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Diallel Analysis of Some Quantitative Traits in Egyptian cotton Varieties

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Abstract

Half diallel among six Egyptian cotton varieties were used for yield and its components and fiber quality. Results illuminated that mean squares of each genotype (G), Parents (P), Crosses (C), (P vs C), general (GCA) and specific (SCA) combining ability were significant or highly significant for most studied traits. Mean performances of most the 15 F_1 hybrids were better than their corresponded parents. Parental varieties recorded variable performances for studied traits. Giza 95 (P_2) followed by Giza 94 (P_1) were superior for most yield traits and also, Giza 94 (P_1) followed by Giza 75 (P_3) which possessed best values for all fiber quality traits. Diallel cross analysis exhibited that, the cross P_4 x P_6 gave the highest SCA effects ($\hat{S}_{ij}$) for B/P, SCY/P, LY/P and FF. Furthermore, the crosses P_1 x P_3, P_2 x P_5, P_2 x P_3, P_3xP_6 and P_2xP_6 were desirable for BW, L%, FS, UHM and UI, respectively. Magnitudes of SCA variance were larger than those of GCA variance, for all studied traits except for L% indicating the predominance of non-additive genetic variance in the inheritance of these traits. It could be concluded that yield components and fiber properties, were mainly controlled by dominance variance effect. The estimated heritability values in broad sense ($h^2_{b.s.}$%) were larger than the heritability values in narrow sense ($h^2_{n.s.}$%) for all studied traits.

Keyword: *Diallel analysis, combining ability, Heterosis, Heritability, Gene action and cotton.*

Introduction

Detection of suitable cross combination is an important task to upgrade the efficiency of breeding programs. Diallel analysis has been widely used by geneticists and plant breeders to evaluate parents and their crosses. The knowledge of genetic components of any breeding materials is useful for choosing the proper breeding procedure cotton cultivars (Al-Ashmoony *et al*. 2016).

The theoretical aspects of diallel crosses analysis has been outlined by (Griffing, 1956). El-Fesheikawy *et al*. (2012) found that, variance due to GCA and SCA were highly significant for all studied traits indicating that both additive and non-additive gene effects were playing role to inheritance of these characters. The results also showed that the performances of most the 10 F_1 hybrids under study were better than their both parents. They added that, mean squares of genotypes were significant or highly significant for all studied traits except of fiber fineness and fiber strength. Patel *et al*. (2014) showed that variance due to GCA was greater than SCA one for fiber strength. Contrarily, σ^2GCA/σ^2SCA was less than unity for UHM. El-Fesheikawy *et al.* (2015) 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-parent were found for seed cotton yield/plant SCY/P and lint cotton yield/plant LY/P in the first cross and for SCY/P and LY/P in the second cross. Also they added that, high to moderate heritability in broad (H^2_b %) sense estimates were associated with low and medium heritability in narrow sense (h^2_n %) in most characters in both crosses. Al-Ashmoony *et al.* (2016) found that the parent Giza-95 possessed highest values for BW, SCY/P, LY/P and L%. The parent Giza-90 displayed highest value for BW. The cross (Giza-90×Giza-95) displayed highest values for yield traits; BW, SCY/P, LY/P and L%. Giza 86 (P_5) was the best for FS and UHM. AL-Hibbiny *et al* (2019) they found that, broad sense heritability (H^2_b%) were larger than the corresponding values of narrow sense heritability (h^2_n%) for all traits studied. Nawaz *et al*. (2019) studied the gene action for B/P, BW, SCY, LY and L%. The results presented that, all studied traits were controlled by over-dominance gene action except, BW that was controlled by additive gene action. Zapadiya (2019) reported that, the results presented that both GCA and SCA variances were important for inheritance of SCY/P and its contributing traits. Otherwise, the ratio of σ^2GCA/σ^2SCA was less than unity for SCY/P and BW, which indicated the importance of non-additive genetic variance for inheritance of these traits. Recently, Yehia and El-Hashash (2022) reported that, G.90 x Aus.12 and Uzbekistan lines and the tester G.97 showed superior cotton yield and most studied traits based on mean performance compared to the other parents. TNB x G. 94, (G.90x Aus.12) x G.86 and G.96 x G.94 hybrid combinations were identified as excellent based on mean performance, mid and better parents heterosis for cotton yield and most studied traits. Genetic parameters indicated that non-additive gene action effects had a more important role compared to the additive in controlling all the studied traits. Finally, and based on the results of statistical methods used in this study, the parents, and hybrids above are promising enhancement and improvement of cotton productivity and its fiber quality through use in cotton breeding programs in Egypt.

The present work was designed to evaluate the type of gene action controlling the inheritance of yield components and fiber quality using six parents diallel cross. The combining ability, heterosis and heritability estimates for these traits were also calculated to determine those parents or crosses which could be used in the improvement of high yielding and fiber quality.

Material and Methods:

Genetic materials and Mating design:

Six divergent Egyptian cotton genotypes were used in this study namely, Giza 94 (P_1), Giza 95 (P_2), Giza 75 (P_3), Giza 83 (P_4), Giza 80 (P_5), and Giza 85 (P_6). These genotypes are classified as long staple and belonged to *Gossypium barbadense,* L. Pure seeds of these varieties were kindly by Cotton Research Institute, Agriculture Research Center at Giza, Egypt.

In during 2019 growing season, the six parents were crossed in all possible combinations, excluding reciprocals, to produce a total 15 F_1 hybrids. Crossing of parents was carried out at Sids Agric. Res. Station at Beni-suef Governorate.

In 2020 season, the six parents along with their 15 F_1's (21 genotypes) were evaluated under field conditions of Sids Agric. Res. Station. The sowing date was on summer 2020. The experimental design was a randomized complete blocks (RCBD) with three replications. Each plot included three ridges, each ridges, was four m long and 65 cm apart. Hills were spaced at 25 cm within rows and seedlings were later thinned to two plants per hill. Ordinary cultural practices of cotton production were applied.

The data were recorded on the following traits: number of bolls/plant (B/P), boll weight g (BW), seed cotton yield/plant g (SCY/P), lint yield/ plant g (LY/P), lint percentage (L %), fiber fineness (FF), fiber strength (FS), upper half mean mm (UHM) and uniformity index (UI). The fiber properties were measured in the laboratories of the Cotton Fiber Research Section, Cotton Research Institute, Egypt, According to A.S.T.M.D-4605-98 and D-3818-98 (1998).

Statistical analysis:

Analysis of variance:

Statistical procedures used in this study were done according to the analysis of variance for a randomized complete block design as outlined by Steel and Torrie (1980).

The amount of heterosis were estimated as the percentage increase of the overall means of the F_1 hybrids over the average overall two parents (M.P) or above the better parent (B.P). Therefore, the values of heterosis could be estimated from the following equations:

$$M.P\ H\% = [(F_1\text{-}M.P)/M.P] \times 100$$

$$B.P\ H\% = [(F_1\text{-}B.P)/B.P] \times 100$$

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

Heritability was estimated in both broad (H^2b %) and narrow (h^2n %) senses from two formulas given by, Falconer (1989), Chaudhary (1991) and Dabholkar (1992).

Statistical Model:

The procedures of this analysis was described by Griffing (1956), method 2, model 1 which outlined by Singh and Chaudhary (1985).

Results and Discussion:

Mean squares:

Analysis of variance of the six parents and their 15 F_1's hybrids were made for all studied traits, the mean squares are presented in Table (1).

Table 1. Mean squares for yield and yield components and Fiber quality traits.

S O V	d f	B/P	BW(g)	SCY/P(g)	LY/P(g)	L %	FF	FS	UHM	UI
Rep	2	8.769	0.006	67.57	6.692	0.415	0.027	0.136	0.101	1.472
Genotypes	20	41.383**	0.095**	602.56**	104.69**	4.938**	0.166**	0.444**	2.361**	1.460*
Parents(P)	5	44.556**	0.090**	660.62**	127.55**	7.471**	0.108**	0.997**	3.889**	1.789*
Cross (C)	14	42.594*	0.091*	604.58**	102.36**	4.123**	0.187**	0.247**	1.577**	1.347

P. *vs* C.	1	8.557	0.165**	283.28**	22.978	3.688**	0.165**	0.432*	5.714**	1.400
Error	40	3.693	0.016	31.110	6.206	0.319	0.021	0.061	0.377	0.682
GCA	5	26.787**	0.063**	465.79**	84.065**	5.247**	0.074**	0.261**	1.492**	0.989**
SCA	15	9.463**	0.021**	112.53**	18.506**	0.446**	0.049**	0.110**	0.552**	0.319
δ^2_e	-	1.231	0.005	10.370	2.069	0.106	0.007	0.020	0.126	0.227

*, ** Denote significant at (P≤0.05) and (P≤0.01) levels of probability, respectively. B/P= number of bolls/plant, BW=boll weight, SCY/P=Seed cotton yield/plant, LY/P= lint yield/plant, L%= lint percentage, FF=fiber fineness, FS=fiber strength, UHM= upper half mean and UI= uniformity index.

The mean squares of genotypes (G), Parents (P) and crosses were significant and/or highly significant for all studied traits except UI for crosses. Also, the parents vs. crosses mean squares (P *vs* C) were significant and/or highly significant for all studied traits except for B/P, LY/P and UI. This indicates that the crosses were sufficiently different from each other for these traits and hence, selection is possible to identify the most desirable crosses. These differences could be attributed to large differences between the parental lines of different studies. The mean squares of GCA and SCA showed highly significant differences for most studied traits, indicating the importance of both additive and non-additive gene actions in controlling these traits. Also, indicated that the selection of parents and crosses appeared appropriate (Al-Ashmoony *et al*. 2016, Abd El Samad et al., 2017, Heba-Hamed and Said 2021 and Yehia and El-Hashash 2022).

Genetic parameters and heritability:

Apportioning of genetic variance into general (GCA) and specific (SCA) combining ability are shown in Table (2). Results revealed that, the magnitudes of SCA variance were positive and larger than those of GCA variance for all studied traits except lint percentage (L %). These indicated the predominance of non-additive genetic variance in the inheritance of these traits. It could be concluded that yield and its components as well as fiber properties were mainly controlled by non-additive variance. Similar results were detected by, Al-Ashmoony *et al* (2016) and Yehia and El-Hashash (2022).

For yield and yield components traits, the ratios of σ^2GCA/σ^2SCA indicated that, non-additive gene effect play a major role in the inheritance of all studied traits except lint percentage (L %), the additive play a major role in the inheritance of this trait. Results are acceptance with those reported by: El-Fesheikawy *et al.* (2012), Al-Ashmoony *et al* (2016) and Heba-Hamed and said (2021), while reported that non-additive gene effect play a major role in the inheritance of seed cotton yield and its components. For fiber quality, the ratio of GCA/SCA indicated that, the additive plays major part in the inheritance of fiber fineness. While, for fiber strength was controlled by the non-additive gene effect. These results agree with each other with those reported by Berger *et al*. (2012) and El-Kadi *et al*. (2013),

Heritability in both broad and narrow senses are presented in Table (2). High heritability values in broad sense were detected for all studied characters which ranged from 53.27% for UI to 94.84% for SCY/P, indicating that superior genotypes for these characters could be identified from the expression and illustrate the importance of straight forward phenotypic selection for the improvement of these traits. Narrow-sense heritability estimates were-generally-lower than the corresponding broad sense heritability, indicating the presence of non-additive gene action. However, h^2_n% estimates ranged from 11.32 for FF to 72.91% for L%. These finding are in general acceptance with those obtained by Al-Ashmoony *et al* (2016) and Hassan (2018), Heba-Hamed and said (2021).

Table 2. Genetic variance components and heritability for yield and yield components and Fiber quality traits**.**

Parameters	B/P	BW(g)	SCY/P(g)	LY/P(g)	L %	FF	FS	UHM	UI
σ^2 GCA	2.165	0.005	44.158	8.195	0.600	0.003	0.019	0.118	0.084
σ^2SCA	8.232	0.016	102.154	16.437	0.340	0.042	0.090	0.427	0.092
σ^2 GCA/σ^2SCA	0.26	0.31	0.43	0.50	1.76	0.07	0.21	0.28	0.91
σ^2_e	1.231	0.005	10.370	2.069	0.106	0.007	0.020	0.126	0.227
$h^2_{b.s}$%	91.076	83.241	94.837	94.072	93.540	87.252	86.284	84.038	53.269
$h^2_{n.s}$%	31.396	32.845	43.973	46.969	72.911	11.317	25.445	29.856	34.410

(σ^2g): is the general combining ability variance, (σ^2S): is specific combining ability variance, $\sigma^2g = ½\,\sigma^2A$ or $2\,\sigma^2g = \sigma^2A$, $\sigma^2S = \sigma^2D$, (H^2 b %) = Heritability in broad sense, (h^2_n %) = Heritability in narrow sense and σ^2e: is the error variance divided by the number of replications.

Mean performance:

The mean performances of the six parents and their 15 F_1's hybrids were estimated for all studied traits and the results are presented in Table 3. The results showed that the best mean performances were found for the parent Giza 95 (P_2) followed by Giza 94 (P_1) for most yield traits and also, the best mean performances were organized for the parental variety Giza 94 (P_1) followed by Giza 75 (P_3) which possessed best values for all fiber quality traits. With respect to the diallel crosses, the means showed that there was no specific cross, which was superior or inferior for all studied traits. The results showed that the cross P_1 x P_2 gave the highest mean for B/P, SCY/P and LY/P with means of (31.50), (111.64g) and (45.05g), respectively. In the same time, the results also revealed that the highest mean performances were found for the cross P_1 x P_3 for BW (3.79g), P_2 x P_5 for L% (40.61%). Concerning, FF the results revealed that the two crosses P_4 x P_5 and P_4 x P_6 gave the highest mean with only one value 3.6. For fiber strength, the crosses P_2 x P_3, P_1 x P_2 and P_1 x P_4 gives 11.13, 11.10 and 11.03, respectively for this trait. Also, the longest combination was found to be for UHM in the cross P_1 x P_5 and P_3 x P_6 with the mean value of (34.57) and (34.00), respectively. The hybrid P_1 x P_3 was the highest hybrid in uniformity index, with the mean value (86.03). Attia (2014), Al-Ashmoony *et al.* (2016), Mabrouk *et al* (2018), Yehia and El-Hashash (2019), Salem(2020) and Yehia and El-Hashash (2022),found difference between mean performances of erosion.

Table 3. Mean performances of parents and 15 F_1 hybrids for yield component traits and fiber quality properties**.**

Genotypes	B/P	BW(g)	SCY/P(g)	LY/P(g)	L%	FF	FS	UHM	UI
Giza 94 (P_1)	29.00	3.28	95.24	37.58	39.59	3.90	11.47	34.20	85.80
Giza 95 (P_2)	31.07	3.33	102.92	41.31	40.15	4.4	9.73	31.97	84.00
Giza 75 (P_3)	25.50	3.45	87.27	32.90	36.04	4.13	10.57	32.77	85.10
Giza 83 (P_4)	22.11	2.96	68.54	24.66	37.87	4.0	10.13	30.70	83.70
Giza 80 (P_5)	21.94	3.09	67.28	26.91	39.94	4.2	10.43	32.57	84.83
Giza 85 (P_6)	22.88	3.22	73.97	28.24	38.17	4.3	10.50	32.33	84.33
Mean	25.42	3.22	82.54	31.93	38.63	4.16	10.47	32.42	84.63
P_1 x P_2	31.50	3.54	111.64	45.05	40.38	4.3	11.10	32.97	85.87
P_1 x P_3	27.65	3.79	105.07	39.44	37.59	4.1	10.97	33.17	86.03
P_1 x P_4	28.74	3.34	95.57	37.10	38.83	4.1	11.03	33.23	84.77
P_1 x P_5	20.80	3.16	65.37	25.07	38.32	4.0	10.40	34.57	85.37
P_1 x P_6	30.06	3.20	95.37	35.28	37.04	4.1	10.30	33.73	84.97
P_2 x P_3	24.07	3.49	83.59	31.71	37.85	4.1	11.13	31.67	84.00
P_2 x P_4	22.82	3.26	75.07	29.02	38.56	4.4	10.33	32.70	84.77
P_2 x P_5	29.55	3.25	95.41	38.72	40.61	4.4	10.73	33.20	85.37
P_2 x P_6	29.03	3.44	99.25	37.72	37.97	4.0	10.40	33.47	85.47
P_3 x P_4	28.00	3.28	91.63	34.19	37.39	4.0	10.50	32.80	84.80
P_3 x P_5	22.67	3.38	75.65	28.00	37.02	3.8	10.70	33.10	85.00
P_3 x P_6	25.06	3.17	78.85	28.78	36.45	4.3	10.73	34.00	85.53
P_4 x P_5	19.66	3.36	65.51	25.13	38.37	3.6	10.40	33.20	84.63
P_4 x P_6	30.26	3.18	95.60	35.52	37.11	3.6	10.53	32.50	84.00
P_5 x P_6	23.62	3.17	74.75	28.32	37.88	3.8	10.57	32.03	83.80
Mean	26.23	3.33	87.22	33.27	38.09	4.04	10.65	33.09	84.96
LSD 5%	3.17	0.21	9.20	4.11	0.93	0.24	0.41	1.01	1.36
LSD 1%	4.24	0.28	12.32	5.50	1.25	0.32	0.54	1.36	1.82

B/P= number of bolls/plant, BW=boll weight, SCY/P=Seed cotton yield/plant, LY/P= lint yield/plant, L%= lint percentage, FF=fiber fineness, FS=fiber strength, UHM= upper half mean and UI= uniformity index.

Combining Ability Effects

1 – General Combining Ability effects ($\hat{g}_i$).

The data illustrated that P_2 and P_1 had highly positive significant general combining ability effects. For B/P, SCY/P and LY/P. The data in Table (4) showed that P_3 followed by P_2 and P_1 had positive and highly significant GCA effects ($\hat{g}_i$) for BW, indicating that these parents were good combiners. Also, the parents P_2 followed by P_5 and P_1 were good combiners for L%. These results suggested that P_1, P_2, P_3 and P_5 could be used to improve yield and its components. These results are in harmony with these reported by, El-Fesheikawy *et al.* (2012), Al-Ashmoony *et al* (2016) and El-Aref *et al* (2019). For FF, the results showed that P_4 followed by P_5 were good combiners and could be used to improve fiber fineness trait since they had negative general combining ability effects ($\hat{g}_i$). Regarding fiber strength, P_1 followed by P_3 were good combiner because they had positive and highly significant general combining ability effects. Also, P_1 was good combiner for UHM and UI so we can use the four parents i.e., P_1, P_3, P_4 and P_5 as parents in breeding programs to improve fiber quality traits. These results are in harmony with those reported by El-Kadi *et al.* (2013) and Yehia and El-Hashash, (2019).

Table 4 . Parental general combining ability effects ($\hat{g}_i$) of each parents for yield and yield components and fiber quality traits.

Parent		B/P	BW (g)	SCY/P (g)	LY/P (g)	L %	FF	FS	UHM	UI
Giza 94	**(P_1)**	**1.845****	**0.058***	**7.791****	**3.361****	**0.452****	**-0.017**	**0.314****	**0.722****	**0.569****
Giza 95	**(P_2)**	**2.140****	**0.065****	**8.702****	**4.328****	**0.996****	**0.183****	**-0.132****	**-0.294***	**-0.072**
Giza 75	**(P_3)**	**-0.445**	**0.112****	**1.018**	**-0.286**	**-1.166****	**-0.004**	**0.118****	**-0.003**	**0.19**
Giza 83	**(P_4)**	**-1.036****	**-0.096****	**-5.089****	**-2.492****	**-0.214***	**-0.092****	**-0.144****	**-0.557****	**-0.460****
Giza 80	**(P_5)**	**-2.727****	**-0.076****	**-11.242****	**-3.897****	**0.546****	**-0.062***	**-0.069**	**0.118**	**-0.026**
Giza 85	**(P_6)**	**0.222**	**-0.063****	**-1.18**	**-1.015***	**-0.614****	**-0.008**	**-0.086***	**0.014**	**-0.201**
SE($\hat{g}_i$)		**0.358**	**0.0235**	**1.0393**	**0.464**	**0.105**	**0.0271**	**0.0459**	**0.1144**	**0.154**

*, ** Denote significant at (P≤0.05) and (P≤0.01) levels of probability, respectively. B/P= number of bolls/plant, BW=boll weight, SCY/P=Seed cotton yield/plant, LY/P= lint yield/plant, L%= lint percentage, FF=fiber fineness, FS=fiber strength, UHM= upper half mean and UI= uniformity index.

2 – Specific Combining Ability effects ($\hat{S}_{ij}$).

The results are shown in Table (5). The results cleared that No hybrid exhibited positive and significant values for all studied yield traits. Out of 15 F_1 crosses studied, 5, 4, 7, 7, and 3 showed positive and significant or highly significant specific combining ability effects ($\hat{S}_{ij}$) values for B/P, BW, SCY/P, LY/P and L%, respectively. It is worth to notice that these crosses in cases of yield and yield component traits were a result of crossing [(P_2 x P_5), (P_1 x P_2) and (P_3 x P_4)]. The same trend was observed in other yield component traits. Thus, it is not necessary that parents having low general combination ability effect ($\hat{g}_i$) would also contribute to low specific combining ability effects ($\hat{S}_{ij}$).Concerning, fiber quality traits, there were 6, 4, 5 and 1 out of 15 crosses showed desirable significant specific combining ability effects ($\hat{S}_{ij}$) estimates in the cases of FF, FS, UHM and UI traits, respectively. These results were in common agreement with the results obtained by many authors among them Al-Ashmoony *et al* (2016) and Yehia and El-Hashash(2019), El-Aref et al (2019) and Heba Hamed and Said (2021).

Table 5. Cross-combinations specific combining ability effects ($\hat{s}_{ij}$) for yield and yield components and Fiber quality traits.

Crosses	B/P	BW (g)	SCY/P(g)	LY/P(g)	L %	FF	FS	UHM	UI
P1 x P2	1.513	0.110*	9.265**	4.477**	0.687**	0.014	0.315**	-0.36	0.506
P1 x P3	0.251	0.316**	10.381**	3.476**	0.056	0.068	-0.068	-0.451	0.41
P1 x P4	1.936*	0.079	6.989**	3.339**	0.345	0.123*	0.261*	0.17	-0.207
P1 x P5	-4.316**	-0.124*	-17.059**	-7.286**	-0.923**	0.027	-0.448**	0.828**	-0.04
P1 x P6	1.996*	-0.095	2.873	0.044	-1.042**	0.073	-0.531**	0.099	-0.265
P2 x P3	-3.623**	0.013	-12.016**	-5.216**	-0.221	-0.198**	0.544**	-0.935**	-0.982
P2 x P4	-4.278**	-0.007	-14.422**	-5.707**	-0.466	0.223**	0.007	0.653*	0.435
P2 x P5	4.140**	-0.042	12.064**	5.400**	0.820**	0.227**	0.332**	0.478	0.602
P2 x P6	0.665	0.138**	5.842**	1.52	-0.653**	-0.227**	0.015	0.849**	0.877
P3 x P4	3.479**	-0.035	9.815**	4.083**	0.530*	0.043	-0.077	0.461	0.206
P3 x P5	-0.161	0.043	-0.013	-0.708	-0.604*	-0.252**	0.048	0.086	-0.027
P3 x P6	-0.72	-0.181**	-6.875**	-2.807*	-0.017	0.227**	0.098	1.090**	0.681
P4 x P5	-2.577**	0.228**	-4.039	-1.372	-0.203	-0.298**	0.011	0.740**	0.256
P4 x P6	5.071**	0.035	15.986**	6.144**	-0.309	-0.352**	0.161	0.145	-0.202
P5 x P6	0.121	0.008	1.285	0.341**	-0.296	-0.182**	0.119	-0.997**	0.836
SE(Sij)	**0.812**	**0.0532**	**2.357**	**1.053**	**0.239**	**0.0614**	**0.104**	**0.259**	**NS**

*, ** Denote significant at (P≤0.05) and (P≤0.01) levels of probability, respectively.
P_1, P_2, P_3, P_4, P_5 and P_6 were Giza 94, Giza95, Giza75, Giza 83, Giza 80 and Giza 85, respectively B/P: number of bolls/plant, BW: boll weight, SCY/P: seed cotton yield/plant, LY/P: lint yield/plant, L%: lint percentage, FF: fiber fineness, FS: fiber strength, UHM: upper half mean and UI: uniformity index.

Heterosis:

Mid-parent (MP) and better parent (BP) for studied traits are given in Table (6).The estimates of heterosis revealed that none of the hybrids was consistently proved to be superior for all investigated traits. However, outside F_1s crosses (15), 5 and 1 crosses for number of bolls/plant; 4 and 3 crosses for boll weight; 8 and 1 crosses for seed cotton yield/plant; 6 and 1 crosses for lint cotton yield/plant; 0 and 0 crosses for lint percentage; 0 and 0 crosses for fiber strength; 5 and 2 crosses for upper half mean and 0 and 0 crosses for uniformity index showed positive and significant or highly significant heterosis relative to mid-parent and better parent, respectively. As for fiber fineness trait, 5 and 6 crosses had negative and significant or highly significant heterosis relative to mid-parent and better parent, respectively. On the other hand, the other crosses had undesirable heterosis relative to mid-parent and better parent for all investigated traits. Present study confirm the findings of Mabrouk *et al* (2018) and Patel and Patel (2018) who had reported significant heterosis in desired direction for all studied traits.

From the results can conclude that, the two crosses G.94 (P_1) x G.83 (P_4) and G.83(P_4) x G.85(P_6) for yield and its components traits, and the two crosses G.95(P_2) x G.85(P_6) and G.83(P_4) x G.80 (P_5) for fiber traits exhibited the best heterosis versus both mid-parents and better parent. These crosses can be introduced into the cross breeding program with multipurpose objectives to improve both yield and fiber quality traits for cotton in Egypt. These results indicates the importance of low x average, average x average, low x high and high x high parent combinations in the development of crosses exhibiting high level of hybrid vigour for yield and yield related traits. Thus, it can be concluded that the parents possessing only high values need not necessarily produce high yielding hybrids as indicated by the present study (Kumar, 2008). Also, El-Hashash (2013) reported that some crosses exhibited significant or highly significant positive heterosis over mid-parent for yield, yield components and fiber traits, while the heterosis over better parent exhibited insignificant positive and desirable for all studied traits. The significant negative heterosis suggested the importance of additive genetic components . Useful and significant heterosis over mid-parents and better parents were observed for yield and yield components traits by El-Fesheikawy *et al.* (2012 and 2015), Al-Ashmoony *et al* (2016), Babu *et al*., (2018) and Bilwal *et al*. (2018) and for fiber quality traits by Babu *et al*., (2018).

Table 6. Estimates of heterosis relative to mid-parents (MP) and heterobeltiosis relative to better- parent (BP) of 15 F_1 crosses for yield and yield components traits and Fiber quality traits.

Crosses	B/P		BW (g)		SCY/P (g)		LY/P (g)		L %	
	(M.P)	(B.P)	(M.P)	(B.P)	(M.P)	(B.P)	(M.P)	(B.P)	(M.P)	(B.P)
P1 x P2	4.87	1.37	7.08*	6.26*	12.68**	8.47	14.22**	9.07	1.28	0.56
P1 x P3	1.47	-5.29	12.69**	9.90**	15.14**	11.27	11.90*	5.63	-0.60	-5.55**
P1 x P4	12.48*	-0.88	7.21*	2.04	16.71**	0.35	19.20**	-1.3	0.26	-1.92
P1 x P5	-18.33**	-28.27**	-0.77	-3.54	-19.55**	-31.36**	-22.27**	-33.31**	-3.63**	-4.09**
P1 x P6	15.90**	3.67	-1.48	-2.28	12.72*	0.13	7.19	-6.14	-4.73**	-6.43**
P2 x P3	-14.89**	-27.45**	3.11	1.32	-12.10**	-22.15**	-14.53**	-29.16**	-0.64	-6.38**
P2 x P4	-14.16**	-26.54**	3.84	-1.88	-12.43*	-27.06**	-12.02*	-29.75**	-1.15	-3.97**
P2 x P5	11.49*	-4.89	1.23	-2.32	12.11*	-7.3	13.52*	-6.26	1.40	1.13
P2 x P6	7.61	-6.58	5.09	3.45	12.21*	-3.57	8.48	-8.68	-3.04**	-5.43**
P3 x P4	17.61**	9.8	2.48	-4.76	17.61**	4.99	18.80**	3.92	1.19	-1.31
P3 x P5	-4.44	-11.1	3.36	-1.93	-2.11	-13.32*	-6.38	-14.91*	-2.55*	-8.10**
P3 x P6	3.59	-1.73	-4.96	-8.05**	-2.2	-9.66	-5.85	-12.53*	-1.78	-4.79**
P4 x P5	-10.75	-11.18	10.93**	8.53*	-3.53	-2.63	-2.55	-6.61	-1.36	-3.92**
P4 x P6	34.50**	32.25**	2.78	-1.41	34.17**	29.25**	34.32**	25.81**	-2.40*	-2.79*
P5 x P6	5.38	3.22	0.40	-1.61	5.84	1.05	2.70	0.28	-3.01**	-5.40**
LSD 0.05	**2.75**	**3.17**	**0.18**	**0.21**	**7.97**	**9.20**	**3.56**	**4.11**	**0.81**	**0.93**
0.01	**3.68**	**4.24**	**0.24**	**0.28**	**10.67**	**12.32**	**4.76**	**5.50**	**1.08**	**1.25**

Cont.: Table 6:

Crosses	FF		FS		UHM		UI	
	(M.P)	(B.P)	(M.P)	(B.P)	(M.P)	(B.P)	(M.P)	(B.P)
P1 x P2	2.4	-3.76	4.72	-3.77	-0.35	-3.86	1.14	2.22
P1 x P3	2.9	0.00	-0.45	-4.73	-0.95	-3.15	0.68	0.27
P1 x P4	3.36	1.71	2.16	-3.78	2.41	-2.83	0.02	-1.2
P1 x P5	-0.41	-4.27	-5.02	-9.3	3.54*	1.07	0.06	-0.51
P1 x P6	0.81	-4.27	-6.22	-10.17	1.4	-1.36	-0.12	-0.97
P2 x P3	-5.06	-8.87**	9.69	5.36	-2.16	-3.36	-0.65	-1.29
P2 x P4	3.94	-0.75	4.03	2.05	4.36*	6.26**	1.09	0.91
P2 x P5	2.7	0.00	6.45	3.08	2.89	1.98	1.13	1.63
P2 x P6	-7.63**	-9.02**	2.8	-1.03	4.10*	4.69*	1.54	1.75
P3 x P4	-1.22	-2.42	1.45	-0.63	3.36	0.1	0.47	-0.35
P3 x P5	-9.60**	-8.87**	1.9	1.26	1.33	1.02	0.04	-0.12
P3 x P6	1.98	0.00	1.9	1.58	4.45*	3.76	0.96	0.51
P4 x P5	-11.74**	-13.49**	1.13	-0.32	4.95**	1.94	0.44	-0.24
P4 x P6	-12.80**	-15.50**	2.1	0.32	3.12	0.52	-0.02	-0.4
P5 x P6	-9.80**	-10.85**	0.96	0.63	-1.28	-1.65	-0.93	-0.63
LSD 0.05	**0.21**	**0.24**	**0.35**	**0.41**	**0.88**	**1.01**	**1.18**	**1.36**
0.01	**0.28**	**0.32**	**0.47**	**0.54**	**1.17**	**1.36**	**1.58**	**1.82**

*, **denote significance at (P≤0.05) and (P≤0.01) levels of probability, respectively.
P_1, P_2, P_3, P_4, P_5 and P_6 were Giza 94, Giza95, Giza75, Giza 83, Giza 80 and Giza 85, respectively B/P: number of bolls/plant, BW: boll weight, SCY/P: seed cotton yield/plant, LY/P: lint yield/plant, L%: lint percentage, FF: fiber fineness, FS: fiber strength, UHM: upper half mean and UI: uniformity index.

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تحليل الهجن التبادلية لبعض الصفات الكميه في أصناف القطن المصرى

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الدراسة إشتملت على ست من أصناف القطن المصرى هى: جيزه ٩٤ (P_1) ، جيزة ٩٥ (P_2) ، جيزة ٧٥ (P_3) ، جيزة ٨٣(P_4) ، جيزه ٨٠ (P_5) بالإضافة الى جيزه ٨٥(P_6). وطبقاً لنظام التهجين الدائرى النصف كامل تم إنتاج ١٥ هجين جيل أول خلال موسم النمو ٢٠١٩. وفى موسم النمو ٢٠٢٠، قيمت التراكيب الوراثية وهى (الآباء الست، ١٥ هجين فردى) فى تجربة حقلية بتصميم القطاعات الكاملة العشوائية بثلاث مكرارات بمحطة البحوث الزراعية بسدس حيث تم قياس الصفات الآتية: عدد اللوز المتفتح للنبات ، وزن اللوزة ، محصول القطن الزهر للنبات، محصول القطن الشعر للنبات، تصافى الحليج. وتم قياس الصفات التكنولوجية بمعامل التكنولوجى بمعهد بحوث القطن وهى: نعومة التيلة، متانة التيلة وطول وانتظام التيلة وذلك طبقاً لنظام التهجين النصف دائرى وكانت الاهداف الرئيسية من الدارسة الحالية هى تحديد قوة الهجين بالا ضافة الى القدرة العامة والخاصة على التآلف. ويمكن تلخيص النتائج المتحصل عليها من هذه الدراسة من خلال النقاط التالية: أوضح تحليل التباين الراجع للقدرة العامة على التآلف تبايناً بين الأصناف حيث كان الصنف جيزة ٩٥ أفضل الآباء لصفات عدد اللوز المتفتح للنبات، محصول النبات من القطن الزهر والشعر للنبات، تصافى الحليج بينما الصنف جيزة ٩٤ فقد كان أفضل الأصناف قدرة عامة على الإئتلاف لصفات المتانة ، طول التيلة و الإنتظام فى حين كان الصنف جيزة ٧٥ أفضل الآباء لمتوسط وزن اللوزة أما الصنف جيزة ٨٣ فقد كان الأفضل فى نعومة التيلة. كان متوسط مجموع المربعات الخاصة بالتراكيب الوراثية معنوى أو عالى المعنوية لكل الصفات المدروسة مما يؤكد على أن يوجد إختلافات بين هذه التراكيب الوراثية. من نتائج قياس قوة الهجين وتأثيرات القدرة الخاصة للتآلف فقد أظهرت الهجن التالية تأثيرات مرغوبة مما يدل على إمكانية إستخدامها في برامج التربية حيث أظهرت الهجن التالية أفضل نتائج لتحسين صفات المحصول ومكوناته وهذه الهجن هى: [(جيزة ٩٥xجيزة ٨٠)، (جيزة ٧٥xجيزة ٨٣)، (جيزة ٩٤×جيزة ٩٥)، (جيزة ٨٣× جيزة ٨٥) و (جيزة ٩٤×جيزة ٧٥)] بينما لصفات جودة التيلة أظهر الهجن (جيزة ٨٣× جيزة ٨٥) ،(جيزة ٨٣ x جيزة ٨٠) و(جيزة ٧٥ x جيزة ٨٠) قدرة خاصة لتحسين نعومة الألياف والهجن [(جيزة ٨٥xجيزة ٩٠)، (جيزة ٩٠xجيزة ٩٥)، (جيزة ٨٥xجيزة ٧٥)] للمتانة والهجن [(جيزة ٩٥xجيزة ٧٥)، (جيزة ٩٥xجيزة ٨٠) و(جيزة ٩٤xجيزة٩٥)] ولصفة طول التيلةكان أفضل الهجن(جيزة ٧٥ x جيزة ٨٥) و (جيزة ٩٥ x جيزة ٨٥) وبالنسبة لصفة الانتظام كان أفضل الهجين (جيزة ٩٥ x جيزة ٨٥).حيث أظهرت هذه الهجن أفضل إمكانية لإستخدامها فى تحسين الصفات تحت الدراسة. بينت النتائج أن قيم معامل التوريث فى المعنى العام تتراوح من ٥٣.٢٧٪ إلى ٩٤.٨٤٪ لصفتى معامل الإنتظام و محصول القطن الزهر للنبات ، بينما فى المعنى الخاص تراوحت القيم من ١١.٣٢٪ لصفة نعومة التيلة إلى ٧٢.٩١٪ لصفة تصافى الحليج. ومن خلال النتائج يمكن إدخال و استخدام الهجن و الأصناف ذات القدرة العالية على التآلف والمميزة في صفاتها التكنولوجية وذات الإنتاجية العالية في برامج إستنباط و تحسين الأصناف المصرية ضمن برامج تربية الاقطان المصرية .