-additive genetic variance in the inheritance of these traits. It could be concluded that earliness were mainly controlled by dominance variance. Meanwhile, mean squares for both GCA and SCA for all yield and yield components and fiber quality traits except SI and FS were significant or highly significant.

The results revealed that the cross (P_2 x P_6) was exhibited positive and highly significant and (P_3 x P_6) was negative and highly significant for heterosis relative to heterosis mid-parent and better-parent for all earliness traits. While the useful heterosis relative to mid parents were found for most yield and yield components, the cross (P_2 x P_7) had positive and highly significant heterosis for SCY/P and NB/P traits, while, cross (P_1 x P_7) for BW and the cross (P_2 x P_5) for LY/P and L% possessed negative and highly significant heterosis . Concerning the results of heterosis versus better parents, the cross (P_4 x P_6) was positive and highly significant for FF and UHM and the cross (P_1 x P_5) for FS.

The estimated values of heritability showed that broad sense heritability (H^2b %) estimates were higher than their corresponding values of narrow sense heritability (H^2n %) for all traits under study. Narrow sense heritability estimates were high and ranged from 79.0 % for DFF to 81.90 % for DFB. While, broad sense heritability estimates were moderate to high and ranged from 39.90 % for SI to 93.10 % for L%, while the estimates of heritability in narrow sense show low estimates for all studied yield and its components traits, and also found that Broad sense heritability estimates was moderate estimate 76.80 % for UHM. While the heritability in narrow sense show low estimate 11.60 % for Mic.

Key words: *G. barbadense* L., Half diallel, *Heterosis, Combining ability, Heritability.*

INTRODUCTION

Cotton is an important source in the Egyptian economy. Accordingly, improving cotton is of great significance for plant breeders who need more information about the genetic behavior of the economic traits of cotton.

The main objective of cotton breeding programs in Egypt is to increase the yielding capacity and improve fiber properties of commercial cotton varieties. The selection of parents and crosses either for heterosis production or for pedigree breeding is based on knowledge of the nature and magnitude of the genotypic variances and their interactions with environments.

Abd El-Hadi *et al.* (2005) cleared that, the magnitude of general combining ability (GCA) variance was highly significant and larger than that of specific combining ability (SCA) variance for fiber strength, fiber fineness and 2.5% span length. Their results indicated that the additive genetic effect predominated and played the major role in the expression of most studied traits. The magnitude of GCA variance was highly significant and larger than that of SCA variance for number of days to first flower. Abd El-Bary *et al.* (2008) found that heritability in broad sense was larger than the heritability in narrow senses for all studied traits. They cleared that the calculated values in broad sense ranged from 63.70 to 97.12% for boll weight and seed cotton yield/ plant, respectively. Narrow senes ranged from 0.00 to 23.87% for seed cotton yield / plant and boll weight, respectively.

Abd El-Zaher *et al.* (2009) showed that the four crosses; ($p_1 \times p_5$), ($p_2 \times p_5$), ($p_2 \times p_6$) and ($p_3 \times p_6$) showed positive and highly significant specific combining ability effects values for seed cotton yield /plant, lint yield /plant, boll weight and number of bolls /plant, and cross ($p_2 \times p_4$) for lint percentage. Darweesh (2010) stated that, the values of heritability in broad sense ranged from 93.13% for seed index to 99.52% for seed cotton yield/plant. He also found that, a value of heritability in broad sense was 89.31% for days to first flower traits. While, the narrow sense heritability values was 28.33% for the same trait. Also, he recorded that, the heterosis relative to mid-parent was highly significant and positive for seed cotton yield/ plant, lint cotton yield/plant and lint percentage.

Khan *et al.* (2011) recorded that the mean squares due to (G.C.A.) and (S.C.A.) were highly significant for days to first flowering. Mean square due to (G.C.A.) was higher in magnitude than (S.C.A.) for majority of the earliness traits and their inheritance was mainly governed by additive type of gene action and partially by non-additive. Imran *et al.* (2012) reported that specific combining ability (SCA) variance was greater than general combining ability (GCA) variance for bolls per plant (9.987), lint per seed (4.174), boll size

(3.69), seed cotton yield (0.315), and lint percentage (0.470), showing predominance of non-additive genes, while seed volume (3.84) was controlled by additive gene action based on maximum GCA variance. Saleh and Ali (2012) found that heritability in broad sense was larger than the corresponding values of narrow sense heritability for all traits. El-Kadi *et al.* (2013) showed that the heritability in broad sense (h^2b.s. %) showed high values for all traits, indicating the low effect of environment on studied traits. Heritability in narrow sense (h2n.s. %) showed moderate value (30-50 %) for position of first node and high values (>50 %) for days to first flower. Simon *et al.* (2013) revealed that, GCA effects were lower than SCA effects for seed yield and lint yield, suggesting the inheritance of these characters is governed mainly by non-additive gene effects.

Attia (2014) showed that, the cross P_1 x P_3 for SCY/P, LY/P, NB/P and L% traits, the cross P_1 x P_2 for SCY/P, LY/P and BW traits, the cross P_2 x P_4 for SI, LI, BW and L % exhibited the greatest values of heterosis versus mid and better parent. Ekinci and Basbag (2015) evaluated GCA of parents and SCA of F1 diallel crosses. They found that greater parents were Paum-15'and 'Stoneville-453' for the number of bolls and the seed-cotton yield; 'Stoneville-453' and 'Nazilli-84S' for the lint percentage, while greater cross combinations were (Paum-15 x Stoneville-453); (Stoneville-453 x Nazilli-84S); (Stoneville-453 x Fantom); (Stoneville-453 x Delcerro) and (Stoneville-453 x Giza-45) for the number of bolls.

El- Fesheikawy *et al.* (2015) in two intra-barbadense cotton crosses namely; [(Giza 90xAustralian) x (Dandara x Giza 72) x Giza 83] (cross I) and [(Giza 91 x Dandara) x (Australian)] (cross II), reported that, both additive and dominance gene effects are important in the inheritance of these characters. Significant either positive or negative heterotic effects relative to mid-parents were found for days to first flower, days to first opened boll, seed cotton yield/plant or lint cotton yield/plant in the first cross and for DFB, SCY/P and LCY/P in the second cross. Also they added that high to moderate heritability in broad sense estimates were associated with low and medium heritability in narrow sense in most characters in both crosses.

Sorour *et al.* (2015) reported that additive effects were important for the inheritance of fiber length and fiber fineness, while dominance effects were important for inheritance of fiber strength. Negative heterotic effects relative to the mid and better parents were found for earliness traits in the crosses (Pima S1 × C.B.58), (Suvin × G.93), (TNB × C.B.58) and ((10229 × G.86) × Suvin). Ibrahim (2016), found that heritability values in broad sense were larger than the heritability values in narrow sense for all studied traits. They also cleared that the calculated values in broad sense ranged from 61.20 % to 97.12 % for fiber strength and seed cotton yield/plant, respectively. Narrow sense ranged from 0.00 % for seed cotton yield/plant and uniformity ratio to 61.47 % for fiber fineness.

The present study was designed to estimate the heterosis, combining ability and heritability controlling the inheritance of earliness, yield components and fiber quality traits after crossing of seven parents in a half diallel system which could be used in the improvement of these traits.

MATERIALS AND METHODS

Genetic materials and mating design:

Seven divergent Egyptian cotton genotypes were used in this investigation namely; Giza 80 (P_1), Giza 90 (P_2), Giza 86 (P_3), (long stable) and Giza 87 (P_4), Giza 88 (P_5), Giza 92 (P_6) and Giza 93 (P_7) (extra-long). All the used seven genotypes belong to *Gossypium barbadense L.* Pure seeds of these varieties were supplied by Cotton Breeding Section, Cotton Research Institute, Agriculture Research Center at Giza, Egypt. In 2014 growing season, the seven parents were crossed in all possible combinations, excluding reciprocals, to obtain a total 21 F1 hybrids. In April 2015 growing season, the seven parents and their 21 F1 crosses were planted in a randomized complete block design (RCBD) with three replications at Shadwell Research Station، Sohag governorate.

The plot size was three rows 4.0 m long and 0.7 m wide. Hills were spaced at 40 cm. and thinned to one plant per hill. All Recommended cultural practices of cotton were followed to raise ergonomically good managed crop. Ten plants (except two border plants) were harvested to determine earliness، yield، yield components and fiber traits. The data were recorded in the field and laboratory on all guarded plants of each population to evaluate the performance of the studied traits.

Data were recorded on the following traits: days to first flower (DFF), days to first opened boll (DFB), seed cotton yield/plant (SCY/P g), lint yield/ plant (LY/P g), boll weight (BW g), number of bolls/plant (B/P), lint percentage (L%), seed index (S I g), micronaire reading (Mic.), pressely index (P I) and upper half mean (UHM mm). The fiber properties were measured in the laboratories of the Cotton Fiber Research Section, Cotton Research Institute according to (D-1448-59, D-1445-60T and D-1447-67.).

Statistical analysis:

Analysis of variance:

Statistical procedures used in this study were done according to the analysis of variance for a randomized complete blocks design as outlined by Cochran and Cox (1957).

The amount of heterosis were estimated as the percentage increase of the the F_1 hybrid over the mid-parents

(M.P) or above the better parent (B.P) as:

mid-parents heterosis = $[(F_1 - M.P)/M.P] \times 100$

better parent (B.P) heterosis = $[(F_1 - B.P)/B.P] \times 100$

The significance of means and heterosis were determined using the least significant difference (L.S.D) at 0.05 and 0.01 levels of significance, according to Steel and Torrie (1980).

Statistical Model:

The combining ability analysis was done as described by Griffing (1956), method 2, model 1 and outlined by Singh and Chaudhary (1985).

Heritability was estimated in both broad sense (H^2_b) and narrow sense ($H^2_{n.}$) for generations as follows:

Heritability in broad sense:

$H2\ b\ \% = [((2\sigma 2\ gca + \sigma 2\ sca) / (\sigma 2\ gca + \sigma 2\ sca + \sigma 2\ e)) \times 100]$

Dudley and Moll (1969), Meredith (1984) and Dabholkar (1992).

Heritability in narrow sense:

$H^2\ n\ \% = [(2\sigma^2\ gca / (\sigma^2\ gca + \sigma^2\ sca + \sigma^2\ e)) \times 100]$

Dudley and Moll (1969), Meredith (1984), Falconer (1989) and Chaudhary (1991).

Where;

$\sigma 2$ e: is the error variance divided by the number of replications.

RESULTS AND DISCUSSION

Mean performance:

Results indicated that Giza 90 (P2) was the earliest genotype parent for DFF and DFB with values of 65.67 and 118.33, respectively, and the cross (P3 x P6) was the earliest combination for the same traits with the mean of 65.00 and 117.00, respectively.

The highest mean performances were found for the parent Giza 88 (P5) for SCY/P, LY/P, NB/P, SI, and LI traits, and the parent Giza 80 (P1) was organized the better mean performance for L % trait, and manifested that the highest yielding cross combination was (P2 x P7) with the means of 133.8, 47.6 and 45.5 for SCY/P, LY/P and NB/P, and the cross (P2 x P6) was the highest yielding for the BW (g) and SI (g) with the mean of 3.1 g and 10.3g.

The results indicated that the best mean performance was observed by the parent Giza 86 (P3) for UHM (35.6 mm), Giza 87 (P4) for Mic. (2.8 units) and Giza 93 (P7) for PI (10.2 g/tex). Concerning F1 crosses, the combination (P1 x P4) showed the best mean performance was observed for Mic. (2.9 units), UHM (36.3 mm) and (P1 x P5) for PI (11.1 g/tex).

Mean squares:

Analysis of variance presented in Table 3 indicates that mean squares due to all 28 genotypes as well as mean squares due to parents and crosses are significant or highly significant for most studied traits.

Combining ability analysis:

The analysis of variance for combining ability (Table 4) shows highly significant mean squares for all earliness traits for specific combining abilities (SCA). Meanwhile, significant or highly significant mean squares for both GCA and SCA were recorded for all yield and yield components and fiber quality traits except SI and PI.

These results are in harmony with those reported by Abd El-Hadi *et al.* (2005a) and Ekinci and Basbag (2015).

Table 2: Mean performances of seven parents and 21 F_1 hybrids for earliness, yield component traits and fiber quality properties.

Genotypes	D.F.F.	D.F.B.	SCY/P(g)	LY/P(g)	BW (g)	N.B/P	SI (g)	L %	Mic.	PI	UHM
P1	71.33	123.33	97.6	40.4	2.9	34.0	9.5	41.4	3.9	10.1	32.0
P2	65.67	118.33	87.6	35.1	2.9	29.8	10.0	40.1	3.7	9.5	31.9
P3	71.00	123.67	85.5	29.7	2.9	29.4	10.0	34.9	3.1	9.5	35.6
P4	70.33	121.33	79.5	27.2	2.5	31.9	9.5	34.2	2.8	9.6	35.3
P5	70.00	121.67	114.6	44.8	2.8	40.7	10.7	39.3	3.3	9.8	33.4
P6	69.67	120.67	96.5	35.9	2.8	35.5	10.1	37.1	3.3	9.1	33.7
P7	68.00	120.67	109.2	42.0	2.9	38.1	9.9	38.4	3.2	10.2	33.2
P1 x P2	65.33	117.67	121.5	48.7	2.9	41.3	9.8	40.1	3.7	9.3	30.5
P1 x P3	70.67	122.67	89.5	36.1	2.9	30.5	9.8	40.3	4.0	9.4	33.9
P1 x P4	71.67	124.00	81.3	26.8	2.8	29.3	9.4	32.8	2.9	10.2	36.3
P1 x P5	69.67	121.67	83.8	31.0	2.6	32.3	8.9	37.0	3.3	11.1	34.9
P1 x P6	73.67	125.00	94.5	33.3	2.8	33.5	10.0	35.1	3.1	10.0	33.2
P1 x P7	67.67	119.67	90.7	32.1	2.4	38.3	9.7	35.3	2.9	9.8	35.5
P2 x P3	68.67	121.00	104.8	42.4	3.0	35.4	9.4	40.3	3.5	9.4	32.1
P2 x P4	72.33	124.67	73.1	26.2	3.0	24.3	9.6	35.7	3.1	9.5	34.4
P2 x P5	71.67	124.00	70.0	23.7	2.5	27.9	9.3	34.0	3.0	9.3	34.7
P2 x P6	72.67	125.00	78.2	29.7	3.1	25.3	10.3	38.1	4.1	10.1	34.9
P2 x P7	69.67	121.00	133.8	47.6	2.9	45.5	9.4	35.6	3.1	9.5	32.8
P3 x P4	70.33	121.67	87.4	28.3	2.8	32.0	9.3	31.8	3.1	9.4	33.4
P3 x P5	69.00	121.00	97.2	36.3	2.8	34.7	9.9	37.3	3.0	9.7	34.6
P3 x P6	65.00	117.00	91.9	35.3	2.7	34.0	9.9	38.4	3.6	10.1	32.3
P3 x P7	69.00	120.67	90.9	31.7	3.0	30.4	9.7	34.9	3.1	9.8	34.2
P4 x P5	68.33	121.00	69.9	25.3	2.8	25.1	9.7	36.2	3.5	9.3	34.9
P4 x P6	67.67	119.33	100.0	37.2	2.7	36.5	9.8	37.1	3.6	9.7	30.7
P4 x P7	72.33	123.00	98.3	36.1	2.6	38.3	9.7	36.6	3.0	9.1	34.8
P5 x P6	70.00	121.67	114.6	44.8	2.8	40.7	10.7	39.3	3.3	9.8	33.4
P5 x P7	69.67	120.67	96.5	35.9	2.8	35.5	10.1	37.1	3.3	9.1	33.7
P6 x P7	68.00	120.67	109.2	42.0	2.9	38.1	9.9	38.4	3.2	10.2	33.2
LSD 5%	3.07	2.75	28.18	10.7	0.28	10.6	0.77	1.79	0.59	1.024	2.11
1%	4.09	3.67	37.57	14.3	0.38	14.1	1.02	2.39	0.79	1.366	2.81

P_1, P_2, P_3, P_4, P_5, P_6 and P_7 were; Giza 80, Giza 90, Giza 86, Giza 87, Giza 88, Giza 92 and Giza 93, respectively.

DFF: days to first flower and DFB: days to first opening boll. SCY/P: seed cotton yield/plant, LY/P: lint yield/plant, BW: boll weight, B/P: number of bolls/plant, L%: lint percentage, seed index (S I g), FF: fiber fineness, FS: fiber strength and UHM: upper half mean.

Table (3): Mean squares for earliness, yield and yield components and Fiber quality traits.

S.O.V	df	D.F.F.	D.F.B.	SCY/P(g)	LY/P(g)	BW (g)	N.B/P	Lp (%)	SI (g)	Mic.	PI	uhm
Rep.	2	5.80	4.80	2742.46**	404.58**	0.001	352.81**	1.68	0.26	0.33	0.002	9.45**
Genotypes	27	14.33**	13.31**	646.46**	129.77**	0.085**	76.03*	17.19**	0.36	.038**	0.56	7.12**
Parents(P)	6	10.76*	9.83**	402.52	115.98*	0.07	45.26	22.88**	0.59*	0.35*	0.20	10.35 **
Cross (C)	20	16.11**	15.02**	749.14**	140.34**	0.09**	88.70*	15.36**	0.30	0.40**	0.68	6.48**
P. vs C.	1	0.02	0.14	56.38	1.003	0.001	7.44	19.67**	0.21	0.03	0.17	0.59
Error	54	3.49	2.81	294.76	42.38	0.03	41.50	1.19	0.22	0.13	0.39	1.65

*, ** Denote significant at ($P \leq 0.05$) and ($P \leq 0.01$) levels of probability, respectively.

Table (4): The analysis of variance and mean squares of diallel crosses earliness, yield and yield components and Fiber quality traits.

SOV	df	D.F.F.	D.F.B.	SCY/P (g)	LY/P(g)	BW (g)	N.B/P	Lp (%)	SI (g)	Mic.	PI	uhm
GCA	6	2.10	1.87	189.39	48.59**	0.04**	25.53	8.23**	0.13	0.18**	0.20	3.17**
SCA	20	5.54**	5.17**	222.94**	41.73**	0.03**	25.29*	5.02**	0.12	0.11**	0.18	2.15**
RI	--	0.36	0.38	0.85	1.16	1.53	1.01	1.64	1.09	1.59	1.12	1.48
Error	54	1.16	0.94	98.25	14.12	0.01	13.83	0.40	0.07	0.04	0.13	0.55

*, ** Denote significant at ($P \leq 0.05$) and ($P \leq 0.01$) levels of probability, respectively.

General ($\hat{g}_i$) and specific ($\hat{S}_{ij}$) combining ability effects:

The estimates of general combining ability effects of parents are presented in Table (5). These results indicated that, the genotype P4 followed by P1 expressed its superiority and proved to be the best general combiner for DFF and DFB traits, which should be used in breeding program to pass favorable genes for improving these traits. The data indicated that the best general combiners with maximum positive general combining ability effects were P1 and P2 for yield and yield components traits followed by P4. Thus, it could be suggested that these parental genotypes could be utilized in a breeding program for improving these yield traits. While the genotype P2 and P6 were the best combiner for UHM trait followed by P4 and P7 for Mic. and proved to be the best general combiners for fiber traits, so we can use the three parents i.e. P_4, P_6 and P_7 as parents in breeding programs to improve fiber quality traits. These results are in harmony with those reported by Abd El-Zaher *et al.* (2009), Khan *et al.* (2011) and Imran *et al.* (2012).

The specific combining ability effects ($\hat{S}_{ij}$) for all studied crosses are shown in Table 6. For SCA, the results indicated that, the combinations (P_1 x P_6)**,** (P_2 x P_4)**,** (P_2 x P_5)**,** (P_2 x P_6) and (P_4 x P_7) appeared to be the best promising for developing pure lines as all of them involve at least one good combiner for traits DFF and DFB involved. It could be recommended that the combinations (P2 x P5) and (P2 x P7) followed by (P1 x P4), (P_1 x P_5), (P_1 x P_7), (P_3 x P_4) and (P_3 x P_6) exhibited favorable SCA effects for the greatest number of yield traits. With regard to SCA, the results indicated that significant and positive SCA effects were obtained for some crosses, indicating the presence of a considerable non-allelic gene action. These results were in common agreement with the results obtained by many authors among them Abd El-Hadi *et al.* (2005), Imran *et al.* (2012), Simon *et al.* (2013). Ekinci and Basbag (2015).

Heterosis:

Heterosis estimates of hybrid combinations are presented in Tables (7 and 8). The results emphasize that the best crosses were (P_2 x P_6) and (P_3 x P_6) for heterosis relative values of the both mid-parents and better-parent for all studied earliness traits.

While the results concluded that useful heterosis relative to mid parents for most yield and yield components were observed, the crosses (P1 x P2) and (P2 x P7) for SCY/P, LY/P and NB/P traits, the two crosses (P2 x P4) and (P2 x P6) for BW, the three crosses (P1 x P3), (P2 x P3) and (P3 x P6) for L%.

Table (5): Estimates of general combining ability effects ($\hat{g}_i$) of each parent for earliness, yield and yield components and Fiber quality traits**.**

Parents	DFF	DFB	SCY/P(g)	LCY/P (g)	BW (g)	NB/P	L%	SI (g)	FF	FS	UHM
P1	0.55	0.64*	1.37	1.42	-0.05	0.68	0.92**	-0.13	0.135*	0.254*	-0.237
P2	-0.52	-0.18	1.40	1.40	0.10**	-0.85	1.00**	0.01	0.165*	-0.157	-0.807**
P3	-0.19	-0.03	-1.28	-0.71	0.07*	-1.25	-0.28	0.03	0.032	-0.090	0.141
P4	0.77*	0.52	-8.35**	-4.63**	-0.08*	-1.98	-1.85**	-0.15	-0.172**	-0.131	0.515*
P5	-0.01	0.08	1.29	0.86	-0.04	0.88	0.38	0.17*	-0.057	0.092	0.252
P6	-0.23	-0.48	-1.34	-0.62	0.01	-0.53	-0.05	0.13	0.076	0.092	-0.656**
P7	-0.38	-0.55	6.90*	2.30	-0.05	3.05*	-0.12	-0.06	-0.179**	-0.060	0.793**
LSD 0.05	0.67	0.60	6.15	2.33	0.06	2.31	0.39	0.17	0.129	0.224	0.460
0.01	0.89	0.80	8.20	3.11	0.08	3.08	0.52	0.22	0.172	0.298	0.614

*, ** Denote significant at ($P\leq0.05$) and ($P\leq0.01$) levels of probability, respectively.

Table (6): Estimates of specific combining ability effects ($\hat{s}_{ij}$) of each cross for earliness yield and yield components and Fiber quality traits.

Crosses	DFF	DFB	SCY/P (g.)	LCY/P (g.)	BW (g.)	NB/P	L%	SI	F.F.	FS	uhm
P_1xP_2	-4.24**	-4.24**	25.72**	11.38**	0.06	8.06**	1.25*	0.16	0.14	-0.52	-2.24**
P_1xP_3	0.80	0.61	-3.64	0.86	0.09	-2.31	2.78**	0.18	0.54**	-0.49	0.21
P_1xP_4	0.80	1.39	-4.70	-4.48	0.07	-2.75	-3.15**	-0.08	-0.33*	0.35	2.21**
P_1xP_5	-0.43	-0.50	-11.91	-5.81*	-0.13	-2.67	-1.18*	-0.82**	-0.109	1.06**	1.07
P_1xP_6	3.80**	3.39**	1.42	-1.95	0.02	-0.03	-2.65**	0.31	-0.44**	-0.01	0.28
P_1xP_7	-2.06*	-1.87*	-10.56	-6.11*	-0.36**	1.16	-2.41*	0.17	-0.39*	-0.12	1.16*
P_2xP_3	-0.17	-0.24	11.70	7.25*	-0.003	4.12	2.71**	-0.39	0.01	-0.08	-1.05
P_2xP_4	2.54**	2.87**	-12.93	-5.10	0.18*	-6.22*	-0.32	0.05	-0.22	0.09	0.84
P_2xP_5	2.65**	2.65**	-25.70**	-13.06**	-0.36*	-5.47	-4.25**	-0.56**	-0.37*	-0.29	1.44*
P_2xP_6	3.87**	4.20**	-14.84	-5.53	0.19*	-6.70*	0.25	0.47*	0.59**	0.44	2.58**
P_2xP_7	1.02	0.28	32.46**	9.41**	0.08	9.89**	-2.14**	-0.24	-0.22	0.06	-0.97
P_3xP_4	0.20	-0.28	3.98	-0.82	0.01	1.85	-3.02**	-0.26	-0.06	-0.07	-1.04
P_3xP_5	-0.35	-0.50	4.14	1.65	-0.03	1.69	0.32	-0.01	-0.24	0.04	0.36
P_3xP_6	-4.13**	-3.94**	1.46	2.15	-0.18*	2.36	1.78**	0.03	0.23	0.41	-0.97
P_3xP_7	0.02	-0.20	-7.77	-4.35	0.18*	-4.82	-1.58**	0.05	-0.02	0.22	-0.52
P_4xP_5	-1.98*	-1.06	-16.06*	-5.39	0.12	-7.22*	0.76	-0.04	0.40*	-0.32	0.35
P_4xP_6	-2.43**	-2.17**	16.64*	7.94*	-0.003	5.65	2.12**	0.10	0.43**	0.05	-2.98**
P_4xP_7	2.39**	1.57*	6.70	3.91	-0.08	3.81	1.696**	0.16	0.02	-0.37	-0.29
P_5xP_6	0.35	-0.39	3.56	1.15	-0.003	1.80	-0.12	0.12	0.02	-0.78**	0.25
P_5xP_7	-1.17	-0.32	8.03	4.31	0.16*	0.82	1.23*	0.08	0.14	0.44	-1.69**
P_6xP_7	-1.278	-0.759	2.25	1.23	0.03	0.59	0.06	-0.09	-0.33*	0.44	-0.02
LSD 0.05	1.656	1.486	15.22	5.77	0.15	5.71	0.97	0.41	0.32	0.55	1.14
0.01	2.207	1.981	20.29	7.69	0.21	7.61	1.29	0.55	0.43	0.74	1.52

*, ** Denote significant at ($P \leq 0.05$) and ($P \leq 0.01$) levels of probability, respectively.

Table (7): Estimates of heterosis relative to mid-parents (M.P.) of 21 F_1 crosses for earliness, yield and yield components and Fiber quality traits**.**

Crosses	DFF	DFB	SCY/P (g.)	LY/P (g.)	BW (g.)	B/P	L%	SI (g.)	FF	FS	UHM
P_1xP_2	-4.62*	-2.62*	31.21*	28.95*	1.15	29.30*	-1.76	0.17	-0.89	-5.44	-4.43
P_1xP_3	-0.70	-0.68`	-2.29	2.90	1.734	-3.84	5.72**	0.69	14.29	-4.26	0.39
P_1xP_4	1.18	1.36	-8.15	-20.71	3.106	-10.93	-13.1**	-1.23	-12.44	3.57	7.88**
P_1xP_5	-1.42	-0.68	-21.04	-27.31*	-8.77*	-13.57	-8.26**	-11.4**	-8.41	11.75*	6.67*
P_1xP_6	4.49*	2.46*	-2.68	-12.59	-0.59	-3.64	-10.6**	2.21	-14.8*	4.10	1.12
P_1xP_7	-2.87	-1.91	-12.26	-22.06	-17.4**	6.10	-11.6**	0.00	-18.9*	-3.46	9.05**
P_2xP_3	0.49	0.00	21.10	30.90*	1.71	19.46	7.56**	-6.18	2.94	-1.58	-4.89
P_2xP_4	6.37**	4.03**	-12.47	-16.04	10.43*	-21.12	-3.81	-1.03	-5.64	-0.52	2.28
P_2xP_5	5.65**	3.33**	-30.75**	-40.7**	-13.3**	-20.76	-14.3**	-9.68**	-12.50	-3.45	6.22*
P_2xP_6	7.39**	4.60**	-15.03	-16.24	8.77*	-22.59	-1.38	2.65	18.10*	8.05	6.56*
P_2xP_7	4.24*	1.26	35.92**	23.48	1.15	33.79*	-9.25**	-5.19	-10.68	-3.22	0.92
P_3xP_4	-0.47	-0.68	5.88	-0.41	3.70	4.41	-7.97**	-3.95	3.91	-1.40	-5.69*
P_3xP_5	-2.13	-1.36	-2.88	-2.550	-2.33	-1.00	0.67	-4.04	-5.21	0.86	0.15
P_3xP_6	-7.58**	-4.23**	0.92	7.68	-4.71	4.57	6.57**	-1.49	12.37	8.60	-6.64*
P_3xP_7	-0.72	-1.23	-6.69	-11.44	4.05	-10.11	-4.64*	-2.01	-1.05	-0.68	-0.44
P_4xP_5	-2.61	-0.41	-27.96*	-29.63*	5.00	-30.88*	-1.45	-3.64	13.66	-3.61	1.65
P_4xP_6	-3.33	-1.38	13.58	17.87	3.80	8.41	4.16	0.00	17.84*	3.93	-10.97**
P_4xp_7	4.5/*	1.65	4.13	4.29	-3.11	9.33	0.97	-0.17	-1.66	-7.43	1.75
P_5xP_6	0.24	0.41	8.54	11.07	1.19	6.74	2.84	2.56	-1.01	3.70	-0.35
P_5xP_7	0.97	-0.41	-13.73	-17.33	-2.92	-9.81	-4.42*	-1.46	3.09	-8.85	1.10
P_6xP_7	-1.21	0.00	6.17	7.89	1.78	3.53	1.68	-1.17	-2.04	5.54	-0.75
LSD 0.05	2.66	2.38	24.40	9.25	0.25	9.16	1.55	0.66	0.51	0.89	1.83
0.01	3.54	3.18	32.54	12.34	0.33	12.21	2.07	0.88	0.68	1.18	2.44

*, ** Denote significant at ($P \leq 0.05$) and ($P \leq 0.01$) levels of probability, respectively.

Table (8): Estimates of heterobeltiosis relative to better-parents (B.P.) of 21 F_1 crosses for earliness, yield and yield components and Fiber quality traits.

Crosses	DFF	DFB	SCY/P (g.)	LY/P (g.)	BW (g.)	B/P	L %	SI (g.)	FF	FS	UHM
P_1xP_2	-0.51	-0.56	24.49	20.55	0.00	21.37	-3.30	-2.33	1.82	-7.95	-4.58
P_1xP_3	-0.47	-0.54	-8.33	-10.73	1.15	-10.29	-2.66	-1.67	27.66**	-6.95	-4.68
P_1xP_4	1.90	2.20	-16.67	-33.66*	-3.49	-13.73	-20.8**	-1.40	3.53	0.99	2.83
P_1xP_5	-0.48	0.00	-26.88*	-30.88*	-9.30	-20.66	-10.6**	-16.3**	0.00	10.27*	4.39
P_1xP_6	5.74*	3.59**	-3.21	-17.49	-2.33	-5.72	-15.2**	-0.99	-8.00	-0.33	-1.39
P_1xP_7	-0.49	-0.83	-16.94	-23.51	-17.4**	0.35	-14.8**	-2.02	-10.42	-3.93	7.14*
P_2xP_3	4.57	2.25	19.67	20.78	1.14	18.66	0.50	-6.33	11.70	-1.75	-9.83**
P_2xP_4	10.15**	5.35**	-16.51	-25.52	2.27	-23.64	-11.0**	-3.68	8.24	-0.70	-2.64
P_2xP_5	9.14**	4.79**	-38.9**	-47.1**	-14.8**	-31.31*	-15.2**	-12.5**	-7.14	-4.76	3.79
P_2xP_6	10.66**	5.63**	-18.96	-17.10	5.68	-28.80	-5.07*	1.97	24.00**	5.59	3.76
P_2xP_7	6.09*	2.25	22.46	13.42	0.00	19.23	-11.2**	-5.67	-4.17	-6.23	-1.01
P_3xP_4	0.00	0.28	2.14	-4.60	-3.45	0.42	-8.89**	-6.36	9.41	-1.74	-6.09*
P_3xP_5	-1.43	-0.55	-15.19	-18.97	-3.45	-14.67	-5.004*	-7.19*	-3.19	-0.68	-2.90
P_3xP_6	-6.70**	-3.04*	-4.83	-1.58	-6.90	-4.41	3.32	-2.30	15.96	6.32	-9.18**
P_3xP_7	1.47	0.00	-16.81	-24.38	3.45	-20.37	-9.03**	-2.34	0.00	-3.93	-3.84
P_4xP_5	-2.38	-0.28	-39.0**	-43.5**	-1.18	-38.4**	-7.89**	-9.06*	22.35*	-4.76	-1.04
P_4xP_6	-2.87	-1.11	3.56	3.63	-1.21	2.81	0.00	-3.30	28.24**	1.39	-13.03**
P_4xP_7	6.37**	1.93	-10.04	-14.06	-9.30	0.35	-4.60	-2.36	4.71	-10.2*	-1.32
P_5xP_6	0.48	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-6.4**	-3.2*
P_5xP_7	2.45	0.00	-15.74	-19.94	-3.49	-12.62	-5.51*	-5.00	4.17	-7.1**	-7.0**
P_6xP_7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.30	9.24*	0.34	0.11
LSD 0.05	3.07	2.75	28.18	10.68	0.28	10.57	1.79	0.76	0.37	0.45	1.04
0.01	4.09	3.67	37.57	14.25	0.38	14.10	2.39	1.02	0.49	0.61	1.39

*, ** Denote significant at ($P\leq0.05$) and ($P\leq0.01$) levels of probability, respectively.

From the previous results, it can concluded that, the following crosses elucidated the maximum values of heterosis versus mid and better parents, the crosses (P1 x P3), (P2 x P6), (P4 x P5) and (P4 x P6) for FF, the cross (P1 x P5) for FS and the crosses (P1 x P4), (P1 x P5), (P1 x P7), (P2 x P5) and (P2 x P6) for UHM. These results were in harmony with those obtained by Attia (2014), El-Fesheikawy *et al.* (2015), Sorour *et al.* and (2015) Salem (2016).

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قوة الهجين والقدرة على التالف لصفات التبكير والمحصول وجودة التيلة فى القطن المصرى

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اشتملت الدراسة على سبعة أصناف من القطن المصرى هى: جيزة 80، جيزة 90، جيزة 86، جيزة 87، جيزة 88، جيزة 92 وجيزة 93. وطبقاً لنظام التزاوج الدائرى النصف كامل فقد أدخلت هذه الآباء فى سلسلة من التهجينات لتنتج 21 هجن جيل أول خلال موسم النمو 2014. وفى موسم النمو 2015، قيمت هذه التراكيب الوراثية المختلفة (الآباء السبعة، 21 هجين فردى) بمحطة البحوث الزراعية بشندويل حيث تم قياس الصفات الآتية: تاريخ تفتح أول زهرة، تاريخ تشقق أول لوزة على النبات، محصول القطن الزهر للنبات، محصول القطن الشعر للنبات، وزن اللوزة، عدد اللوز المتفتح للنبات، تصافى الحليج، معامل البذرة، نعومة التيلة، متانة التيلة وطول التيلة.

ويمكن تلخيص النتائج المتحصل عليها من هذه الدراسة فى النقاط التالية:

- أظهرت النتائج أن الصنف جيزة 90 ابكر الاصناف تحت الدراسة وأعطى أفضل القيم لصفات تاريخ تفتح اول زهرة و تاريخ تفتح اول لوزة وأظهرت البيانات ان الصنف جيزة 88 قد سجل اعلى قيمة لصفات محصول القطن الزهر/نبات ومحصول القطن الشعر/نبات وعدد اللوز /نبات ومعامل البذرة ومعامل الشعر، بينما الصنف جيزة 80 كان الأحسن فى صفة معدل الحليج. كذلك أوضحت النتائج أن الصنف جيزة 86 كان الأحسن لصفات متوسط الطول عند 2.5% (35.6 مم) اما الصنف جيزة 87 فقد أعطى أعلى قيمة لصفة نعومة التيلة (2.8 وحدة) والصنف جيزة 93 قد أعطى أعلى قيمة لصفة متانة التيلة (10.2جم/تكس) . كما ان متوسطات الاداء أظهرت ان الهجين (جيزة 86 x جيزة 92) قد أعطى أفضل متوسط لصفات تاريخ تفتح اول زهرة و تاريخ تفتح اول لوزة. كما ان الهجين (جيزة 90 x جيزة 93) قد أعطى أعلى قيمة لمحصول القطن الزهر/نبات (133.8 جم) وعدد اللوز/نبات (45.5) والهجين (جيزة 90 x جيزة 92) كان الأحسن في وزن اللوزة (3.1 جم) ومعامل البذرة (10.3 جم). وفى نفس الوقت اظهر متوسط الأداء للهجن الفردية ان الهجن (جيزة 80 x جيزة 87) قد سجل اعلى قيمة لنعومة التيلة (2.9 ميكرونير) ومتوسط الطول عند 2.5% (36.3 مم) و الهجن (جيزة 80 x جيزة 88) سجل اعلى

قيمة لصفة متانة التيلة (11.1 جم/تكس).

- اختبار المعنوية لمتوسط المربعات الخاصة بالتراكيب الوراثية أشار إلى أن هناك اختلافا معنوى أو عالى المعنوية بين هذه التراكيب الوراثية لمعظم الصفات المدروسة.
- كان تباين القدرة الخاصة للتآلف أكبر من تباين القدرة العامة للتآلف فى صفتى تاريخ تفتح اول زهرة و تاريخ تفتح اول لوزة مما يشير إلى أن التأثير السيادى هو المتحكم الأكبر فى توريث تلك الصفات.
- كانت قيم التباين الوراثي للقدرة العامة على التآلف وكذلك تباين القدرة الخاصة للتآلف معنوية أو عالية المعنوية لصفات محصول القطن وجودة التيلة ماعدا صفتى معامل البذرة ومتانة التيلة.
- كانت قيم قوة الهجين منسوبة الى متوسط الابوين وافضل الابوين موجبة وعالية المعنوية للهجين (جيزة 90 x جيزة 92) وكذلك سالبة وعالية المعنوية للهجين (جيزة 86 x جيزة 92) لصفات التبكير.
- كذلك كانت قيم قوة الهجين منسوبة الى متوسط الابوين موجبة وعالية المعنوية للهجين (جيزة 90 x جيزة 93) لصفات محصول القطن الزهر وعدد اللوز المتفتح على النبات بينما كانت سالبة وعالية المعنوية للهجين (جيزة 90 x جيزة 88) لصفات محصول القطن الشعر ومعدل الحليج والهجين (جيزة 80 x جيزة 93) لصفة وزن اللوزة.
- وكانت قيم قوة الهجين منسوبة الى افضل الابوين موجبة وعالية المعنوية للهجين (جيزة 87 x جيزة 93) لصفات نعومة التيلة وطول التيلة والهجين (جيزة 80 x جيزة 88) لصفة متانة التيلة.

نستنتج من ذلك أنه يمكن استخدام الأصناف ذات القدرة العامة العالية للتآلف والهجن المبكرة فى النضج والمميزة في صفاتها التكنولوجية وذات الإنتاجية العالية في تحسين الأقطان المصرية من خلال برامج التربية.