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ANALYSIS OF HETEROSIS AND GENE ACTION USING DIALLEL, TRIALLEL AND QUADRIALLEL CROSSES FOR YIELD COMPONENTS AND FIBER TRAITS IN *Gossypium barbadense* L.

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ABSTRACT

The genetic materials used in the present study included 60 genotypes (5 parental varieties, 10 F_1 hybrids, 30 three way crosses and 15 double crosses). All these varieties belong to the species *Gossypium barbadense* L. In 2006 growing season, these genotypes were evaluated in a field trial experiment at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate for the following traits: seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.), boll weight (BW), number of bolls/plant (N.B./P.), lint percentage (L.%), fiber fineness (F.F), fiber strength (F.S) and upper half mean (UHM). The results indicated that the magnitudes of the parents mean squares of all studied traits were significant or highly significant except (L. %), (N.B. /P.) and (F.S.), while the parents vs. crosses (F, T and Q) mean squares were highly significant for all studied traits except (F.F.). In addition, the mean squares of genotypes (PFTQ) and crosses (FTQ) were highly significant for all studied traits. Furthermore, parents vs. F_1 crosses (P vs. F), parents vs. three-way crosses (P vs. T), parents vs. double crosses (P vs. Q), (F vs. T), (F vs. Q), (PF vs. T); (T vs. Q) and (PT vs. Q) were either significant or highly significant for most studied traits.

The amount of desirable heterosis for Q over better-parent ranged from (12.57 % to 44.64 %), (18.61 % to 65.34 %), (13.00 % to 15.50 %), (22.49 % to 39.39 %) for (S.C.Y. / P.), (L.Y. /P), (L %) and (N.B. /P), respectively. The results cleared that the 4, 4, 4, 2, 3, 2, and 1 out of 15 studied double crosses (Q) had significant positive heterosis (useful) relative to better – F_1 hybrid for (B.W.); (S.C.Y./ P.); (L.Y./P.); (N.B. /P.); (L %); (F.S.) and (UHM) which ranged from (11.69 to 15.48%), (24.30 to 50.92%), (10.71 to 20.51 %), (3.01 to 3.72%), (5.23 to 12.96%), (1.25 %) and (1.55 %) for the previous traits, respectively. For seed cotton yield/plant, 2 out of 15 double crosses revealed significant positive heterosis (useful) relative to better parent or three-way cross which ranged from 44.64 % for (23 x 45) to 72.52 % for (14 x 23). For lint cotton yield/plant relative heterosis versus better parent or three-way cross, 4 crosses out of 15 F_1 double crosses possessed significant positive heterosis which ranged from 14.38 % for (15 x 34) to 72.48 % for (14 x 23).

Keywords: Cotton, Diallel, Triallel, Quadriallel crosses, Heterosis and Gene action

INTRODUCTION

The intent of majority plant breeding programs is planned to increase the crop yield either by selection programs or hybridization to produce superior F_1 hybrids. The production of promising hybrids depends on the choice of parental lines as well as their order in hybridization which yielded the useful heterosis when crossed together. The critical test in F_1 hybrids is the expression of heterosis that means significant superiority of the F_1 hybrids over their better-parent (B.P) and/or mid-parents (M.P). Therefore, one of the ongoing goal of this research is the determination of the amount of heterobeltiosis and heterosis.

Heterosis is fundamentally depending on the genetic effect of dominance (Falconer 1960). As a consequence, maximizing genetic diversity between inbred is a major goal in hybrid breeding programs in order to maximize heterozygosity in the progeny. The understanding of nature of gene action with respect to the relative magnitudes of additive and non-additive genetic variance requires the determination of the different variance components of general combining ability variance (σ^2g) and specific combining ability variance (σ^2s). Therefore, in this investigation three mating systems were used for this purpose on the assumption of no epistasis. Diallel crosses analyses were used to partition the genotypic variance to its components, which included additive and non-additive genetic variance. In addition, triallel and quadriallel crosses analysis were used for further partition of non-additive genetic variance to its components, which included dominance and epistatic variances, based on the assumption of presence of epistasis. Therefore, the estimates of different variance components were calculated for all studied traits. Many investigators studied heterosis and gene action in cotton among them, Nadarajan and Rangasamy (1992), Ji and Zhou (1994), Abo-Arab *et al.* (1997), Abd El-Maksoud *et al.* (2000), Kumaresan *et al.* (2000) and Allam (2003).

Udayakumar *et al.* (1984) claimed that raw cotton yield showed highly significant heterosis with the mean of 222% over the mid-parents. Abd El-Bary (2003) found that the amounts of heterosis versus mid-parents were significant for most studied traits. While, heterosis versus better-parent was not of economical importance.

Concerning heterosis versus better-parents, Al-Zanati (1993) found that the useful heterosis values ranged from 8.64% to 51.03% in comparison with their respective better-parent for seed cotton yield. In this respect, Hamoud (2000) reported that heterosis versus mid and better-parents exhibited undesirable values for all studied fiber traits. Abou El-Yazied (2004) obtained significant heterosis values to better-parent for seed cotton yield /plant, lint yield /plant, boll weight, seed index and lint percentage, respectively, by the crosses (Suvin x Giza 88 and P.H.P X Suvin). Abd El- Hadi , *et al.* (2005 a) noticed that heterosis estimates versus better-parent were highly significant and positive for seed cotton yield /plant, lint yield /plant, boll weight, seed index and lint percentage, respectively.

MATERIALS AND METHODS

The genetic materials used in the present investigation included five cotton varieties belong to *Gossypium barbadense* L., three of them are Egyptian cotton varieties: Giza 86 (P_1) very late in maturity, high yielding characters, long staple (33.2 mm.), coarse lint (4.3 Micronaire value) and strong lint (11.0 Pressley index), Giza 85 (P_4) exhibited fiber strength (10.4) and Micronaire value (3.8) and Giza 89 (P_5) early mature, moderate in yield characters with high number of bolls per plant, long staple (32.0 mm.) and coarse lint (Micronaire value 4.1).The other two varieties were TNB1 Sea Island (P_2) an extra long staple variety characterized by Micronaire value (3.1), Pressley index (10.3), lint length (33.7 mm.) and boll weight (2.7 g.)

and Suvin (P_3) Indian long staple germplasm, characterized by earliness, high yield and its components. The inbred seeds of all varieties were obtained from The Cotton Breeding Section, Cotton Research Institute, Agricultural Research Center, Giza, Egypt.

Mating design:These five varieties were involved in a series of hybridization according to diallel, triallel and quadriallel crosses (double crosses) mating design as following:

In the growing season of 2004, the five parents were planted and mated in a diallel fashion excluding reciprocals to obtain 10 single crosses. The parental varieties were also self-pollinated to obtain enough seeds for further investigations.

In 2005 growing season, mating of single crosses with parents were done in such a way that no parent should appear more than once in the same three-way cross to obtain 30 three-way crosses;number of three-way crosses = n (n-1)(n-2)/2 .In the same time, mating of single cross with another single crosses was done in such a way that no parent should appear more than once in the same double cross to obtain 15 double crosses; number of double crosses = n (n-1) (n-2) (n-3)/8 where, n: is number of parental varieties.

The genetic materials used in this experiment consisted of 60 genotypes (the 5 parental varieties, 10 F_1 hybrids, 30 three way crosses and 15 double crosses). In 2006 growing season, the genetic materials obtained from hybridization and the five parental varieties were evaluated in a field trial experiment at Sakha Agricultural Research Station,. Kafr El-Sheikh Governorate. The experimental design used was a randomized complete blocks design with three replications. Each plot was one row 4.0 m. long and 0.6 m. wide. Hills were 0.4 m. apart to insure 10 hills per row. Hills were thinned to keep a constant stand of one plant per hill at seedlings stage. Ordinary cultural practices were followed as the recommendations for the cotton field.

Data were recorded on the following traits: Seed cotton yield per plant in grams (S.C.Y. / P.); lint yield per plant in grams (L.Y./P.);boll weight in grams (B.W.) and number of open bolls per plant (N.B. /P.); lint percentage (L %), fiber fineness (F.F.) fiber strength (F.S.) and upper half mean (UHM) as a measure of span length in mm. The fiber properties were measured in the laboratories of Cotton Fiber Research Section , Cotton Research Institute according to (A.S.T.M.D-1448-59, D-1445-60T and D-1447-67).

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 heterotic effects were determined for 10 F_1 hybrids, 30 three way crosses and 15 double crosses by comparing their average overall mean as all by the average mean of the five parents as well as the mean of the best one. In addition the comparison between and within F_1 hybrids, three way crosses and double crosses were made for all studied traits.Therefore, the values of heterosis could be estimated from the following equations:

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

$H(F_1,B.P)\%$	$= [(F_1-B.P) / B.P] \times 100$
$H(T,M.P)\%$	$= [(T-M.P) / M.P] \times 100$
$H(T,B.P)\%$	$= [(T-B.P) / B.P] \times 100$
$H(T,M.F_1)\%$	$= [(T-M.\ F_1) / M.\ F_1] \times 100$
$H(T,B.F_1)\%$	$= [(T-B.\ F_1) / B.\ F_1] \times 100$
$H(T,M.(P,F_1))\%$	$= [(T-M.\ (P,F_1)) / M.\ (P,F_1)] \times 100$
$H(T,B.(P,F_1))\%$	$= [(T-B.\ (P,F_1)) / B.\ (P,F_1)] \times 100$
$H(Q,M.P)\%$	$= [(Q-M.P) / M.P] \times 100$
$H(Q,B.P)\%$	$= [(Q-B.P) / B.P] \times 100$
$H(Q,M.\ F_1)\%$	$= [(Q-M.\ F_1) / M.\ F_1] \times 100$
$H(Q,B.\ F_1)\%$	$= [(Q-B.P) / B.\ F_1] \times 100$
$H(Q,B.T)\%$	$= [(Q-B.T) / B.T] \times 100$
$H(Q,M.T)\%$	$= [(Q-M.T) / M.T] \times 100$
$H(Q,M.(P,T))\%$	$= [(Q-M.\ (P,T)) / M.\ (P,T)] \times 100$
$H(Q,B.(P,T))\%$	$= [(Q-B.\ (P,T)) / B.\ (P,T)] \times 100$

The significance of heterosis was 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).

The procedures of diallel analysis was described by Griffing's method 2 (1956), the theoretical aspect of triallel analysis has been illustrated by Rawlign and Cockerham (1962) and the theoretical aspect of quadriallel analysis has been dealt with by Rawlign and Cockerham (1962b) and outlined by Singh and Chaudhary (1985).

RESULTS AND DISCUSSION

The estimates of genetic parameters, which included additive and non-additive genetic variances for yield component traits and fiber quality properties from the diallel crosses analysis were obtained and the results are presented in Table 1. The results revealed that the magnitudes of dominance genetic variance (σ^2D) were positive and larger than those of additive genetic variance (σ^2A), for all studied yield and yield component traits [seed cotton yield/plant (S.C.Y./P.), lint yield/plant (L.Y./P.), boll weight (B.W.), lint percentage (L.%) and number of bolls/plant (N.B./P.)] and some fiber properties [fiber strength (F.S.) and upper half mean (UHM)]. It could be concluded that fiber properties and yield components were mainly controlled by dominance variance.

The estimates of genetic parameters from the three – way crosses analysis for yield components traits and some fiber properties are presented in Table 1. The results revealed that the magnitudes of additive genetic variance (σ^2A) were positive and larger than those of dominance genetic variance (σ^2D), with respect to (L. %), (F.S.) and (UHM). These results indicate the predominance of additive genetic variance (σ^2A) in the inheritance of these traits. Concerning epistatic variances, additive by additive genetic variance (σ^2AA) showed positive values for all studied traits except of the same three previous traits [(L.%), (F.S.) and (UHM)]. While, additive by dominance genetic variance (σ^2AD) showed positive and considerable magnitude for all studied traits. It could be concluded that fiber properties and yield components were mainly controlled by additive variance and /or additive x dominance epistatic variances. These results were in common agreement with the results obtained by many authors among them Abd El-Maksoud *et al.* (2000), Hamoud (2000) and Abd El-Bary (2003).

Table 1: The estimates of genetic parameters from the F_1 hybrids, three -way and double crosses for yield and yield components traits and some fiber properties

Genetic parameters		B. W.	S.C.Y/ P	L.Y/ P	L. %	N. B./ P	F.F	F.S	UHM
σ^2 A	Diallel	0.005	12.637	-1.780	-1.175	1.003	0.099	0.007	0.258
σ^2 D		0.020	93.231	28.957	5.120	8.093	0.027	0.246	0.778
σ^2 e		0.014	8.054	2.299	1.416	2.853	0.012	0.130	0.151
σ^2A	Triallel	-0.09	-887.32	-74.07	0.27	-37.67	-0.01	0.13	0.23
σ^2D		-0.32	-2832.96	-369.71	-8.37	-401.19	-0.42	-1.42	-6.94
σ^2AA		0.22	2042.06	170.47	-0.50	86.69	0.03	-0.22	-0.39
σ^2AD		0.93	7505.35	970.58	33.20	881.78	0.96	6.08	27.43
σ^2DD		-0.28	-2081.53	-245.51	-2.08	-271.16	-0.39	-0.38	-1.71
σ^2A	Quadriallel	861.9	104.2	-9.82	-0.16	18.30	-0.98	-0.77	-4.95
σ^2D		10112.4	1287.0	-17.27	0.22	963.43	1.73	5.93	-8.47
σ^2AA		-11450.8	-1444.1	33.02	-0.05	-1041.49	-0.09	-5.27	18.35
σ^2AD		-46585.6	-5711.6	57.07	-1.95	-4546.73	-7.51	-30.56	52.88
σ^2DD		46051.8	5723.3	-17.44	2.72	4583.35	5.63	26.14	-5.49
σ^2AAA		31057.1	3807.7	-38.05	1.30	3031.16	5.01	20.37	-35.25

Concerning double crosses, the results revealed that the magnitudes of dominance genetic variance (σ^2D) were positive and larger than those of additive genetic variance (σ^2A), for all studied traits except of the (L. %) and (UHM). In addition, additive by additive (σ^2AA) and additive by dominance (σ^2AD) epistatic genetic variances showed negative and considerable magnitudes for all studied traits except for the same two previous traits (L.%) and (UHM). While, dominance by dominance (σ^2DD) and additive by additive by additive (σ^2AAA) epistatic genetic variances revealed positive and considerable magnitudes for all studied traits with the exception of the (L.%) and (UHM). It could be concluded that fiber properties and yield components were mainly controlled by dominance by dominance (σ^2DD) and additive by additive by additive (σ^2AAA) epistatic variances. This finding may explain the superiority of most studied double crosses than their parents in most of yield components traits. Therefore, it could be recommended that production of double crosses to involved in the selection breeding programs is the desirable way for improvement these traits.

Analysis of variance of five parents and their 55 crosses (F, T and Q) were made for all studied traits (S.C.Y. /P.), (L.Y. /P.), (B.W.), (L. %) and (N.B. /P.), (F.F.), (F.S.) and (UHM) and the mean square are presented in Table 2. The results indicated that the magnitudes of the parents mean squares of all studied traits were either significant or highly significant except

(L.%), (N.B./P.) and (F.S.), while the parents vs. (F,T and Q) crosses (heterosis measurements) mean squares were highly significant for all studied traits except (F.F.). In addition, the mean squares of genotypes (PFTQ) and crosses (FTQ) were highly significant for all studied traits. Furthermore, parents vs. F_1 crosses (P vs. F), parents vs. three-way crosses (P vs. T), parents vs. double crosses (P vs. Q), (F vs. T), (F vs. Q), (PF vs. T), (T vs. Q) and (PT vs. Q) were either significant or highly significant for most studied traits indicating the presence of heterosis effect for all studied traits except for non significant traits.

Table 2: The analysis of variance and the mean squares of the parents, F_1 hybrids, three-way and double crosses for yield component and fiber quality properties

S .O .V	d f	B.W.	S.C.Y./P.	L.Y./P.	L.%	N.B./P.	F.F.	F. S	U.H.M
R	2	0.001	220.4*	9.9	8.57	27.68	0.77**	5.40**	1.53
PFTQ	59	0.22**	2191.7**	294.1**	10.69**	217.3**	0.32**	1.24**	4.96**
P	4	0.15**	234.42*	34.53*	2.24	13.87	0.73**	1.39	6.53**
FTQ	54	0.22**	2344.38**	301.11**	7.67**	235.33**	0.30**	1.13**	4.77**
P. vs F	1	0.01	1716.97**	677.32**	103.38**	181.81**	0.00	1.09	2.70*
PF error	28	0.04	24.16	6.90	4.25	8.56	0.04	0.39	0.45
P. vs T	1	0.27**	1327.11**	824.08**	207.47**	32.40	0.16	7.48**	12.69**
PT error	68	0.03	81.59	15.86	4.69	13.86	0.08	0.72	1.17
P. vs Q	1	0.58**	1781.64**	913.62**	186.66**	19.74	0.03	5.78**	3.78**
PQ error	38	0.04	76.45	18.47	7.23	11.52	0.05	0.37	0.48
F vs T	1	0.33**	194.96	1.13	14.47*	161.19**	0.38*	4.21*	5.04*
FT error	78	0.02	60.79	11.48	2.10	12.10	0.07	0.66	1.16
F vs Q	1	0.74**	4.85	11.00	13.25*	155.52**	0.02	2.69**	0.06
FQ error	48	0.03	44.20	10.80	2.46	9.45	0.05	0.26	0.69
FP vs T	1	0.50**	60.85	190.41**	105.30**	47.27	0.46*	8.84	12.55**
PFT error	88	0.03	64.58	12.35	3.70	12.22	0.07	0.64	1.05
T vs Q	1	0.20**	176.38	30.34	0.10	2.07	0.77**	0.06	5.13*
TQ error	88	0.02	71.86	15.89	2.88	12.59	0.08	0.63	1.12
PT vs Q	1	0.33**	473.26*	145.53**	12.51	0.04	0.66**	0.12	2.32
PTQ error	98	0.03	76.04	16.24	4.44	12.76	0.07	0.63	1.01
P. vs FTQ	1	0.29**	1773.25**	952.03**	207.70**	55.13*	0.03	6.20**	8.68**
PFTQ error	118	0.03	65.14	13.57	3.77	11.85	0.07	0.57	0.96

P, F, T and Q are parents, diallel, triallel and quadriallel crosses, respectively
***, ** Significant at 0.05 and 0.01 levels of probability, respectively**

The amounts of heterosis versus the mid-parents (M.P) compared to F_1 hybrids (F_1), the amounts of heterosis versus the mid-parents (M.P) and mid F_1 hybrids (M.F_1) compared to three-way crosses (T) and the amounts of heterosis versus the mid-parents (M.P), mid - F_1 hybrids (M.F_1) and mid - three-way crosses (M.T) compared to the double crosses (Q) as over all mean for yield component traits and some fiber properties were obtained and the results are presented in Table 3. The results indicated the presence of desirable heterosis for F_1 over mid-parents (M.P) and (Q) over mid-parents (M.P) for all studied traits except (F.F) property. The amounts of desirable heterosis for F_1 over mid-parents (M.P) ranged from 0.85% to 23.18% for boll weight (B.W) and lint yield/plant (L.Y. /P.), respectively. In addition, the amounts of desirable heterosis for Q over mid-parents (M.P) ranged from 1.78 % to 25.42 % for (UHM) and (L.Y. /P.), respectively.

Table 3: The amount of heterosis over mid-parents (M.P) mid-F_1 hybrids ($M.F_1$) and mid- three-way crosses (M.T) compared to the double crosses (Q) as over all mean for yield component traits and fiber quality properties

Comparison	B.W.	S.C.Y./P.	L.Y./P.	L.%	N.B./P.	F.F.	F. S	U.H.M
F_1 - M.P	0.85	12.34**	23.18**	9.81**	11.52**	0.47	3.63	1.59*
LSD 1%	0.181	4.290	2.292	1.799	2.554	0.164	0.544	0.587
5%	0.135	3.187	1.702	1.336	1.897	0.122	0.404	0.436
T - M.P	5.04**	9.57**	22.53**	12.26**	4.33	-2.59	8.40**	3.04**
LSD 1%	0.127	6.701	2.954	1.606	2.762	0.211	0.630	0.802
5%	0.095	5.038	2.221	1.207	2.077	0.159	0.474	0.603
T - $M.F_1$	4.16**	-2.47	-0.52	2.23*	-6.45**	-3.05*	4.60*	1.43*
LSD 1%	0.083	4.372	1.900	0.814	1.950	0.150	0.456	0.605
5%	0.063	3.287	1.429	0.612	1.466	0.113	0.343	0.455
T - M. (F_1, P.)	4.45**	1.24	6.13**	5.37**	-3.11	-2.90*	5.84**	1.96**
LSD 1%	0.082	3.903	1.707	0.934	1.697	0.128	0.387	0.497
5%	0.061	2.934	1.283	0.703	1.276	0.096	0.291	0.373
Q - M.P	7.91**	11.85**	25.42**	12.43**	3.62	1.18	7.89**	1.78**
LSD 1%	0.170	7.038	3.459	2.165	2.733	0.181	0.488	0.559
5%	0.128	5.266	2.588	1.619	2.044	0.135	0.365	0.418
Q- $M.F_1$	7.00**	-0.44	1.82	2.39*	-7.08**	0.70	4.11**	0.18
LSD 1%	0.110	4.200	2.076	0.991	1.942	0.136	0.325	0.523
5%	0.082	3.150	1.557	0.743	1.456	0.102	0.244	0.393
Q - M.T	2.73**	2.08	2.36	0.15	-0.68	3.87**	-0.47	-1.23*
LSD 1%	0.077	4.117	1.936	0.824	1.723	0.135	0.385	0.515
5%	0.058	3.095	1.456	0.620	1.295	0.101	0.290	0.387
Q - M. (T, P)	3.44**	3.37*	5.12**	1.74	-0.09	3.48**	0.65	-0.81
LSD 1%	0.081	4.071	1.881	0.984	1.668	0.127	0.369	0.470
5%	0.061	3.076	1.422	0.743	1.260	0.096	0.279	0.355

P, F, T and Q are parents, diallel, triallel and quadriallel crosses, respectively
***, ** Significant at 0.05 and 0.01 levels of probability, respectively**

The amounts of heterosis versus the mid -parents (M.P) compared to the means of three-way crosses (T) were desirable and highly significant for all studied traits except (F.F) and (N.B./P) which were insignificant (desirable) values. These values ranged from -2.59% to 22.53% for (F.F) and (L.Y. /P), respectively. In the same time, the amounts of heterosis versus the mid -F_1's hybrids ($M.F_1$) compared to the means of three-way crosses (T) were desirable and significant for (B.W) and (L. %) and all studied fiber properties.

Meanwhile, the comparisons between three-way crosses (T) and mid-parents and F_1's hybrids (M.P, F_1) were desirable either significant or highly significant for all studied yield and fiber properties except (N.B. /P). In the same time, the comparisons between double crosses (Q) and mid- F_1's hybrids ($M.F_1$) were desirable, significant or highly significant for (B.W), (L.%) and (F.S). concerning comparisons between double crosses (Q) and mid-three-way crosses (M.T) were desirable and highly significant for (B.W) only. In addition, comparisons between double crosses (Q) and mid-three-way crosses and parents (M.T, P) were desirable and significant for most studied yield component traits and (F.S) property. Heterosis is a result of superiority of dominant alleles when recessive alleles are deleterious. Here, the deleterious recessive genes of one parent are hidden by the dominant genes of another parent and the hybrid exhibits heterosis.

On the other hand, the amount of desirable heterosis (Table 4) for F_1 over better-parent ranged from 3.30 % to 7.19 % for (N.B. /P) and (L.Y. /P), respectively. Meanwhile, the comparisons between three-way crosses (T) and better-parent were positive, significant and insignificant for L. % (8.77%) and L.Y. /P (6.63 %) traits, respectively. In the same time, estimated values of heterobeltiosis were undesirable for all studied yield component traits and fiber properties for the comparisons between the average overall three-way crosses and their better- F_1 hybrid (T, B. F_1).

Table 4: The amount of heterosis over better-parent (B.P), better-F_1 hybrid (B.F_1) and better- three-way crosses (B.T) compared to the double crosses (Q) as over all mean for yield component traits and fiber quality properties

comparison	B.W	S.C.Y/P	L.Y./P	L.%	N.B./P	F.F	F. S	U.H.M
F_1 - B.P	-10.26*	-0.61	7.19	6.40	3.30	25.29**	-4.95	-3.04*
LSD 1%	0.348	8.215	4.389	3.445	4.890	0.315	1.042	1.124
5%	0.258	6.102	3.260	2.559	3.632	0.234	0.774	0.835
T - B.P	-6.53*	-3.06	6.63	8.77*	-3.36	21.47**	-0.58	-1.66
LSD 1%	0.267	14.101	6.217	3.379	5.812	0.445	1.326	1.688
5%	0.201	10.602	4.674	2.541	4.370	0.334	0.997	1.269
T- B. (F_1,P)	-8.38**	-13.83**	-15.11**	-6.22*	-14.40**	21.47**	-4.90	-3.49*
LSD 1%	0.262	12.546	5.487	3.004	5.456	0.410	1.245	1.597
5%	0.197	9.433	4.126	2.258	4.103	0.308	0.936	1.201
Q - B.P	-3.98	-1.04	9.15	8.93	-4.02	26.18**	-1.04	-2.87*
LSD 1%	0.341	14.077	6.918	4.329	5.465	0.362	0.977	1.118
5%	0.255	10.532	5.176	3.239	4.089	0.271	0.731	0.837
Q - B.F_1	-5.88	-12.04**	-13.11**	-6.08*	-14.98**	15.95**	-5.35	-4.68**
LSD 1%	0.278	10.625	5.252	2.507	4.912	0.344	0.821	1.324
5%	0.209	7.969	3.939	1.880	3.684	0.258	0.616	0.993
Q - B.T	-12.39**	-31.65**	-31.56**	-7.24**	-33.16**	28.06**	-15.18**	-9.11**
LSD 1%	0.250	13.445	6.323	2.692	5.627	0.440	1.258	1.681
5%	0.188	10.109	4.754	2.024	4.231	0.331	0.946	1.264

P, F, T and Q are parents, diallel, triallel and quadriallel crosses, respectively
***, ** Significant at 0.05 and 0.01 levels of probability, respectively**

In addition, estimated values of heterobeltiosis were undesirable for the comparison between double crosses (Q) and their better-parent (B.P) for all studied traits except of lint yield/plant and lint percentage, which exhibited positive (desirable) but insignificant values. Furthermore, the comparisons between double crosses (Q) either their better- F_1 hybrid (B.F_1) or their better-three-way cross (B.T) were undesirable for all studied traits. In general, the absence of heterobeltiosis over all was expected in these genetic materials, because, most of them may be developed from very narrow germplasm. The improvement would depend on selection program for the superior specific hybrids through segregating generations.

Heterosis relative to better-parent (B.P) for yield component traits and fiber quality properties in the 10 studied F_1, s hybrids were obtained and the results are presented in Table 5. The significant desirable heterosis found would be only discussed here. For seed cotton yield/plant 5 out of 10 crosses studied were possessed significant positive heterosis (useful) relative to better -parent which ranged from 12.50 % for P_1 x P_5 to 18.13 % for P_3 x P_4. For lint cotton yield/plant relative heterosis versus better -parents, 6 out of 10 F_1 crosses possessed significant positive heterosis which ranged from 11.59 % for P_2 x P_3 to 35.93 % for P_3 x P_4. The results of heterosis versus better - parent revealed that 1, 2 and 4 crosses out of 10 F_1 crosses were significant and positive for boll weight, number of bolls/plant and lint percentage, respectively. Concerning upper half mean (UHM), the results cleared that heterosis versus better parents was significant, positive and ranged form 3.69 % for P_3 x P_4 to 4.50 % for P_2 x P_4.

Table 5: Heterosis relative to better parent (B.P.) for yield component traits and fiber quality properties in the 10 studied F_1, s hybrids

Crosses	B.W.	S.C.Y/P.	L.Y/P.	L.%	N.B/P.	F.F.	F. S	U.H.M
P_1 x P_2	-11.46*	1.67	0.15	-1.43	11.98	8.82	-10.61*	-2.49
P_1 x P_3	-5.26	-6.67	-3.32	3.67	-1.48	6.98	-2.02	-0.73
P_1 x P_4	-12.07*	-5.00	11.71*	15.98**	8.05	-2.33	-5.56	-3.65*
P_1 x P_5	-7.28	12.50**	25.61**	11.71*	12.89*	9.30*	-9.60	-2.05
P_2 x P_3	-9.12	4.00	17.59*	13.15*	3.41	11.76*	3.11	-3.90*
P_2 x P_4	15.41*	16.75**	18.32**	1.39	-5.60	23.53**	7.25	4.50*
P_2 x P_5	-5.26	3.64	11.31	7.49	9.39	23.53**	-4.66	-3.15
P_3 x P_4	-0.86	18.13**	35.93**	15.14**	17.10*	2.27	11.17	3.69*
P_3 x P_5	1.20	13.91**	24.05**	8.95	6.74	-4.55	-6.15	-1.37
P_4 x P_5	0.35	16.36**	26.01**	4.49	11.90	2.27	9.30	-1.07
LSD 1%	0.469	11.077	5.918	4.645	6.593	0.424	1.406	1.515
5%	0.348	8.228	4.396	3.450	4.897	0.315	1.044	1.125

1, 2, 3, 4 and 5: Giza 86, TNB1, Suvin, Giza 85, and Giza 89, respectively
***, ** Significant at 0.05 and 0.01 levels of probability, respectively**

Heterosis relative to better parent (B.P.) for yield component traits and fiber quality properties in the 30 studied three-way crosses (T) were obtained and the results are presented in Table 6. The significant desirable heterosis would be only discussed here. 5,11,13, 6,14, 3, 1 and 3 out of 30 three-way crosses studied were possessed significant heterosis (useful) relative to better -parents for (B.W.); (S.C.Y./ P.); (L.Y./P.); (N.B. /P.); (L %); (F.F.); (F.S.) and (UHM) which ranged from (9.29 to 13.94%), (13.38 to 44.78%), (17.63 to 59.49 %), (10.66 to 19.14%), (18.72 to 44.95%), (-11.36 to - 19.38%), (16.67%) and (6.45 to 7.31%) for these traits, respectively. These results revealed that there are agreements with the analysis of variance data where parent vs. three-way crosses (heterosis mean squares over all) were significance for most traits and the same trend was observed, which large number of crosses showed significant amount of heterosis.

Heterosis values relative to better F_1 or parent [B. (F_1, P)] for yield component traits and fiber quality properties in the 30 studied three-way crosses (T) are presented in Table 7. With regard to the boll weight, 4 crosses out of 30 three-way crosses recorded significant and positive desirable heterosis ranging from 13.94 % for (25 x 3) to 23.78 % for (12 x 5). For seed cotton yield/plant 10 out of 30 T crosses studied recorded significant positive heterosis (useful) relative to better-parent which ranged from 11.01% for (25 x 1) to 40.68% for (13 x 2). Concerning lint yield/plant, 10 out of 30 T crosses studied revealed significant heterosis (useful) relative to better-parent which ranged from 15.71% to 38.16% for (14 x 3) and (13 x 2), respectively. Regarding (N.B. /P.); (L %); (F.F.); (F.S.) and (UHM), 5, 7, 6, 3 and 4 crosses out of 30 three-way crosses had significant and desirable heterosis versus better -parent which ranged from (9.44 to 13.28%), (17.25 to 44.07%), (-11.36 to -21.21%), (16.67 to 19.57%) and (5.46 to 9.91%) for the 5 previous traits, respectively. These results were in common agreement with the results obtained by many authors among them Abd El-Bary (2003), and Yehia (2005).

Table 6: Heterosis relative to better parent (B.P.) for yield component traits and fiber quality properties in the 30 studied three-way crosses (T)

Crosses	B.W.	S.C.Y./P.	L.Y./P.	L.%	N.B./P.	F.F.	F. S	U.H.M
12 3	9.29*	-1.75	-0.50	1.35	-12.33	20.59**	-12.12	-4.97
12 4	-9.91*	-16.69**	-9.94	6.57	-9.82	26.47**	-10.10	-2.83
12 5	9.60*	6.38	14.20	7.19	-9.69	26.47**	-9.76	-9.26**
13 2	-4.42	31.30**	33.57**	1.77	33.97**	32.35**	3.03	-2.34
13 4	0.31	15.88*	28.42**	9.26	15.52	2.33	4.04	-1.75
13 5	-3.10	17.24**	33.31**	13.73*	12.57	2.33	0.51	-4.39
14 2	-6.38	-16.89**	-5.51	11.93*	-13.43	23.53**	-4.04	-3.07
14 3	-4.02	18.67**	29.26**	7.13	23.64**	-4.65	-1.01	1.61
14 5	-27.24**	-40.13**	-32.00**	11.95*	-23.42**	-16.28**	5.05	0.58
15 2	-6.19	44.78**	59.49**	10.11	43.60**	23.53**	2.02	0.29
15 3	8.82*	13.38*	15.58	2.19	-3.06	-19.38**	1.68	0.39
15 4	-12.07**	-17.82**	-4.03	14.99**	-13.03	-3.49	2.53	6.87**
23 1	2.68	-0.20	18.74*	19.14**	-5.21	36.76**	-1.52	1.61
23 4	-10.15*	-4.63	5.47	10.66*	-2.64	-1.47	-3.11	-2.25
23 5	-3.79	-0.42	16.90	17.46**	-1.85	26.47**	2.07	0.91
24 1	0.62	22.49**	37.90**	10.97*	18.72*	29.41**	-11.11	3.51
24 3	-3.10	43.69**	51.95**	5.60	36.01**	8.82	-2.59	3.15
24 5	13.60**	-30.95**	-20.26*	11.74*	-42.36**	22.06**	-1.04	1.98
25 1	-0.31	11.01	17.63*	5.63	3.62	32.35**	1.52	-5.26*
25 3	13.94**	-16.14*	-0.70	18.61**	-30.20**	22.06**	-1.04	6.45*
25 4	2.93	17.18*	31.46**	8.27	7.97	16.18*	13.99	7.31**
34 1	-2.43	-37.31**	-32.50**	7.79	-35.75**	3.88	12.12	-5.56*
34 2	-14.29**	35.47**	43.46**	5.86	44.95**	20.59**	5.01	-4.20
34 5	-8.61	-2.00	9.80	7.93	1.69	-9.85	11.73	-0.46
35 1	8.36	26.75**	42.72**	12.53*	8.84	6.98	-0.51	-1.90
35 2	-4.30	-3.59	2.05	5.86	-4.46	14.71*	-4.15	0.45
35 4	-8.84	-43.85**	-35.79**	10.16	-41.59**	-6.82	10.06	-0.76
45 1	-13.16**	-43.92**	-36.50**	11.66*	-39.91**	2.33	16.67*	-0.73
45 2	-9.06	5.56	22.20*	11.76*	10.09	5.88	4.15	2.10
45 3	3.10	1.36	16.82	10.86*	-6.76	-11.36*	2.79	1.98
LSD 1%	0.372	19.618	8.649	4.701	8.086	0.618	1.845	2.349
5%	0.279	14.750	6.503	3.535	6.079	0.465	1.387	1.766

1, 2, 3, 4 and 5: Giza 86, TNB1, Suvin, Giza 85, and Giza 89, respectively
***, ** Significant at 0.05 and 0.01 levels of probability, respectively**

Heterosis relative to better - parent (B.P) for yield component traits and fiber quality properties in the 15 studied double crosses (Q) were estimated and the results are presented in Table 8. The amount of desirable heterosis for Q over better-parent ranged from (12.57 % to 44.64 %), (18.61 % to 65.34 %), (13.00 % to 15.50 %), (22.49 % to 39.39 %) for (S.C.Y. / P.), (L.Y. /P), (L

%) and (N.B. /P), respectively. Meanwhile, the desirable comparisons between double crosses (Q) and better-parent were insignificant for (B.W) and (F.S) traits. In the same time, estimated values of desirable heterobeltiosis were -9.30 % and 4.09 % for the two double crosses (14 x 35) and (15 x 24) for (F.F) and (UHM), respectively.

Table 7: Heterosis relative to better F_1 or parent [B. (F_1, P)] for yield component traits and fiber quality properties in the 30 studied three-way crosses (T)

Crosses	B.W.	S.C.Y./P.	L.Y./P.	L.%	N.B./P.	F.F.	F. S	U.H.M
12 3	23.43**	-3.36	-0.64	2.82	-21.70**	10.81	-2.79	-2.55
12 4	1.75	-18.06**	-10.07	6.57	-19.47**	16.22**	0.56	-0.35
12 5	23.78**	4.63	14.04	8.74	-15.47*	16.22**	0.94	-6.95**
13 2	0.89	40.68**	38.16**	-1.84	33.97**	32.35**	5.15	-1.62
13 4	5.88	24.15**	32.83**	6.92	17.25*	0.00	6.19	-1.03
13 5	2.29	25.61**	37.89**	9.70*	12.57	-4.35	2.58	-3.68
14 2	6.48	-12.52*	-15.41*	-3.49	-17.84*	23.53**	-1.55	-0.60
14 3	6.71	24.91**	15.71*	-7.63	14.44*	-2.38	4.81	5.46*
14 5	-17.25**	-36.97**	-39.12**	-3.47	-23.83**	-14.29**	11.23	4.40
15 2	1.17	28.69**	26.97**	-1.43	27.20**	23.53**	4.66	2.39
15 3	17.36**	0.78	-7.98	-8.52*	-14.13*	-21.21**	12.48	2.49
15 4	-5.18	-26.95**	-23.60**	4.43	-22.96**	-5.68	13.41	9.10**
23 1	2.68	-0.20	18.74	7.95	-8.34	22.37**	-2.01	1.61
23 4	-8.58	-6.92	-5.31	1.72	-5.85	-11.84*	-6.03	0.15
23 5	1.45	-0.42	9.67	4.10	-1.85	13.16*	-1.01	0.91
24 1	-1.37	22.49**	35.82**	9.44*	21.73**	4.76	-14.98*	1.58
24 3	-14.57**	23.08**	28.42**	4.15	44.07**	-11.90*	-9.18	-1.29
24 5	0.15	-35.91**	-29.58**	10.21*	-42.36**	-1.19	-7.73	-3.87
25 1	-0.31	11.01*	17.63*	0.46	-5.28	7.14	1.52	-5.26*
25 3	13.94**	-19.08**	-10.79	10.35*	-36.19**	-1.19	3.80	9.91**
25 4	4.73	13.07*	18.11*	4.47	-1.30	-5.95	19.57**	8.29**
34 1	-2.43	-37.31**	-42.13**	-7.72	-42.66**	3.88	11.56	-5.56*
34 2	-13.54**	14.68**	5.54	-8.06	32.64**	20.59**	1.84	-5.33*
34 5	-7.81	-10.09	-15.59*	-6.26	-2.47	-11.85*	0.50	-3.11
35 1	8.36	21.39**	28.31**	5.59	1.97	9.52	-0.51	-1.90
35 2	-5.44	-15.36**	-17.73**	-2.83	-10.49	14.71*	-4.15	3.40
35 4	-9.92*	-50.70**	-48.24**	4.86	-45.28**	-2.38	17.26*	0.62
45 1	-13.16**	-47.42**	-43.80**	13.28**	-46.30**	2.33	16.67*	-0.73
45 2	-7.80	-9.28	-3.02	6.96	-1.61	5.88	4.15	2.10
45 3	4.54	-12.89*	-7.29	6.10	-16.67*	-11.36*	-2.13	3.08
LSD 1%	0.365	17.454	7.634	4.179	7.591	0.570	1.732	2.221
5%	0.274	13.123	5.740	3.142	5.708	0.429	1.302	1.670

1, 2, 3, 4 and 5: Giza 86, TNB1, Suvin, Giza 85, and Giza 89, respectively
***, ** Significant at 0.05 and 0.01 levels of probability, respectively**

Heterosis relative to better – F_1 hybrid (B.F_1) for yield components and some fiber traits in the 15 studied double crosses (Q) are presented in Table 9. The results cleared that the 4, 4, 4, 2, 3, 2, and 1 out of 15 studied double crosses (Q) possessed significant positive heterosis (useful) relative to better – F_1 hybrid for (B.W.); (S.C.Y./ P.); (L.Y./P.); (N.B. /P.); (L %); (F.S.) and (UHM) which ranged from (11.69 to 15.48%), (24.30 to 50.92%), (10.71

to 20.51 %), (3.01 to 3.72%), (5.23 to 12.96%), (1.25 %) and (1.55 %) for the previous traits, respectively.

Table 8: Heterosis relative to better - parent (B.P) for yield component traits and fiber quality properties in the 15 studied double crosses (Q)

Crosses	B.W.	S.C.Y./P.	L.Y./P.	L.%	N.B./P.	F.F.	F.S	U.H.M
12 34	-12.69*	-21.17**	-13.94	7.87	-11.94	16.18**	4.04	-5.26**
12 35	5.11	-33.96**	-25.87**	11.92	-41.54**	32.35**	2.02	-1.90
12 45	1.70	-2.04	5.31	5.83	-10.38	30.88**	1.52	2.19
13 24	-2.48	-39.92**	-37.50**	2.13	-39.92**	26.47**	1.52	1.90
13 25	-2.17	28.79**	35.51**	7.52	22.49**	29.41**	-3.54	-2.05
13 45	-4.02	-23.46**	-10.37	15.50*	-25.79**	9.30*	0.00	-0.15
14 23	0.31	43.38**	62.97**	12.12	39.39**	26.47**	-4.55	-10.09**
14 25	-4.02	-23.13**	-10.50	14.76*	-25.47**	35.29**	-4.04	-7.16**
14 35	-12.85*	-3.08	4.00	5.75	3.47	-9.30*	7.07	-11.70**
15 23	-3.72	41.79**	52.38**	7.40	37.03**	17.65**	-1.52	2.49
15 24	-4.18	12.57*	18.61*	3.76	9.31	19.12**	-3.54	4.09*
15 34	-2.63	18.75**	32.20**	9.45	13.48	0.00	-0.51	-2.63
23 45	10.15	44.64**	65.34**	10.01	24.52**	32.35**	7.25	-2.70
24 35	6.71	-36.09**	-24.55*	13.95*	-43.20**	20.59**	-9.84	-2.40
25 34	-3.44	3.30	20.98*	13.00*	1.46	26.47**	-4.15	-0.30
LSD 1%	0.467	19.276	9.473	5.928	7.483	0.495	1.338	1.531
5%	0.349	14.421	7.087	4.435	5.599	0.371	1.001	1.145

1, 2, 3, 4 and 5: Giza 86, TNB1, Suvin, Giza 85, and Giza 89, respectively.
*, ** Significant at 0.05 and 0.01 levels of probability, respectively

Table 9: Heterosis relative to better – F_1 hybrid ($B.F_1$) for yield components and some fiber traits in the 15 studied double crosses (Q)

Crosses	B.W.	S.C.Y./P.	L.Y./P.	L.%	N.B./P.	F.F.	F.S	U.H.M
12 34	-2.08	-22.46**	-12.23**	-2.46	-9.11**	0.25	0.35	-1.35
12 35	15.48**	-36.75**	-14.84**	1.78	-19.31**	0.80**	1.25**	0.20
12 45	14.66**	-8.16	-3.07	0.45	-8.89**	0.75**	0.65	1.20
13 24	-4.40	-39.16**	-15.61**	-0.02	-13.71**	0.10	-0.30	0.00
13 25	3.27	35.57**	14.28**	0.01	5.23*	0.20	-0.15	-0.45
13 45	1.31	-28.24**	-9.34**	3.72**	-15.05**	0.20	0.20	0.20
14 23	14.08**	50.92**	20.51**	-1.31	12.96**	0.50**	-0.50	-2.20**
14 25	9.15	-19.08**	-8.88	-0.41	-13.92**	0.40*	0.15	-1.20
14 35	-4.25	-7.18	-3.08	-3.46**	-1.30	-0.30	1.25**	-2.75**
15 23	3.84	26.04**	10.71**	-1.43	9.64**	0.20	-0.20	1.55*
15 24	-6.07	0.06	-2.80	-2.15	-1.43	-0.15	-0.80	0.75
15 34	5.01	5.56	2.64	-1.92	0.23	-0.20	-0.10	-0.45
23 45	11.69*	24.30**	14.11**	0.41	5.04	0.70**	0.40	-0.05
24 35	-5.92	-43.89**	-17.43**	3.01*	-19.94**	-0.10	-1.65**	-2.30**
25 34	-2.60	-5.23	-3.27	-0.73	-1.12	0.10	-0.70	-0.50
LSD 1%	0.381	14.548	7.192	3.432	6.726	0.472	1.125	1.813
5%	0.286	10.911	5.394	2.574	5.044	0.354	0.844	1.360

1, 2, 3, 4 and 5: Giza 86, TNB1, Suvin, Giza 85, and Giza 89, respectively.
*, ** Significant at 0.05 and 0.01 levels of probability, respectively

Heterosis relative to better three-way cross or parent [B.(T,P)] for yield components and some fiber traits in the 15 studied double crosses (Q) were calculated and the results are presented in Table 10. For seed cotton yield/plant 2 out of 15 double crosses studied showed significant positive heterosis (useful) relative to better –parent or three-way cross which ranged from 44.64 % for (23 x 45) to 72.52 % for (14 x 23). For lint cotton yield/plant relative heterosis versus better -parent or three-way cross, 4 crosses out of 15 F_1 double crosses possessed significant positive heterosis which ranged from 14.38 % for (15 x 34) to 72.48 % for (14 x 23).The results of heterosis versus better -parent or three-way cross revealed that 3, 1, 3 and 1 crosses out of 15 double crosses were significant and positive for (B.W.); (L %); (N.B./P.) and (UHM), respectively.

Table 10: Heterosis relative to better three-way cross or parent [B. (T, P)] for yield components and some fiber traits in the 15 studied double crosses (Q)

Crosses	B.W.	S.C.Y./P.	L.Y./P.	L.%	N.B./P.	F.F.	F. S	U.H.M
12 34	-20.11**	-19.76**	-13.51	7.98	-5.64	18.39*	-3.66	-0.46
12 35	-3.82	-32.78**	-25.50**	10.43*	-41.54**	16.09*	9.76	2.13
12 45	12.89**	6.86	16.93	-0.70	-10.38	12.92	3.49	5.17*
13 24	2.04	-54.24**	-53.21**	1.81	-55.15**	-1.47	-4.44	4.34
13 25	2.36	-1.91	1.45	3.34	-4.17	-6.37	-2.22	0.30
13 45	-4.32	-33.94**	-30.21**	5.71	-30.96**	-3.88	6.82	1.64
14 23	7.14	72.52**	72.48**	0.16	55.30**	-0.53	2.38	-7.24**
14 25	2.51	-16.14*	-5.27	2.52	-25.47**	0.00	9.52	-4.22
14 35	-9.19*	-18.33**	-19.54**	-1.29	-10.06	8.16	-4.88	-13.09**
15 23	2.64	-2.06	-4.46	-2.46	-4.58	-3.47	-4.76	2.19
15 24	2.15	-22.25**	-25.63**	-4.41	-23.88**	-3.57	-5.45	3.79
15 34	-10.53*	4.74	14.38*	8.66	17.06**	24.04**	-2.15	-3.01
23 45	16.15**	44.64**	63.81**	-0.59	24.52**	34.33**	10.70	-1.22
24 35	10.12*	-51.80**	-48.11**	7.91	-56.23**	10.81	-7.45	-5.38**
25 34	-15.26**	11.95	21.83*	-1.19	13.95	3.61	-3.14	-6.34**
LSD 1%	0.372	18.654	8.621	4.508	7.642	0.581	1.692	2.153
5%	0.281	14.097	6.515	3.407	5.775	0.439	1.279	1.627

1, 2, 3, 4 and 5: Giza 86, TNB1, Suvin, Giza 85, and Giza 89, respectively.
***, ** Significant at 0.05 and 0.01 levels of probability, respectively**

In conclusion, judging by the results of this investigation, the comparisons of three-way crosses as well as double crosses with the single crosses (involved in hybridization), showed the superiority of most three-way crosses as well as double crosses with respect to most of studied traits. In addition, the comparisons of double crosses with three-way crosses and/or parents (involved in hybridization), showed the superiority of some double crosses with respect to most of studied traits. However, the results of three-way crosses revealed that most of studied traits were mainly controlled by additive and additive by dominance gene action, while the dominance and other epistatic effects (additive by additive and dominance by dominance) played the minor role in the inheritance of these traits. In addition, the results of double crosses revealed that fiber properties and yield components were mainly controlled by dominance by dominance (σ^2DD) and additive by additive by additive (σ^2AAA) epistatic variances. Therefore, the breeder would design breeding programs which make use of these advantages to select superior lines from the advanced segregating generations of the high yielding three way crosses and double crosses.

REFERENCES

Abd El-Bary, A.M. (2003). Triallel analysis of some quantitatively inherited traits in *Gossypium barbadense*, L. Ph.D. Thesis, Fac. of Agric. Mansoura Univ., Egypt.

Abd El – Hadi, A.H; Z.A.Kosba; A.M Zeina and Hamoud (2005 a). Type of gene action,heterosis inbreeding depression and heritability in intra-specific cross of cotton G.barbadence I.Egypt.J.Gent.Cytol.,34:111-121

Abd El-Maksoud,M.M.; A.M.El-Adl; Z.M.El-Diasty and M.A.El-Yazied (2000).Estimation of genetic parameters for some important traits in cotton under different environmental conditions.Proceedings of 2nd Arab Cong.Biotech.(Oct.,23-26,2000):433-447.

Abo-Arab, A.R.A.; A.F. Lasheen and Z.F. Abo-Sen (1997). Genetical analysis of yield and its components in Egyptian cotton. J. Agric. Sci. Mansoura Univ., 22(1): 3675-3681.

Abou El – Yazied , M. A.(2004). Biochemical analysis as a tool to the prediction of heterosis and combining ability in some cotton crosses . Ph . D thesis, Fac. Of Agric. Mansoura, Univ.,Egypt

Allam, M.A.M. (2003). Genetic behavior of some economic characters in a hybrid between two genotypes of Extra-Long cotton. Agric. Sci. Mansoura Univ. 28(2): 811-818.

Al-Zanati, A.M. (1993). Estimation of genetic variance for some quantitative traits in cotton. M.Sc. Thesis Fac. of Agric. Menofiya Univ., Egypt.

A.S.T.M. (1967). American Society for Testing Materials. Part 25, Designation, D-1447-59, D-1447-60Tand D-1447-67. USA.

Cochran, W.C. and G.M. Cox (1957). Experimental design. 2nd ed., Jon Willey and Sons. New York. U.S.A.

Falconer, D.S. 1960, Introduction to quantitative genetics. 3rd ed Longman Scientific & Technical, Harlow (U. K).

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

Hamoud, H.M. (2000). Inheritance of quantitative traits of Egyptian Cotton. M.Sc. Thesis, Fac. of Agric. Mansoura Univ. Egypt.

Ji, W.C. and Y.Y. Zhou (1994). Genetic analysis of earliness and fiber properties in Upland cotton. Acta Agric Univ. Pekinensis. 0(4):389-396.

Kumaresan, D.; J. Ganesan and S. Ashok (2000). Genetic analysis of quantitative characters in cotton (*Gossypium hirsutum* L.). Crop Research Hisar, 19(3): 481-484.

Nadarajan, N. and S.R.S. Rangasamy (1992). Genetic analysis of certain fiber characters in Gossypium hirsutum L. Indian J. of Genetics and Plant-Breeding. 52(3): 245-251.

Rawling, J.O. and C.C. Cockerham (1962). Triallel analysis. Crop Sci., 2: 228-231.

Rawling, J.O. and C.C. Cockerham (1962b). Analysis of double cross hybrid population. Biometrics, 18: 229-244.

Singh, R.K. and B.D. Chaudhary (1985). Biometrical Method in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.

Steel, R.G.D. and J.H. Torrie (1980). Principles and procedures of statistics. McGraw Hill Book Company Inc., New York.

Udayakumar Holla; S.N. Kadapa and J.V. Goud (1984). Heterosis in *Gossypium herbaceum* x *G.arboreum*. Indian J. Agric. Sci. 54(1):16-24.

Yehia, W.M.B. (2005).Three-way crosses analysis of Egyption cotton (*Gossypium barbadense* L.) Ph.D. Thesis, Fac. of Agric. Mansoura, Univ., Egypt.

قوة الهجين وطبيعة فعل الجين فى الهجن الفردية و الثلاثية و الرباعية لمكونات المحصول وصفات التيلة في القطن

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اشتملت الدراسة على خمسة أصناف من القطن الباربادنس هى : جيزه ٨٦ (١) ، TNB1 (٢) ، Suvin(٣) ، جيزه ٨٥ (٤) و جيزه٨٩ (٥). طبقا لنظام التزاوج الدائرى النصف كامل أدخلت هذه الأباء فى سلسلة من التهجينات لتنتج ١٠ هجن جيل أول خلال موسم النمو ٢٠٠٤ وفى موسم النمو ٢٠٠٥ تم تزاوج هجن الجيل الأول مع الأباء لإنتاج ٣٠ هجين ثلاثي (بشرط ظهور اي أب في الهجين الثلاثي مرة واحدة) وكذلك تم تزاوج هجن الجيل الأول معا لإنتاج ١٥ هجين رباعى (زوجى) (بشرط ظهور أي أب في الهجين الرباعى مرة واحدة) . وفى موسم النمو ٢٠٠٦ ، تم تقييم هذه التراكيب الوراثية المختلفة (الأباء الخمسة ، ١٠ هجن جيل أول ، ٣٠ هجين ثلاثى ، ٤٥ هجين رباعى) بمحطة البحوث الزراعية بسخا حيث تم قياس الصفات الآتية: محصول القطن الزهر للنبات ، محصول القطن الشعر للنبات ، وزن اللوزة ، عدد اللوز المتفتح للنبات ، معامل الحليج ، متانة التيلة ،نعومة التيلة، طول التيلة.

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

- أظهر تحليل التباين وجود اختلافات معنوية بين التراكيب الوراثية تعود أساسا الى الاختلافات المعنوية بين الهجن الناتجة منها لجميع الصفات محل الدراسة بينما كانت الاختلافات بين الأباء معنوية لجميع الصفات المدروسة عدا صفات عدد اللوز للنبات و التصافى و متانة التيلة.
- أعطت الهجن الفردية (١×٥) ، (٣×٤) أفضل قيم لقوة الهجين عند مقارنتها بالأب الأفضل حيث تراوحت من ١٢,٥٠ إلى ١٨,١٣ % لصفة محصول القطن الزهر للنبات كما سجلت سبعة هجن فردية قيما مرغوبة لقوة الهجين عند مقارنتها بالأب الأول لصفة المحصول القطن الشعر حيث تراوحت القيم من ١١,٥٩ إلى ٣٥,٩٣ % للهجن الفردية (٢×٣) ، (٣×٤) على الترتيب.
- أظهرت عشرة هجن ثلاثية تفوقا ملحوظا عند مقارنتها بأفضل آبائها (الهجين الفردي أو الأب الثالث) لصفة القطن الزهر /نبات وتراوحت القيم من ١١,٠١ % للهجين الثلاثي (٢×٥)×١ إلى ٤٠,٦٨ % للهجين الثلاثي (١×٣)×٢ بالنسبة لصفة القطن الشعر تراوحت القيم من ١٥,٧١ ــ ٣٨,١٦ % للهجن الثلاثية (١×٤)×٣ و (١×٣)×٢ على التوالي.
- أظهرت النتائج وجود قوة هجين مرغوبة عند مقارنة الهجن الرباعية (الزوجية) مع الأب الأفضل وتراوحت القيم من (١٢,٥٧ الي ٤٤,٦٤ %)،(١٨,٦١ الي ٦٥,٣٤ %) ، (١٣,٠ الي ١٥,٥ %) و(٢٢,٤٩ الي ٣٩,٣٩ %) لصفات القطن الزهر /نبات والقطن الشعر /نبات والتصافي وعدد اللوز المتفتح /نبات على الترتيب .
- أوضحت النتائج عند مقارنة الهجن الرباعية مع أفضل الهجن الفردية وجود عدد من الهجن الرباعية ٤ ،٤ ،٤ ،٢ ،٣ ،٢ ،١ تمتلك قوة هجين معنوية مرغوبة لصفات وزن اللوزة ــ القطن الزهر ــ القطن الشعر ــ عدد اللوز ــ التصافي ــ المتانة و طول التيلة وتراوحت القيم (١١,٦٩ الي ١٥,٤٨ %) ، (٢٤,٣٠ الي ٥٠,٩٢ %) ، (١٠,٧١ الي ٢٠,٥١ %) ، (٣,٠١ الي ٣,٧٢ %) ، (٥,٢٣ الي ١٢,٩٦ %) ، (١,٢٥ %) و (١,٥٥ %) على الترتيب.
- عند مقارنة الهجن الرباعية مع أفضل آبائها (الهجين الثلاثي أو الأب الرابع) سجل الهجين الرباعي

(٢×٣)×(٤×٥) قوة هجين ٤٤,٦٤% لصفة القطن الزهر للنبات عند مقارنتة بالهجين الثلاثي (٢×٣)× ٤ او الأب ٥ كذلك الهجين الرباعي (١×٤)×(٢×٣) أعطى قوة هجين ٧٢,٥٢% عند مقارنتة بالهجين الثلاثي (١×٤)× ٢ أو الأب ٣ أما بالنسبة لصفة محصول القطن الشعر للنبات تم تحديد أربعة هجن رباعية متفوقة على أفضل آبائها (الهجين الثلاثي أو الأب الرابع) حيث تراوحت القيم من ١٤,٣٨ % للهجين الرباعي (١×٥)×(٣×٤) إلى ٧٢,٤٨ % للهجين الرباعي (١×٤)×(٢×٣).

- أظهر الهجين الفردى (جيزه ٨٦ × جيزه٨٩) أفضل إمكانية لتحسين صفات المحصول ومكوناته كما اوضح الهجين الفردى (Suvin ×جيزة ٨٩) افضل امكانية لإستخدامه فى تحسين صفة متانة التيلة بجانب تحسين صفات المحصول فى حين أظهرت الهجنين (TNB1× جيزه ٨٥) و (Suvin ×جيزة ٨٥) افضل امكانية لإستخدامهما فى تحسين صفات المحصول وطول التيلة معا.
- تم تحديد بعض الهجن الثلاثية المتميزة التى أظهرت أفضل إمكانية لإستخدامها في برامج التربية لتحسين صفات المحصول الى جانب صفات التيلة منها [(جيزه ٨٦ × Suvin) × TNB1] ، [(جيزه ٨٦ × جيزه ٨٩) × TNB1] ، [(TNB1× جيزه ٨٥) × Suvin] ، [(Suvin × جيزه ٨٩) × جيزه ٨٦] ، [(جيزه ٨٦ × Suvin) × جيزه ٨٥] ، [(جيزه ٨٦ × Suvin) × جيزه ٨٩] وأخيرا الهجين الثلاثى [(TNB1× جيزه ٨٩) × جيزه ٨٥] .
- امكن تحديد بعض الهجن الرباعية المتميزة منها [(جيزه ٨٦ × Suvin) (TNB1× جيزه ٨٩)] ، [(جيزه ٨٦ × جيزه ٨٥) (TNB1 × Suvin)] ، [(جيزه ٨٦ × جيزه٨٩) (TNB1 × Suvin)] و [(TNB1 × Suvin) (جيزه ٨٥ × جيزه ٨٩)] للاستفاده منها في برامج التربية لتحسين صفات المحصول و التيلة معا.