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THREE WAY CROSSES ANALYSIS FOR VEGETATIVE, EARLINESS AND FIBER TRAITS OF EGYPTIAN COTTON (*Gossypium barbadense, L.*)

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ABSTRACT

This investigation was directed to determine the manifestation of heterosis, types of gene action, heritability and their interactions with locations. There for many vegetative, earliness and fiber traits were studied in 60 three- way crosses of Gossypium barbadense, L. The parental varieties: 6022 (P_1), Suvin (P_2), Pima S_7 (P_3), Giza 85(P_4), Giza 88(P_5) and Giza70 (P_6) were crossed to obtain these 60 hybrids. The parental varieties, their 15F_1 crosses and their 60 three way crosses were evaluated at two locations: (Sakha Agric. Res. Station and Cotton Research Experimental at Abo-Kebir, EL-Sharkia Governorate).

The results showed highly significant differences among all the evaluated genotypes for all studied vegetative, earliness and fiber traits. The results also indicated that the mean performances of genotypes revealed that the better means were observed for (P_3 x P_5) x P_6 for number of fruiting branches per plant, (P_3 x P_6) x P_2 for number of vegetative branches per plant, (P_5 x P_6) x P_1 for first fruiting node, (P_1 x P_3) x P_2 For number of days to first flower, and number of days to first opening boll, (P_1 x P_4) x P_2 for fiber fineness, (P_1 x P_3) x P_6 for uniformity ratio and (P_3 x P_4) x P_5 for 50% span length and 2.5% span length.

The obtained values for the heterosis of the mid-parents ($H._{MP}$%) and the better parent ($H._{BP}$%) were significant and exhibited desirable estimates for all studied traits. These results indicated that the additive genetic variances and additive by dominance epistatic genetic variances were predominated and effected in the expression of all studied traits.

The results also illustrated that most studied traits showed high, intermediate or low estimates of heritability in broad ($h^2_{b.s}$%) and narrow ($h^2_{n.s}$%) senses for different studied traits. The heritability values in broad sense ranged from 98.85% for number of fruiting branches per plant to 99.98% for span length 50%. On the other hand, the heritability values in narrow sense ranged from 7.96 to 15.61%, for uniformity ratio % and number of days to first flower, respectively.

INTRODUCTION

The final objective in cotton breeding program is to improve the cotton quality. So, that the cotton breeder must chose the varieties, which lead to this goal.

Therefore, this requires understanding the nature of gene action with respect to the relative additive and non-additive genetic variances including dominance. Fortunately, the inheritance of vegetative, earliness and fiber traits are complicated, since both genetical and environmental effects, as well as their interactions influence them. The latter factor is very important and, interest for plant breeders in the applied programs. Abd El-Bary (1999);Kosba *et al*(2000) and Abd El-Hadi *et al* (2003)

Therefore, the evaluation of the relative magnitudes of these factors could be important for a successful breeding program.

Thus, this investigation was conducted to determine some genetic measurements i.e., genotype by location interactions, the performances of

genotypes, the estimates of heterosis, general and specific combining abilities and heritability values in broad and narrow senses. The estimates of these parameters are important to choose parents for crossing which could lead to desirable features in the progeny.

MATERIALS AND METHODS

Six cotton varieties belong to *Gossypium barbadense*, L. showed a great variability in their performances were used as parental varieties. These varieties were three new germplasm materials; i.e. 6022 (P_1) Russian cotton variety; Suvin (P_2) Indian cotton variety and Pima S_7 (P_3) American cotton variety. The other three varieties were Egyptian cotton varieties, one of them was long staple variety, i.e. Giza 85 (P_4) and two parental varieties were extra long staple, i.e. Giza 88 (P_5) and Giza 70 (P_6).

The pure seeds of these parental genotypes were obtained from Cotton Breeding Section, Cotton Research Institute, and Agricultural Research Center at Giza, Egypt.

In the growing season of 2001, the six parental varieties were planted and crossed in diallel crosses mating design excluding reciprocals to obtain 15 F_1 hybrids. The parental varieties were also selfed to obtain enough seeds for further investigations. In 2002 growing season, the six parental varieties and their 15 F_1 crosses were planted and mated in a three- way crosses fashion to obtain 60 three way crosses. In the growing season of 2003, the genetic materials obtained from hybridization and their parental varieties were evaluated in two field trial experiments at Sakha Agricultural Research Station and Cotton Research Experimental at Abo-Kebir, El-Sharkia Governorate.

The experimental design used was a randomized complete blocks design with three replications in each location. Each plot was one row 4.0.m. long and 0.6 m. wide. The distance between hills was 0.4 m. apart and the plant thinned to keep a constant stand of one plant per hill at seedlings stage.

Data were recorded on the following traits: two vegetative traits i.e.: number of fruiting branches per plant (N.F.B./P.) and number of vegetative branches per plant (N.V.B./P.), three earliness traits. i.e. first fruiting node (F.F.N); number of days to first flower (N.D.F.F.) and number of days to first opening boll (N.D.F.B.) and four fiber traits i.e. fiber fineness (F.F.); span length 50% (S.L. 50%); span length 2.5% (S.L. 2.5%) and uniformity ratio (U.R.%).

Analyses of triallel crosses data were conducted according to the procedures outlined by Singh and Chaudhary (1985). Considering Y_{ijkL} as the measurement recorded on a triallel cross G_{eijjk}, the statistical model takes the following form.

$$Y_{ijkL} = m + b_1 + h_i + h_j + d_{ij} + g_k + s_{ik} + s_{jk} + t_{ijk} + e_{ijkL}$$

Where:

Y_{ikj} :phenotypic value in the I^{th} replication on ij^{th} cross (grand parents) mated to K^{th} parent.

m :general mean.

b_1 :effects of I^{th} replications.

h_i :general line effect of i^{th} parent as grand parent (first kind general line effect).

h_j :general line effect of J^{th} parent as grand parent (first kind general line effect).

d_{ij} :two-line (i x j) specific effect of first kind (grand parents).

g_k :general line effect of K as parent (second kind effect).

S_{iK}, S_{jk} :two-line specific effect where i and J are half parents and K is the parent. Hence specific effects of second kind.

t_{ijk} :three-line specific effect.

e_{ijKL} :error effect.

Estimating of effects and variance:

(i) sum of each cross over the replications, i.e., $\sum_{iJKL.}$

(ii) $Y_{ij..}$:$\sum\sum Y_{iJKL}$ is the sum over replications and third parent.

(iii) $Y_{i.k.}$:$\sum\sum Y_{iJKL}$ is the sum over replications and second parent

(iv) $Y_{i...}$:$\sum\sum\sum Y_{iJKL}$ is the sum over replications, second and third parent.

(v) $Y_{..k.}$:is the sum over first and second parent over replications.

(vi) $Y_{...L}$:$\sum\sum\sum Y_{iKJL}$ is the sum over all the crosses for each replication.

(vii) $Y_{....}$:general total.

Estimation of the various effects:

(i) hi :general line effect of first kind (grand parent). This is in fact the general combining ability effect of a line used as one of the grand parent.

$$h_i = \frac{P-1}{rP(P-2)(P-3)}[Y_{i...} + [(P-4)/(P-1)]\, Y_{..i.} - (P-4)/P-1)]\, Y_{....}].$$

(ii) g_i :general line effect of the second kind. This refers to the general combining ability of a line used as parent, which crossed to the single hybrid

$$g_i = \frac{P-4}{rP(P-3)}[Y_{.i.} + [1/(P-2)]\, Y_{i...}\ [1/(P-2)]\, Y_{....}].$$

(iii) d_{ij} :two-line specific effect of first kind (grand parent)

$d_{iJ=}$

$$\frac{P-3}{r(P-1)(P-4)}[Y_{ij}\frac{1}{P-3}(Y_{i.J}+Y_{J.i}) - \frac{2}{P(P-3)}Y_{....} - \left[\frac{r(P^2-4+P+2)}{P-3}\right](h_i - h_J) - \frac{r}{P-3}(g_i - g_j)$$

(iv) S_{ik}=two-line specific effect where i is half parent and K is parent (specificeffect of second parent).

$$S_{ik} = \frac{D}{D2}[Y_{i.k.} + \frac{1}{D}Y_{k.i.} + \left(\frac{v-3}{D}\right)Y_{ik..} - \left(\frac{2(P-3)}{PD}\right)Y_{....} -$$

$$r(P-2)\, h_i - \left(\frac{P-2}{D}\right) rhi - \frac{rgi}{D} - \frac{D_1}{D}\, rgJ]$$

Where:

$D = P^2 - 5P + 5$

$D_1 = P^3 - 7P^2 + 14P - 7$

$D_2 = r(P-1)(P-3)(P-4)$

(v) T_{ijk} : Three-line specific effect.

$$T_{ijk} = \overline{Y}_{iJK} - \overline{Y} - h_i - h_J - g_K - d_{ij} - S_{ik} - S_{jk}$$

Table 1: The mean performances of three way crosses for vegetative, earliness and fiber traits for the combined data over both locations.

Crosses	Vegetative traits		Earliness traits			Fiber traits			
	N.F.B./P.	N.V.B./P.	F.F.N.	N.D.F.F.	N.D.F.B.	F.F.	S.L.50%	S.L.2.5%	U.R.%
$(P_1xP_2)xP_3$	22.79	2.96	6.57	73.85	123.92	3.77	28.33	33.40	84.87
$(P_1xP_2)xP_4$	24.79	3.21	6.28	69.01	120.43	3.63	25.78	31.22	83.15
$(P_1xP_2)xP_5$	23.63	3.33	6.70	72.25	121.88	3.97	25.42	32.60	83.13
$(P_1xP_2)_xP_6$	22.13	2.96	5.87	72.17	122.05	3.47	26.63	31.93	83.38
$(P_1xP_3)xP_2$	26.71	3.33	5.93	67.86	118.11	3.43	26.35	31.65	83.45
$(P_1xP_3)xP_4$	24.17	3.54	6.30	71.47	120.28	3.73	26.77	32.02	83.33
$(P_1xP_3)xP_5$	25.54	3.04	6.13	73.29	121.91	3.67	26.93	32.45	82.98
$(P_1xP_3)xP_6$	24.96	2.96	6.70	73.59	123.37	3.63	29.07	34.07	85.38
$(P_1xP_4)xP_2$	22.54	3.38	6.63	69.07	119.33	3.33	27.72	33.03	84.00
$(P_1xP_4)xP_3$	24.71	2.88	6.73	72.17	122.26	3.57	28.40	33.70	84.30
$(P_1xP_4)xP_5$	25.00	3.42	5.97	71.79	122.19	3.67	29.13	34.30	84.93
$(P_1xP_4)xP_6$	25.33	3.04	6.03	72.82	123.49	3.77	27.50	32.92	83.63
$(P_1xP_5)xP_2$	24.88	2.71	6.53	70.35	119.85	3.62	26.42	31.83	83.02
$(P_1xP_5)xP_3$	24.04	3.08	6.50	72.31	122.45	4.07	26.43	32.38	81.88
$(P_1xP_5)xP_4$	23.33	3.21	5.73	69.33	120.97	3.80	26.77	32.48	82.95
$(P_1xP_5)xP_6$	26.04	3.29	6.07	70.64	122.47	3.60	28.07	33.23	83.93
$(P_1xP_6)xP_2$	24.79	3.21	6.40	68.00	117.91	3.75	27.63	33.12	83.50
$(P_1xP_6)xP_3$	24.50	3.00	5.73	73.20	122.72	4.00	28.68	33.80	84.82
$(P_1xP_6)xP_4$	24.38	3.33	5.73	71.21	121.54	4.02	26.53	32.73	82.60
$(P_1xP_6)xP_5$	25.33	2.63	6.00	71.60	122.07	4.03	26.88	32.57	82.58
$(P_2xP_3)xP_1$	23.67	3.13	6.27	69.68	120.16	3.82	26.55	32.27	82.23
$(P_2xP_3)xP_4$	24.42	2.46	6.23	70.93	121.27	3.78	26.37	31.77	81.73
$(P_2xP_3)xP_5$	24.21	3.13	7.13	72.06	121.51	3.85	28.47	33.92	83.82
$(P_2xP_3)xP_6$	23.33	3.29	6.67	73.00	122.62	3.95	28.28	33.80	83.65
$(P_2xP_4)xP_1$	23.67	2.79	6.50	69.74	120.28	3.92	25.68	31.47	81.72
$(P_2xP_4)xP_3$	25.67	3.21	6.83	73.35	123.29	3.80	27.52	32.98	83.40
$(P_2xP_4)xP_5$	23.67	3.29	6.67	72.95	122.38	4.08	26.92	32.85	83.17
$(P_2xP_4)xP_6$	25.54	2.79	6.80	72.40	122.37	3.90	26.68	32.55	82.83
$(P_2xP_5)xP_1$	27.13	2.88	6.63	70.47	120.80	4.00	26.70	32.23	82.78
$(P_2xP_5)xP_3$	26.29	2.42	6.67	72.38	122.22	3.92	27.53	33.05	83.32
$(P_2xP_5)xP_4$	26.21	3.04	6.13	70.41	120.45	4.13	27.62	32.67	84.62
$(P_2xP_5)xP_6$	23.96	2.54	6.67	72.69	122.89	3.93	28.15	33.75	83.43
$(P_2xP_6)xP_1$	23.17	3.08	6.43	70.67	120.51	3.80	27.32	32.77	82.98
$(P_2xP_6)xP_3$	21.50	3.46	6.63	72.23	121.72	4.17	27.63	32.93	84.03
$(P_2xP_6)xP_4$	21.96	2.83	6.40	71.42	121.19	4.07	26.25	31.65	82.92
$(P_2xP_6)xP_5$	22.17	3.29	6.60	74.70	124.74	3.87	28.63	34.07	84.08
$(P_3xP_4)xP_1$	23.79	2.83	5.83	70.57	120.17	3.97	28.22	33.72	83.63
$(P_3xP_4)xP_2$	27.33	3.25	6.40	69.59	119.29	3.87	27.75	33.30	83.40
$(P_3xP_4)xP_5$	21.58	3.21	6.90	73.69	123.80	3.73	30.10	35.35	85.10
$(P_3xP_4)xP_6$	25.63	3.25	6.33	73.55	123.68	4.07	29.98	35.22	85.25
$(P_3xP_5)xP_1$	25.96	2.13	6.00	71.06	121.17	3.83	28.52	33.95	84.03
$(P_3xP_5)xP_2$	23.33	2.79	7.30	71.53	121.56	3.53	28.73	34.07	84.32
$(P_3xP_5)xP_4$	24.88	3.13	6.77	70.04	120.88	3.80	28.03	33.47	83.85
$(P_3xP_5)xP_6$	27.38	2.75	6.57	72.28	122.01	4.03	30.17	35.30	85.33
$(P_3xP_6)xP_1$	22.50	2.75	5.77	72.60	122.47	3.73	27.85	33.43	83.37
$(P_3xP_6)xP_2$	22.46	3.58	7.03	72.76	119.62	3.83	28.77	34.08	84.33
$(P_3xP_6)xP_4$	22.29	3.42	6.63	72.76	121.59	3.87	28.22	33.78	83.52
$(P_3xP_6)xP_5$	25.83	3.21	6.93	74.79	123.49	3.80	28.63	34.10	84.33
$(P_4xP_5)xP_1$	22.54	3.21	6.47	69.50	119.56	3.73	28.05	33.35	84.18
$(P_4xP_5)xP_2$	24.63	2.88	6.63	70.15	119.67	4.03	27.40	32.87	83.78
$(P_4xP_5)xP_3$	25.00	2.50	6.27	72.53	123.69	4.13	28.52	33.65	84.90
$(P_4xP_5)xP_6$	23.50	2.92	6.20	73.02	122.02	4.07	28.82	34.17	84.47
$(P_4xP_6)xP_1$	22.38	3.33	5.87	71.22	121.29	4.00	27.70	32.43	83.40
$(P_4xP_6)xP_2$	24.46	2.88	6.73	69.01	120.35	3.83	26.03	31.05	83.55
$(P_4xP_6)xP_3$	25.17	3.29	6.47	73.28	122.33	3.87	27.75	32.93	84.27
$(P_4xP_6)xP_5$	23.79	3.25	6.57	72.01	121.61	4.07	28.67	33.72	84.65
$(P_5xP_6)xP_1$	24.33	2.88	5.30	71.74	121.40	3.97	27.72	33.15	83.60
$(P_5xP_6)xP_2$	22.88	3.42	6.73	72.10	122.82	4.10	27.42	32.48	84.47
$(P_5xP_6)xP_3$	25.04	2.79	6.63	73.95	123.92	4.10	28.05	33.00	83.33
$(P_5xP_6)xP_4$	24.04	3.50	7.37	71.84	120.94	4.20	27.85	33.68	83.75
$L.S.D._{0.05}$%	1.947	0.301	0.598	0.962	1.123	0.303	1.497	1.177	1.156
$L.S.D._{0.01}$%	2.570	0.397	0.789	1.270	1.482	0.400	1.978	1.552	1.526

P_1, P_2, P_3, P_4, P_5 and P_6: 6022, Suvin, Pima S_7, Giza 85, Giza 88 and Giza 70.

RESULTS AND DISCUSSION

The mean performances for 60 three- way crosses of vegetative, earliness and fiber traits were calculated from the combined data over both locations and the results are presented in Table 1.

The results indicated that the means showed that no specific cross was superior or inferior for all studied traits. For N.F.B./P. the cross (P_3 x P_5) x P_6 was the highest cross with the mean of 27.38. In the same time, the cross (P_3 x P_6) x P_2 had the highest mean for N.V.B./P. with the mean of 3.58.

Concerning earliness traits, the cross (P_5 x P_6) x P_1 was the lowest (desirable) for F.F.N., as well as the crosses (P_1 x P_3) x P_2 and (P_1 x P_6) x P_2 exhibited the lowest values for N.D.F.F. and N.D.F.B. with means of 5.30, 67.86 and 117.91days, respectively. For fiber traits, the results showed that the cross (P_1 x P_4) x P_2 was the lowest with the mean 3.33 for F.F. trait and the results showed that the following crosses exhibited the highest means i.e.: (P_1 x P_3) x P_6 for U.R.%, (P_3 x P_4) x P_5 for S.L.50% and S.L.2.5% with the means 85.38, 30.10 and 35.35, respectively.

The amounts of heterosis for vegetative, earliness and fiber traits versus the mid – parents ($H_{M.P.}$%) and better parent ($H_{B.P.}$ %) were calculated from the combined data over both locations and the results are presented in Table2.The results cleared that for N.F.B./P. 15 and 9 out of 60 studied crosses showed significant positive heterosis (useful) relative to mid – parents and better parent and the highest heterosis values were observed for the cross (P_1 x P_3) x P_2 with the heterosis amount of 21.02 and 18.40 %, respectively .

The results also revealed that the means of three way crosses significantly exceeded their parents for N.V.B./P. trait. The results also indicated that the highest heterosis values were noticed for the cross (P_4 x P_5) x P_1 with mean values152.76 and 26.38 % over the mid-parents and the better parent, respectively.

Regarding first fruiting node (F.F.N.), 5 and 2 out of 60 three way crosses exhibited significant negative heterosis versus mid- parents and better parent. In this respect, the cross (P_5 x P_6) x P_1 showed the lowest values versus mid- parents and better parent, with the means –19.08 and –18.46%, respectively. With respect to the number of days to first flower and number of days to first opening boll (N.D.F.F. and N.D.F.B.), the results revealed that 33 and 17 out of 60 three way crosses exhibited significant desirable and negative heterosis versus mid- parents respectively. In the same time, the crosses (P_1 x P_3) x P_2 and (P_1 x P_6) x P_2 gave the lowest of heterosis significant values with the means –5.64 and –3.27%, respectively. Concerning heterosis against better parent, the results revealed that 17 and 8 out of the 60 three way crosses were significant and negative heterosis, while the crosses (P_1 x P_3) x P_2 and (P_1 x P_6) x P_2 showed the lowest heterosis with the mean –4.26 and –2.26 % for the same traits, respectively.

T2

-T2

Regarding fiber fineness (F.F.), 12 and 5 out of the 60 three -way crosses exhibited significant and negative heterosis versus mid – parents and better parent, respectively. The crosses (P_3 x P_6) x P_1 and (P_1 x P_3) x P_6 showed the lowest significant heterosis with means –13.46 and –11.46 %, respectively. Concerning span length 50% (S.L.50%) and span length 2.5% (S.L.2.5%), the results cleared that (8& 7) and (1 & 2) out of 60 crosses showed that significant and positive heterosis over the mid- parents and better parent for the same traits, respectively. Similarly the cross (P_4 x P_5) x P_1 showed the highest positive and significant heterosis versus mid and better parents for the two obvious traits, with the heterosis values 8.07, 6.96, 6.74 and 5.94 %, respectively. On the other hand, for U.R.% four out of the 60 crosses showed significant and positive values of heterosis (desirable) versus mid – parents and the best cross was (P_1 x P_2) x P_3 with (1.79 %). However, no cross showed that positive significant heterosis over the better parent.

These results were in agreement with the results obtained by EL-Nazer (1988); Younis *et al*. (1990); Abo-Arab *et al*. (1992); Percy and Turcotto (1992); EL-Debaby *et al*. (1997); Amer (1998); Abd EL-Bary (1999); Kosba *et a*l.(2000) ;Sorour *et al*. (2000); EL-Helw *et al.* (2002) ; Tuteja and Singh (2002); and Abou EL- Yazied (2004).

The results of the analysis of variances and mean squares of vegetative, earliness and fiber traits for the 60 crosses are shown in Table 3. The results revealed that the mean squares of crosses for N.F.B./P., N.V.B./P., F.F.N., N.D.F.F., F.F., S.L.50%, S.L.2.5% and U.R.% traits showed highly significance while, it was significant only for N.D.F.B. In the same time, the mean squares of crosses x location interactions were insignificant for all studied traits except of N.V.B./P., N.D.F.B. and U.R.% traits, which showed highly significant and significant, respectively. As well as, the mean squares due to h eliminating g were highly significant for all studied traits.

Table 3: The analysis of variances and mean squares of three-way crosses for all studied traits from the combined data over both locations.

S.V	d.f.	Vegetative traits		Earliness traits			Fiber traits			
		N.F.B./P.	N.V.B./P.	F.F.N.	N.D.F.F.	N.D.F.B.	F.F.	S.L.50%	S.L.2.5%	U.R.%
Locations	1	1.70	0.12	0.74	9.86	7.65	0.07	14.52*	5.85	13.23
Reps/L	4	4.18	0.33	1.63	9.23	22.00	0.35	3.914	5.32	3.74
Crosses	59	12.55**	0.56**	1.01**	15.36**	12.79*	0.22**	6.79**	5.37**	4.37**
Due to h eliminating g	5	21.42**	0.96**	3.42**	30.52**	8.86**	1.010**	32.01**	22.87**	9.91**
Due to g eliminating h	5	6.50	0.89**	2.02**	98.57**	94.14**	0.30*	12.90**	12.95**	8.74**
Due to s eliminating d	19	11.54**	0.56**	0.68**	4.70**	4.39**	0.12	3.45**	2.58**	4.02**
Due to d eliminating s	9	18.97**	0.38**	0.37	8.19**	4.09**	0.18**	6.31**	6.56**	2.91**
Due to t	21	10.03**	0.47**	0.77**	4.66**	5.69**	0.11	2.30	1.42	1.70*
Crosses x L.	59	5.95	0.33**	0.17	0.55	1.95**	0.08	1.68	1.27	1.65*
Due to h eliminating g x L	5	8.57*	0.32**	0.07	0.25	0.43	0.12	1.25	1.58	1.58
Due to g eliminating h x L	5	14.03**	0.30**	0.19	0.91	1.37	0.06	2.27	0.86	1.32
Due to s eliminating d x L	19	3.58	0.27**	0.10	0.53	3.47**	0.08	2.13	1.81*	1.40
Due to d eliminating s x L	9	7.06*	0.52**	0.13	0.74	2.41*	0.06	0.73	0.62	3.28**
Due to t x L	21	5.06*	0.31**	0.28	0.47	0.89	0.10	1.64	1.08	1.27
Error	236	2.930	0.070	0.276	0.716	0.974	0.071	1.732	1.07	1.033

***, **: Significant at 0.05 and 0.01 levels of probability, respectively**

Similarly, the mean squares due to g eliminating h were significant or highly significant for all studied traits, with except N.F.B./P. trait. These results suggested that the importance of additive variance and additive x additive epistatic variances in the genetic expression for that traits.

The mean squares due to s eliminating d were highly significant for all studied traits with except of F.F., which the mean squares due to d eliminating s were highly significant for all studied traits with except F.F.N. trait and the mean squares due to t were significant and highly significant for all studied traits except of F.F., S.L.50% and S.L.2.5% traits which were insignificant.

The mean squares due to h eliminating g x L, due to g eliminating h x L, due to s eliminating d x L., due to d eliminating s x L. and due to t x L. were insignificant for all studied traits with few exception. These results were agreement with these reported by Abd EL- Bary (2003) and Abd EL-Maksoud *et al* .(2003).

The estimates of general line combining ability effect of first kind (h_i) and second kind (g_i) of parental varieties were calculated and the results are presented in Table 4. The results indicated that general combining ability of first kind (h_i) showed that no parent was the best combiner for all studied traits. However, for F.F.N., N.D.F.F., N.D.F.B. and F.F. the variety P_1 was the best combiner, which had negative highly significant estimates (desirable) for earliness traits. Concerning, the variety P_6 was the best combiner for N.V.B./P. trait, while P_5 was the best combiner for N.F.B./P. and the variety P_3 was the best combiner for S.L.50%, S.L.2.5% and U.R.%. traits.

The estimates of general combining ability effect of second kind (g_i) of the parental varieties, the results indicated that P_1 was the best combiner for F.F.N., the parent P_2 was the best combiner for N.D.F.F. and N.D.F.B., while P_1 and P_2 were the best combiner for the last two traits, as well as the parent P_4 was the best combiner for N.V.B./P.

The parent P_6 was the best combiner for S.L.50%, S.L.2.5% and U.R.%, as well as the parent P_2 was the best combiner for F.F. These results suggested that these parental varieties could be utilized in a breeding program for improving these traits.

The specific combining ability effect (d_{ij}) for all possible combinations with respect to all studied traits were obtained and the results are shown in Table 5. The results revealed that no combinations were positive or negative (desirable) for all studied traits. The combination P_1 x P_6 was the best combination for F.F.N. and the combination P_2 x P_3 was the best combination for N.D.F.F.

For N.F.B./P. trait the combination P_2 x P_4 was the best, while the combination P_3 x P_6 was the best combination for N.V.B./P., as well as the combination P_1 x P_4 was the best combination for S.L.50% and S.L.2.5% .In the same time , the combination P_1 x P_2 was the best combination for U.R.%. These results explained the minor role of dominance genetic variances in the inheritance of these traits.

T4

Table 5: Two- line specific combining ability effects of first kind (d_{ij}) for all studied traits from the combined data.

Crosses	Vegetative traits		Earliness traits			Fiber traits			
	N.F.B./P.	N.V.B./P.	F.F.N.	N.D.F.F.	N.D.F.B.	F.F.	S.L.50%	S.L.2.5%	U.R%
$P_1 \times P_2$	-0.607	0.071	0.141	0.186	0.122	-0.039	0.079	0.159	0.601*
$P_1 \times P_3$	0.304	0.004	-0.008	0.311	-0.154	0.046	-0.535	-0.704**	0.086
$P_1 \times P_4$	-0.509	0.079	0.187	0.370	0.386	-0.119	0.787*	0.637*	0.368
$P_1 \times P_5$	-0.215	0.106	-0.060	-0.263	-0.097	0.009	-0.695*	-0.494	-0.888**
$P_1 \times P_6$	1.025*	-0.260**	-0.261*	-0.603**	-0.257	0.103	0.365	0.402	-0.167
$P_2 \times P_3$	-0.281	0.088	-0.123	-0.735**	-0.426	0.025	-0.055	-0.131	-0.467
$P_2 \times P_4$	1.236**	-0.142*	0.009	0.203	0.166	0.022	-0.753*	-0.559*	-0.775**
$P_2 \times P_5$	1.092**	-0.065	-0.041	0.474*	0.148	0.038	0.357	0.265	0.342
$P_2 \times P_6$	-1.440**	0.048	0.014	-0.127	-0.008	-0.046	0.374	0.266	0.299
$P_3 \times P_4$	0.125	0.029	-0.144	0.068	0.383	0.074	0.325	0.435	0.075
$P_3 \times P_5$	0.253	-0.252**	0.146	-0.460*	0.057	-0.090	0.162	0.111	0.100
$P_3 \times P_6$	-0.400	0.132*	0.128	0.817**	0.141	-0.055	0.103	0.289	0.206
$P_4 \times P_5$	-1.398**	0.081	-0.108	-0.153	-0.584*	0.034	0.330	0.281	0.559*
$P_4 \times P_6$	0.546	-0.048	0.057	-0.488*	-0.352	-0.011	-0.689*	-0.793**	-0.226
$P_5 \times P_6$	0.269	0.129*	0.063	0.402	0.477*	0.009	-0.153	-0.163	-0.113
S.E.	0.419	0.065	0.128	0.207	0.242	0.065	0.323	0.253	0.249

P_1, P_2, P_3, P_4, P_5 and P_6: 6022, Suvin, Pima S_7, Giza85, Giza88 and Giza70.

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

Table 6: Two –line specific combining ability effect of second kind (S_{ik}) for all studied traits obtained from the combined data over two locations.

Crosses	Vegetative traits		Earliness traits			Fiber traits			
	N.F.B./P.	N.V.B./P.	F.F.N.	N.D.F.F.	N.D.F.B.	F.F.	S.L.50%	S.L.2.5%	U.R.%
S_{12}	0.137	-0.004	0.025**	-0.723**	-0.875**	-0.097	0.285	0.264	0.201
R	0.787*	0.149**	0.369	-0.297	-0.142	0.028	-0.155	-0.092	-0.197
S_{13}	-0.757*	-0.022	0.177	0.721**	0.353	0.095	0.386	0.341	0.318
R	-0.200	-0.245**	-0.215	0.008	0.209	0.068	-0.334	-0.194	-0.041
S_{14}	-0.173	0.166**	-0.038	0.183	0.406	-0.004	0.201	0.147	0.044
R	-1.252**	0.138*	0.227*	-0.031	-0.259	0.010	0.198	0.057	0.023
S_{15}	0.697	-0.085	-0.153	-0.200	-0.358	0.113*	-0.864**	-0.516*	-0.690**
R	0.709	0.029	-0.050	0.043	-0.227	-0.051	0.010	0.016	0.165
S_{16}	0.097	-0.056	-0.012	0.019	0.473*	-0.107	-0.008	-0.235	0.127
R	-0.045	-0.072	-0.331**	0.278	0.419*	-0.054	0.281	0.214	0.049
S_{23}	-0.344	0.148**	-0.042	-0.066	-0.062	-0.019	0.513	0.371	0.345
R	0.369	0.190**	-0.156	-0.260	-0.490*	-0.014	0.039	0.108	-0.206
S_{24}	1.183**	-0.390**	-0.333**	-0.155	0.108	-0.003	-0.180	-0.492*	0.084
R	0.982**	-0.168**	-0.091	-0.350	-0.030	0.027	-0.504	-0.381	-0.484*
S_{25}	-0.273	0.168**	0.051	0.525**	0.283	0.079	0.087	0.387	0.203
R	-0.815*	-0.094	0.087	1.546**	1.362**	0.030	0.078	-0.009	0.177
S_{26}	-1.353**	-0.074	-0.045	-0.008	-0.187	-0.085	-0.266	-0.175	-0.435*
R	-0.673	0.076	0.136	-0.213	0.032	0.056	0.102	0.019	0.312
S_{34}	-0.449	-0.025	-0.001	0.091	0.113	-0.056	-0.306	-0.275	-0.483*
R	0.901*	-0.039	0.016	0.090	0.293	-0.115*	0.011	0.104	0.167
S_{35}	-0.106	-0.073	0.201	-0.014	0.024	-0.130*	-0.020	-0.229	-0.055
R	0.223	-0.251**	-0.038	-0.433*	0.065	0.040	-0.738**	-0.635**	-0.965**
S_{36}	0.385	0.152**	0.170	0.176	0.145	0.131*	0.620*	0.590**	0.784**
R	-0.023	0.163**	-0.114	-0.312	-0.648**	-0.001	-0.172	-0.181	0.136
S_{45}	-1.299**	0.147*	-0.108	-0.143	-0.189	-0.014	0.856**	0.566*	0.717**
R	-0.320	0.260**	0.071	-0.536**	-0.584**	0.014	0.437	0.464*	0.675**
S_{46}	0.669*	-0.079	-0.044	0.434*	0.185	0.093	-0.560*	-0.344	-0.424
R	-0.241	-0.011	0.301**	0.416*	-0.043	0.048	-0.151	0.156	-0.321
S_{56}	0.203	0.057	-0.070	-0.620**	-0.616**	-0.032	0.214	0.164	-0.053
R	0.981**	-0.157**	0.008	-0.169	0.239	-0.049	-0.060	-0.208	-0.176
S.E.	0.368	0.057	0.113	0.182	0.212	0.057	0.283	0.222	0.219

S: cross R: reciprocal cross

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

The estimates of specific combining ability effects of second kind (s_{ik}) for possible combinations for vegetative, earliness and fiber traits and the results are presented in Table 6. The results indicated that no combination exhibited desirable negative or positive values for all studied traits. The results indicated that the combinations S_{12}, S_{24}, r_{42} and r_{65} were the best combinations for N.D.F.F., F.F.N., N.V.B./P. and N.F.B./P. traits, respectively. On the other hand, for fiber traits the combinations S_{36} was the best combination for S.L.2.5% and U.R.% traits. While the combination S_{35} was the lowest negative and significant value for F.F. On the other hand the combination S_{45} was the best for S.L.50%.

The specific combining ability effects (t_{ijk}) for all possible combinations (60 three- way crosses) with respect to the studied vegetative, earliness and fiber traits were calculated and the results are presented in Table 7. The results showed that 3,8,3,9,9,1,zero, zero and 1 out of 60 three way crosses for N.F.B./P., N.V.B./P., F.F.N., N.D.F.F., N.D.F.B., F.F, S.L.50%, S.L.2.5% and U.R.%. traits. These results indicated the importance of epistatic gene effect for the inheritance of those traits.

The estimates of genetic variance components and heritability in broad and narrow senses as well as dominance degree ratio (D.d.) were calculated and the results are presented in Table 8. The results revealed that the additive genetic variances (σ^2A) were positive and larger than those dominance genetic variances (σ^2D) of all studied traits and these could be appeared by the dominance degree (D.d.) which was equal zero for all studied traits.

Concerning epistatic effects genetic variances, the results from each location and combined data over two locations indicated that most of genetic variances were additive x dominance epistatic genetic variances (σ^2AD) were larger than those of dominance x dominance (σ^2DD) and Additive x additive (σ^2AA) for all studied traits. These results suggested that both additive and additive by dominance gene action played the major role in the genetic expression of these traits, and may answer about the question what is the cause of superiority of most three way crosses over the single crosses?

The estimated values of broad sense heritability ($h^2_{b.s.}$ %) were larger than their corresponding of narrow sense heritability ($h^2_{n.s.}$ %) for all studied vegetative, earliness and fiber traits. These values of broad sense heritability ranged from 98.89% for N.F.B./P. to 99.98% for S.L. 2.5%. On the other hand, narrow sense heritability estimates ranged from 6.08% for N.F.B/P. to 15.61% for N.D.F.F., respectively. Generally, these results were inagreement with that reported by Rady and Gomaa (1983);Jagrab and Kolhe (1987);El Helw *et al*. (1988); Zeina(1991); Sorour *et al*. (2000); El-Akhedar(2001);Abd El-Bary(2003) ;Abd El-Hadi *et al*.(2003)and Abou El Yazid (2004) .

Table 7: Three- line specific combining ability effects (t_{ijk}) for all studied traits from the combined data over the two locations.

Crosses	Vegetative traits		Earliness traits			Fiber traits			
	N.F.B./P.	N.V.B./P.	F.F.N.	N.D.F.F.	N.D.F.B.	F.F.	S.L.50%	S.L.2.5%	U.R.%
$(P_1xP_2)xP_3$	0.078	-0.199*	-0.103	0.899**	1.251**	-0.004	0.638	0.275	0.418
$(P_1xP_2)xP_4$	0.552	0.158	0.309	-0.879**	-0.474	-0.057	0.019	0.027	-0.062
$(P_1xP_2)xP_5$	-0.325	0.061	0.226	-0.113	-0.183	0.079	-0.519	0.053	-0.099
$(P_1xP_2)xP_6$	-0.304	-0.021	-0.431*	0.092	-0.594	-0.017	-0.139	-0.354	-0.256
$(P_1xP_3)xP2$	1.117	-0.016	-0.399*	-1.205**	0.190	0.014	-0.659	-0.654	-0.200
$(P_1xP_3)xP_4$	-0.073	0.168	0.229	0.361	-0.648	0.086	0.134	0.113	0.347
$(P_1xP_3)xP_5$	-0.206	0.051	-0.255	0.489	0.086	-0.025	0.110	0.023	-0.332
$(P_1xP_3)xP_6$	-0.839	-0.204*	0.425*	0.355	0.372	-0.071	0.415	0.518	0.185
$(P_1xP_4)xP_2$	-2.452**	0.222*	0.153	0.940**	0.652	-0.054	0.519	0.483	0.427
$(P_1xP_4)xP_3$	0.331	-0.216*	0.158	-1.071**	-1.093**	-0.047	-0.520	-0.392	-0.513
$(P_1xP_4)xP_5$	1.657**	0.046	-0.198	-0.041	0.287	-0.068	0.705	0.343	0.645
$(P_1xP_4)xP_6$	0.464	-0.053	-0.113	0.171	0.155	0.169	-0.704	-0.434	-0.559
$(P_1xP_5)xP_2$	0.720	-0.303**	0.048	0.658*	-0.093	0.025	-0.025	-0.195	0.043
$(P_1xP_5)xP_3$	-0.617	0.421**	0.152	-0.068	-0.546	0.143	-0.400	-0.075	-0.538
$(P_1xP_5)xP_4$	-0.782	-0.396**	-0.320	0.029	0.571	-0.047	-0.002	-0.001	-0.135
$(P_1xP_5)xP_6$	0.680	0.278**	0.120	-0.619*	0.068	-0.076	0.427	0.270	0.631
$(P_1xP_6)xP_2$	0.615	0.096	0.198	-0.394	-0.749*	0.015	0.165	0.365	-0.270
$(P_1xP_6)xP_3$	0.209	-0.007	-0.207	0.238	0.387	-0.047	0.282	0.192	0.634
$(P_1xP_6)xP_4$	0.303	0.070	-0.218	0.490	0.551	0.018	-0.151	-0.139	-0.150
$(P_1xP_6)xP_5$	-1.127	-0.159	0.227	-0.335	-0.189	0.014	-0.297	-0.419	-0.214
$(P_2xP_3)xP_1$	-0.611	0.277**	-0.061	-0.030	-0.007	-0.044	0.010	0.007	0.132
$(P_2xP_3)xP_4$	-0.054	-0.342**	0.004	0.673*	0.652	-0.034	-0.122	0.073	-0.447
$(P_2xP_3)xP_5$	0.556	-0.100	0.088	-0.950*	-0.940**	0.026	0.458	0.158	0.456
$(P_2xP_3)xP_6$	0.110	0.166	-0.030	0.307	0.295	0.051	-0.346	-0.237	-0.141
$(P_2xP_4)xP_1$	-0.677	-0.298**	-0.290	0.031	0.230	0.025	-0.099	-0.012	-0.059
$(P_2xP_4)xP_3$	-0.329	0.270**	0.086	0.529	0.319	-0.030	0.255	0.203	-0.003
$(P_2xP_4)xP_5$	0.089	-0.010	-0.092	0.026	-0.209	0.055	-0.679	-0.670	-0.578
$(P_2xP_4)xP_6$	0.917	0.038	0.296	-0.586*	-0.340	-0.050	0.522	0.480	0.640
$(P_2xP_5)xP_1$	0.300	0.061	0.097	0.116	0.387	0.078	-0.149	-0.265	-0.246
$(P_2xP_5)xP_3$	0.453	-0.145	-0.051	-0.479	-0.866*	-0.159	-0.234	-0.053	-0.067
$(P_2xP_5)xP_4$	-0.031	0.266**	-0.212	0.177	-0.161	0.066	0.421	0.206	0.556
$(P_2xP_5)xP_6$	-0.723	-0.182*	0.165	0.187	0.640	0.016	-0.039	0.112	-0.243
$(P_2xP_6)xP_1$	0.988	-0.041	0.254	-0.117	-0.610	-0.059	0.238	0.270	0.173
$(P_2xP_6)xP_3$	-0.202	0.074	0.068	-0.950**	-0.704*	0.192*	-0.659	-0.424	-0.349
$(P_2xP_6)xP_4$	-0.467	-0.082	-0.100	0.030	-0.018	0.026	-0.318	-0.304	-0.046
$(P_2xP_6)xP_5$	-0.320	0.049	-0.222	1.037**	1.331*	-0.159	0.740	0.459	0.222
$(P_3xP_4)xP_1$	0.825	-0.057	-0.033	-0.166	-0.745*	0.056	-0.073	-0.013	-0.004
$(P_3xP_4)xP_2$	1.293*	0.031	-0.052	-0.083	-0.328	0.089	-0.103	-0.108	-0.036
$(P_3xP_4)xP_5$	-1.771*	-0.049	0.231	0.589*	0.960**	-0.067	-0.075	0.093	-0.092
$(P_3xP_4)xP_6$	-0.347	0.075	-0.146	-0.340	0.114	-0.077	0.251	0.028	0.132
$(P_3xP_5)xP_1$	0.239	-0.132	-0.052	0.488	0.200	0.071	0.452	0.350	0.234
$(P_3xP_5)xP_2$	-1.703**	0.022	0.309	0.194	0.522	-0.160	0.318	0.375	0.246
$(P_3xP_5)xP_4$	0.388	0.146	-0.009	-0.360	0.059	-0.014	-0.950*	-0.416	-0.259
$(P_3xP_5)xP_6$	1.077	-0.037	-0.248	-0.322	-0.780*	0.102	-0.320	-0.308	-0.176
$(P_3xP_6)xP_1$	-0.453	-0.088	0.146	-0.292	0.553	-0.084	-0.388	-0.343	-0.363
$(P_3xP_6)xP_2$	-0.707	-0.038	0.142	1.094**	-0.384	0.057	0.443	0.386	0.036
$(P_3xP_6)xP_4$	-0.261	0.028	-0.224	-0.674*	-0.064	-0.038	0.438	0.231	0.359
$(P_3xP_6)xP_5$	1.421*	0.097	-0.064	-0.129	-0.105	0.065	-0.493	-0.274	-0.032
$(P_4xP_5)xP_1$	-0.077	0.149	0.338	-0.439	-0.064	-0.186*	-0.142	-0.068	-0.057
$(P_4xP_5)xP_2$	1.025	0.043	-0.059	-0.504	-0.943**	0.086	-0.051	0.098	-0.433
$(P_4xP_5)xP_3$	0.085	-0.132	-0.243	0.188	0.935**	0.141	0.261	0.043	0.703*
$(P_4xP_5)xP_6$	-0.534	-0.060	-0.037	0.755**	0.073	-0.041	-0.069	-0.073	-0.212
$(P_4xP_6)xP_1$	-0.073	0.206*	-0.015	0.573*	0.580	0.105	0.313	0.092	0.121
$(P_4xP_6)xP_2$	0.133	-0.296**	-0.042	-0.353	0.619	-0.120	-0.366	-0.473	0.043
$(P_4xP_6)xP_3$	-0.086	0.078	-0.002	0.354	-0.161	-0.065	0.004	0.147	-0.187
$(P_4xP_6)xP_5$	0.025	0.013	0.059	-0.574*	-1.038**	0.080	0.049	0.234	0.025
$(P_5xP_6)xP_1$	-0.463	-0.078	-0.384*	-0.165	-0.522	0.038	-0.162	-0.018	0.070
$(P_5xP_6)xP_2$	-0.042	0.238**	-0.298	-0.348	0.514	0.049	-0.243	-0.279	0.191
$(P_5xP_6)xP_3$	0.079	-0.145	0.141	0.358	0.477	-0.081	0.374	0.085	-0.098
$(P_5xP_6)xP_4$	0.425	-0.0155	0.541*	0.155	-0.469	-0.006	0.031	0.211	-0.162
S.E.	0.585	0.090	0.179	0.289	0.337	0.091	0.450	0.353	0.347

P_1, P_2, P_3, P_4, P_5 and P_6: 6022, Suvin, Pima S_7, Giza85, Giza88 and Giza70.
***, **: Significant at 0.05 and 0.01 levels of probability, respectively.**

Table 8: The estimates of genetic parameters from the three-way crosses analysis for all studied traits obtained from the combined data over both locations.

Genetic	Vegetative traits		Earliness traits			Fiber traits			
Parameters	N.F.B./P.	N.V.B./P.	F.F.N.	N.D.F.F.	N.D.F.B.	F.F.	S.L.50%	S.L.2.5%	U.R.%
σ^2A	2.661	2.957	3.338	6.194	5.833	3.041	4.221	3.754	2.911
σ^2D	-31.472	-28.150	-28.276	-31.064	-34.397	-28.103	-28.981	-28.757	-30.194
σ^2AA	-3.834	-3.415	-3.875	-2.114	-2.613	-3.527	-4.641	-3.780	-3.136
σ^2AD	40.651	28.148	29.203	33.376	42.626	28.272	33.964	31.007	33.468
σ^2DD	-6.859	-13.431	-13.583	-9.710	-10.750	-13.969	-14.487	-14.009	-14.464
σ^2e	2.930	0.070	0.276	0.716	0.974	0.071	1.732	1.070	1.033
D.d	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
$h^2_{b.s}$.%	98.89	99.96	99.86	99.70	99.67	99.96	99.26	98.98	99.53
$h^2_{n.s}$.%	6.08	9.50	10.24	15.61	12.00	9.71	10.97	10.69	7.96

Note: Negative values were considered equal to zero during the calculation of heritabilites and dominance degree ratio.

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تحليل الهجن الثلاثية للصفات الخضرية والتبكير وصفات التيلة في القطن المصري

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كان الغرض الأساسي من هذه الدراسة هو تقدير قوة الهجين وطبيعة فعل الجين والقدرة العامة والخاصة علي التآلف ودرجة التوريث في المدى الواسع والمدي الضيق. كما تم دراسة تأثير التداخل بين نظم فعل الجين والظروف البيئية المختلفة لبعض الصفات الخضرية وصفات التبكير وصفات التيلة . اشتملت هذه الدراسة علي ستة أصناف من القطن هي (١) ٦٠٢٢ (٢) سيوفين (٣) بيما س٧ (٤) جيزة ٨٥ (٥) جيزة ٨٨ (٦) جيزة٧٠ بالإضافة إلى ١٥ هجين ناتجة بنظام التزواج نصف الدائري الي جانب ٦٠ هجين ثلاثي ناتجة بنظام إنتاج الهجن الثلاثية . وتم تقييم جميع التراكيب الوراثية في موقعين مختلفين هما محطة البحوث الزراعية بسخا ومحطة تجارب معهد بحوث القطن بمركز أبو كبير محافظة الشرقية .

والنتائج المتحصل عليها يمكن تلخيصها فيما يلي :-

*- أظهرت جميع التراكيب الوراثية وجود فروق عالية المعنوية بالنسبة لكل الصفات الخضرية وصفات التبكير وصفات التيلة .

*- بالنسبة لمتوسطات الآباء أظهرت النتائج آن أعلي الهجن كانت التالية (بيما س٧ x جـ٨٨) x جـ٧٠ لصفة عدد الأفرع الثمرية لكل نبات و (بيما س٧ x جـ٧٠) x سيوفين لصفة عدد الأفرع الخضرية لكل نبات و (جـ٨٨ x جـ٧٠) x ٦٠٢٢ لصفة أول عقدة تحمل فرع ثمري و(٦٠٢٢ x بيما س٧) x سيوفين لصفة عدد الأيام حتى ظهور أول زهرة و (٦٠٢٢ x جـ٧٠) xسيوفين لصفة ميعاد تفتح أول لوزة و (٦٠٢٢ xجـ٨٥) xسيوفين لصفة النعومة و (٦٠٢٢ x بيما س٧) xجـ٧٠ لصفة معامل الانتظام و الهجين (بيما س٧ x جـ٨٥) xجـ٨٨ لصفة طول التيلة عند٥٠% وعند ٢,٥% .

*- بالنسبة لتقدير قوة الهجين بالنسبة لمتوسط الآباء أو الأب الأفضل أظهرت فروقا معنوية وأظهرت قيما مفيدة لكل الصفات فيما عدا صفة معامل الانتظام .

*- النتائج تشير إلى أن التباين الإضافي كان الأكثر والأكبر من التباين السيادي بجانب التباين الراجع للإضافة x السيادة وهما اللذان يتحكمان في وراثة الصفات ويلعبان الدور الأكبر.

*- معامل التوريث فى المدى الواسع كان أكبر من معامل التوريث في المدى الضيق وقد أعطى كلا منهما قيما مختلفة ومتباينة بالنسبة للصفات المدروسة وكانت قيمة معامل التوريث في المدي الواسع تتراوح بين ٩٨,٨٩% لصفة عدد الأفرع الثمرية الي ٩٩,٩٨% لصفة طول التيلة عند ٥٠% بينما كانت قيم معامل التوريث في المدى الضيق تتراوح بين ٦,٠٨% لصفة عدد الفروع الثمرية للنبات إلى ١٥,٦١% لصفة ميعاد تفتح أول زهرة.

Table 2: The amounts of heterosis versus the mid-parents, better parent and three-way crosses for vegetative, earliness and fiber traits estimated from the combined data over both locations.

	Vegetative traits						Earliness traits						Fiber traits					
Crosses	**N.F.B./P.**		**N.V.B./P.**		**F.F.N.**		**N.D.F.F.**		**N.D.F.B.**		**F.F.**		**S.L.50%**		**S.L.2.5%**		**U.R.%**	
	$H_{M.P.}$%	$H_{B.P.}$%	$H_{M.P.}$%	$H_{B.P.}$%	$H_{M.P.}$%	$H_{B.P.}$%	$H_{M.P.}$%	$H_{B.P.}$%	$H_{M.P.}$%	$H_{B.P.}$%	$H_{M.P.}$%	$H_{B.P.}$%	$H_{M.P.}$%	$H_{B.P.}$%	$H_{M.P.}$%	$H_{B.P.}$%	$H_{M.P.}$%	$H_{B.P.}$%
$(P_1xP_2)xP_3$	-4.12	-6.83	-6.48	-17.32**	5.63	13.86*	2.88**	7.20**	2.24**	4.52**	-4.31	2.45	1.54	-5.31*	0.41	-4.79*	1.79**	-0.42
$(P_1xP_2)xP_4$	7.50*	7.41	4.90	-10.34*	10.76*	12.75*	-1.51**	0.17	0.40	1.58**	-3.97	-1.36	-1.85	-3.26	-1.33	-1.92	0.63	-0.69
$(P_1xP_2)xP_5$	0.11	-2.07	6.56	-6.98	15.12**	16.12**	2.90**	4.88**	1.54**	2.80**	3.39	7.88	-7.45*	-12.50**	-0.84	-4.96*	-0.01	-1.91**
$(P_1xP_2)xP_6$	-2.81	-4.12	-6.48	-17.32**	-3.53	1.73	0.75	4.76**	0.19	2.94**	-11.37**	-5.71	-4.14	-10.28**	-3.71*	-8.43**	0.29	-1.62*
$(P_1xP_3)xP_2$	21.02**	18.40**	16.64**	11.00*	-4.35	-3.26	-5.64**	-4.26**	-2.16**	-2.10**	-10.09**	-2.83	-2.84	-6.79**	-2.91	-6.44**	0.51	-0.30
$(P_1xP_3)xP_4$	8.34*	4.90	27.80**	18.00**	7.69	13.11*	-0.87	0.32	-0.64	-0.42	-6.52	-2.61	-2.51	-5.31*	-2.47	-5.35**	-0.46	-0.48
$(P_1xP_3)xP_5$	11.75**	5.84	7.23	1.33	2.17	4.43	1.45**	2.45**	0.63	0.93	-9.38**	-8.25*	-6.04**	-7.30**	-4.74**	-5.39**	-1.48*	-2.09**
$(P_1xP_3)xP_6$	13.35**	11.13**	6-2.96	-1.33	6.94	9.30	-0.10	0.88	0.36	2.14**	-12.00**	-11.46**	0.33	-2.06	-0.82	-2.29	1.37*	0.74
$(P_1xP_4)xP_2$	-1.42	-2.72	14.97**	6.62	4.08	5.74	-3.02**	-2.55**	-1.70**	-1.09*	-10.36**	-5.67	4.56*	2.48	3.46	1.69	1.38*	0.76
$(P_1xP_4)xP_3$	3.76	1.02	-2.70	-9.15	2.44	4.02	-1.30*	0.85	-0.61	0.09	-11.85**	-8.46*	-0.30	-5.08*	-0.24	-3.93*	0.00	-1.09
$(P_1xP_4)xP_5$	5.71	3.61	17.12**	7.89	-3.24	1.70	0.34	0.35	0.30	0.56	-7.09*	-5.90	3.85	0.28	2.73	0.00	1.03	0.21
$(P_1xP_4)xP_6$	11.02**	9.32*	2.70	-4.10	-6.29	-5.78	-0.21	1.76**	-0.10	1.10*	-6.34	-3.33	-3.05	-7.35**	-2.24	-5.59**	-0.51	-1.32
$(P_1xP_5)xP_2$	5.83	1.72	-3.04	-5.90	6.18	8.29	-1.59**	-0.75	-1.43**	-0.65	-2.95	2.55	-3.79	-8.74**	-3.25	-7.55**	-0.22	-1.23
$(P_1xP_5)xP_3$	-1.72	-1.72	9.41	6.94	2.36	7.79	-1.47**	0.29	-0.61	-0.07	0.12	3.56	-10.21**	-11.66**	-6.83**	-7.70**	-3.26**	-3.93**
$(P_1xP_5)xP_4$	-1.77	-4.62	18.45**	11.46*	-1.21	2.87	-3.26**	-2.68**	-0.79	-0.30	-2.69	-2.06	-3.71	-7.53**	-1.96	-5.66**	-1.12	-1.31
$(P_1xP_5)xP_6$	11.00**	6.46	16.87**	14.24*	-2.33	0.66	-3.55**	-2.02**	-1.08*	-0.06	-10.89**	-8.40*	-4.25*	-5.42*	-4.10*	-4.70*	-0.56	-0.97
$(P_1xP_6)xP_2$	6.97*	4.20	8.45	0.00	3.48	4.92	-5.39**	-4.06**	-3.27**	-2.26**	2.74	6.23	0.16	-5.38*	0.14	-4.77*	0.34	-0.69
$(P_1xP_6)xP_3$	1.55	0.16	0.67	-6.54	-10.26*	-6.07	-0.78	0.45	-0.64	-0.35	0.38	6.10	-2.98	-4.14	-3.24*	-3.65	0.19	-0.48
$(P_1xP_6)xP_4$	4.12	2.48	15.83**	3.74	-1.80	2.87	-1.17*	-0.04	-0.57	0.17	5.10	6.63	-5.00*	-9.14**	-1.73	-5.89**	-1.56*	-1.76*
$(P_1xP_6)xP_5$	5.72	4.97	-10.54*	-18.07**	0.25	2.21	-0.84	0.08	-0.21	0.46	3.73	6.90	-7.71**	-7.95**	-5.70**	-6.35**	-2.17**	-2.56**
$(P_2xP_3)xP_1$	-1.29	-5.02	95.02**	-2.49	-4.06	-3.54	-3.54**	-3.06**	-1.84	-2.21**	-6.60*	7.61	-0.30	-3.91	1.00	-2.27	-1.39*	-1.58*
$(P_2xP_3)xP_4$	1.83	-2.01	-14.43*	-23.36**	2.64	11.85*	-1.38*	-0.44	-0.68	-0.05	0.67	4.13	-2.84	-4.56	-2.02	-3.79	-2.28**	-2.39**
$(P_2xP_3)xP_5$	-1.28	-2.85	6.46	-2.49	14.63**	21.47**	-0.01	0.73	-0.56	0.00	0.92	6.06	0.46	-2.00	0.77	-1.11	-0.39	-1.10
$(P_2xP_3)xP_6$	-1.52	-6.38	10.40*	2.49	2.85	4.22	-0.67	0.55	-1.09*	-0.20	1.54	8.82*	-1.31	-4.72	-0.43	-3.07	-0.59	-1.30
$(P_2xP_4)xP_1$	-2.73	-7.65*	91.10**	-4.45	3.75	7.79	-2.89**	-2.80**	-0.54	0.31	-5.77	3.98	-3.55	-7.02*	-1.73	-5.13*	-1.86**	-1.92**
$(P_2xP_4)xP_3$	2.50	0.16	13.23**	9.93	7.56	13.27*	0.18	2.33**	1.15**	2.82**	-4.64	0.80	-4.34*	-8.02**	-3.36*	-5.99**	-1.04	-2.15**
$(P_2xP_4)xP_5$	-4.86	-7.65*	17.71**	12.67*	12.10*	13.63*	1.82**	1.97**	1.38**	2.06**	5.02	8.22*	-4.99*	-7.33**	-2.62	-4.23*	-1.03	-1.86
$(P_2xP_4)xP_6$	6.22	-0.35	-1.59	-4.45	9.41*	12.77*	-0.91	0.91	-0.10	2.05**	-1.52	3.45	-6.88**	-10.11**	-4.32*	-6.65**	-1.43*	-2.27**
$(P_2xP_5)xP_1$	18.06**	17.75**	123.26**	11.63	-5.08	2.00	-3.02**	-1.96**	-0.74	-0.54	-2.20	10.19*	0.13	-3.61	0.70	-2.72	-0.71	-0.89
$(P_2xP_5)xP_3$	10.98**	7.48*	-9.19	-12.00*	-5.66	0.00	-2.28**	-1.46*	-0.35	0.63	0.13	7.99	-4.44*	-7.99**	-3.09	-5.97**	-1.25*	-2.24**

P_1, P_2, P_3, P_4, P_5 and P_6: 6022, Suvin, Pimas7, G.85, G.88 and G.70.

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

Table 2: Continued.

Crosses	Vegetative traits						Earliness traits						Fiber traits					
	N.F.B./P.		N.V.B./P.		F.F.N.		N.D.F.F.		N.D.F.B.		F.F.		S.L.50%		S.L.2.5%		U.R.%	
$(P_2xP_5)xP_4$	14.06**	13.76**	18.75**	17.83**	-5.98	10.05	-2.67**	-1.17	-0.77	-0.73	9.99**	13.77**	1.64	-0.29	0.58	-1.39	1.19	1.06
$(P_2xP_5)xP_6$	5.60	4.54	-4.69	-7.64	-3.82	4.22	-1.66**	-1.03	-0.30	1.19*	1.03	8.26	-1.88	-5.15*	-0.74	-3.21	-0.84	-1.56*
$(P_2xP_6)xP_1$	-0.79	-2.11	100.00**	0.00	0.70	2.55	-2.60**	-1.68**	-1.10*	-1.01*	-7.09*	4.68	2.51	-1.26	2.44	-1.00	-0.58	-0.86
$(P_2xP_6)xP_3$	-10.66**	-12.10**	18.70**	12.34*	2.47	5.74	-2.33**	-1.37*	-0.88*	-0.02	6.51	14.88**	-4.05*	-7.65**	-3.40*	-6.13**	-0.52	-1.41*
$(P_2xP_6)xP_4$	-5.97	-7.22	0.71	-8.12	8.11	14.90*	-1.13*	0.25	-0.28	-0.12	8.39	12.12**	-3.35	-5.13*	-2.51	-4.38*	-0.95	-0.97
$(P_2xP_6)xP_5$	-7.24*	-6.34	14.43**	6.82	8.73	12.44*	3.20**	4.42**	2.56**	2.66**	1.44	6.61	0.95	-1.45	1.10	-0.67	-0.17	-0.79
$(P_3xP_4)xP_1$	-0.36	-3.72	86.18**	-6.91	-13.87**	-8.77	-2.71**	-1.82**	-1.36**	-1.25*	-5.25	3.66	5.30*	0.89	5.28**	1.63	-0.16	-0.79
$(P_3xP_4)xP_2$	15.63**	10.60**	13.04**	6.91	-5.47	2.07	-3.39**	-1.82**	-1.55**	-1.12*	5.16	9.63*	2.89	-0.79**	3.18	0.36	0.09	-1.07
$(P_3xP_4)xP_5$	-11.63**	-12.67**	12.43**	5.59	5.02	17.55**	1.83**	3.01**	1.81**	1.88**	-4.73	-2.61	5.58**	3.61	4.77**	3.06	0.68	0.41
$(P_3xP_4)xP_6$	8.67**	3.72	12.26**	6.91	-7.39	-1.09	-0.32	0.49	0.24	1.64**	2.01	6.27	4.01*	1.01	3.51*	1.00	0.86	0.59
$(P_3xP_5)xP_1$	10.80**	8.98*	40.13**	-29.93**	-6.47	-5.21	-2.66**	-1.14	-0.79	-0.92	-6.36	5.51	3.00	-4.17	2.99	-3.14	-0.10	-1.14
$(P_3xP_5)xP_2$	0.60	-2.06	-2.96	-8.22	15.87**	16.43**	-1.34*	0.92	0.07	0.76	-1.40	0.00	3.09	-3.49	2.59	-2.80	0.77	-0.80
$(P_3xP_5)xP_4$	6.19	4.45	12.19*	2.96	13.78**	21.54**	-3.64**	-1.68*	-0.77	-0.37	1.20	4.68	-0.64	-5.84*	0.09	-4.51*	-0.61	-1.35
$(P_3xP_5)xP_6$	18.32**	14.95**	-5.01	-9.54	3.22	3.79	-2.66**	-2.50**	-1.35**	-0.24	3.60	11.02*	1.50	1.34	0.97	0.71	0.54	0.39
$(P_3xP_6)xP_1$	-6.66*	-10.61**	90.97**	-4.51	-11.91**	-11.23*	-0.64	1.00	0.23	0.42	-13.46**	-8.35*	1.49	-4.79*	2.08	-3.44	-0.82	-1.80*
$(P_3xP_6)xP_2$	-5.89	-10.77**	28.09**	24.31**	9.25*	12.12*	0.27	2.65**	-1.57**	-0.85	0.79	8.50	4.20*	-1.64	3.29	-1.56	0.84	-0.67
$(P_3xP_6)xP_4$	-7.53*	-11.44**	26.20**	18.75**	8.96	19.03**	0.02	2.13**	-0.23	0.21	-2.64	-0.26	0.97	-3.52	1.67	-2.43	-0.94	-1.63*
$(P_3xP_6)xP_5$	4.79	2.62	15.68**	11.46*	11.15*	18.06	2.60**	4.54**	1.25**	1.63**	-5.82	-5.00	-1.78	-2.12	-1.04	-1.50	-0.58	-0.67
$(P_4xP_5)xP_1$	-6.24	-9.98**	152.76**	26.38**	0.08	0.62	-3.95**	-3.31**	-1.71**	-1.46**	-11.40**	-3.62	8.07**	6.74**	6.96**	5.94**	1.00	0.84
$(P_4xP_5)xP_2$	3.49	-1.64	9.71	6.27	4.41	5.74	-2.37**	-1.03	-1.09*	-0.80	8.92	5.22	4.88*	4.26	4.60*	4.42*	1.04	0.36
$(P_4xP_5)xP_3$	1.01	-0.16	-5.48	-9.09	-4.27	-2.49	-1.66**	-0.41	0.89*	1.95**	2.35	6.72	1.49	-4.68*	1.11	-4.08*	0.65	-0.39
$(P_4xP_5)xP_6$	-1.05	-6.15	10.40*	6.18	-3.35	-3.13	-0.79	0.26	-0.96*	0.57	1.50	5.17	3.00	-2.90	3.00	-2.01	0.42	-0.33
$(P_4xP_6)xP_1$	-4.50	-6.08	149.44**	24.72**	-9.20*	-8.71	-1.58**	-0.92	-0.42	-0.29	-5.33	2.56	4.57*	1.28	2.37	-0.15	-0.36	-0.93
$(P_4xP_6)xP_2$	5.45	2.64	7.06	6.27	5.98	7.34	-3.97**	-2.36**	-0.65	-0.24	3.10	8.50	-3.36	-4.83	-2.74	-4.40*	0.34	-0.75
$(P_4xP_6)xP_3$	4.25	2.90	21.40**	19.64**	-1.22	0.62	-0.66	0.59	-0.34	0.57	-4.44	-0.77	-3.09	-7.25**	-2.52	-6.13**	-0.51	-1.13
$(P_4xP_6)xP_5$	-0.79	-1.41	21.72**	21.72**	6.83	11.93*	-0.26	0.66	0.03	0.08	3.04	4.36	1.67	-1.31	0.99	-1.69	0.22	-0.12
$(P_5xP_6)xP_1$	1.91	-1.54	62.71**	-18.64**	-19.08**	-18.46**	-2.05**	-0.19	-1.36**	-0.46	-5.48	3.12	4.02	0.18	3.63*	0.15	0.21	-0.04
$(P_5xP_6)xP_2$	-3.19	-7.41*	9.44*	-3.39	4.58	7.34	-0.89	1.72**	0.33	1.81**	11.11**	16.15**	2.24	-0.90	0.76	-1.87	1.78**	1.00
$(P_5xP_6)xP_3$	1.85	1.34	-11.29*	-21.19**	-0.08	0.45	-0.93	-0.88	-0.08	0.05	1.86	6.49	-2.59	-6.25**	-3.20	-5.93**	-1.30	-2.23*
$(P_5xP_6)xP_4$	0.69	-2.71	15.13**	-1.13	21.12**	32.32**	-1.49**	0.84	-1.48**	-0.32	8.67*	9.09*	2.54	0.65	3.74*	1.75	0.08	0.02
$L.S.D._{.0.05}$%	1.525	1.761	0.280	0.324	0.567	0.654	0.795	0.918	1.047	1.209	0.264	0.305	1.152	1.330	1.128	1.302	1.014	1.171
$L.S.D._{.0.01}$%	2.005	2.315	0.369	0.426	0.745	0.860	1.046	1.207	1.377	1.590	0.348	0.401	1.514	1.748	1.483	1.712	1.333	1.540

P_1, P_2, P_3, P_4, P_5 and P_6: 6022, Suvin, Pima S_7, Giza 85, Giza 88 and Giza 70.

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

Table 4: General line combining ability effect of the first kind (h_i) and second kind (g_i) for all studied traits from the combined data over two locations.

Crosses	Vegetative traits				Earliness traits						Fiber traits							
	N.F.B./P.		N.V.B./P.		F.F.N.		N.D.F.F.		N.D.F.B.		F.F.		S.L.50%		S.L.2.5%		U.R.%	
	h_i	g_i	h_i	g_i	h_i	g_i	h_i	g_i	h_i	g_i	h_i	g_i	h_i	g_i	h_i	g_i	h_i	g_i
P_1	0.174	-0.299	0.056**	-0.132**	-0.363**	-0.456**	-0.794**	-1.272**	-0.448**	-1.015**	-0.184**	-0.058	-0.612**	-0.500*	-0.484**	-0.442*	-0.274**	-0.606**
P_2	-0.365**	-0.027	-0.046**	0.070	0.206**	0.289**	-0.261**	-1.742**	-0.188**	-1.841**	0.006	-0.126**	-0.856**	-0.608**	-0.674**	-0.628**	-0.567**	-0.135
P_3	0.355**	0.332	-0.021	-0.104*	0.118**	0.124	0.592**	1.482**	0.111	1.282**	-0.068**	0.050	0.752**	0.500*	0.686**	0.351	0.288**	0.338
P_4	-0.044	-0.253	0.066**	0.139**	0.008	-0.065	-0.311**	-0.950**	-0.132*	-0.714**	0.024	0.052	0.162*	-0.554*	0.082	-0.527**	0.208**	-0.365*
P_5	0.621**	0.043	-0.177**	0.054	0.081*	0.166	-0.015	1.228**	0.223**	1.032**	0.099**	0.052	0.306**	0.414	0.318**	0.612**	0.203**	0.270
P_6	-0.740**	0.203	0.121**	-0.027	-0.050	-0.368**	0.788**	1.254**	0.434**	1.256**	0.123**	0.030	0.248**	0.748**	0.118	0.634**	0.143*	0.498**
S.E.	0.106	0.301	0.016	0.047	0.033	0.092	0.053	0.149	0.061	0.173	0.017	0.047	0.082	0.231	0.064	0.182	0.158	0.179

P_1, P_2, P_3, P_4, P_5 and P_6: 6022, Suvin, Pima S_7, Giza85, Giza88 and Giza70.

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