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ESTIMATION OF GENETIC COMPONENTS BY USING TRIALLEL CROSSES MATING DESIGN

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ABSTRACT

This investigation carried out to determine combining ability and types of gene action for yield component traits and some fiber properties in cotton. The genetic materials in this investigation included six cotton varieties i.e. G.85 (P_1) ; Kar. (P_2) ; G.93 (P_3); Pima S7 (P_4) Aust.12 (P_5) and G.86 (P6). All these varieties belong to the species *Gossypium Barbadense* L. and they were utilized in a trialed crosses mating design to produce 60 hybrids. In 2013 growing season all genotypes which included 60 genotypes were evaluated at the Agriculture experimental Station at Sakha using a RCBD with three replications. the following traits were estimated : boll weight, seed cotton yield per plant, lint cotton yield per plant, lint percentage, number of bolls per plant, seed index, fiber fineness, fiber strength, Upper half mean and uniformity ratio %.

The results indicated that the mean squares of genotypes were highly significant for all studied traits. The results also showed that the performances of most the three way crosses were as good as or better than their both grand parents or / and their third parent.

From the analysis of triallel crosses the results illustrated that the variety G.86 (P6) was a good combiner as a parent and / or grand parent for most of studied traits and Kar. (P2) and G.93 (P3) were good combiners for most of studied fiber properties.

In general, the crosses (Kar. X Aust. 12) x G.93, (Kar. X Pima S7) x G.93, (G.85 x Pima S7) x Kar., (Kar. X Pima S7) x Aust. 12, (Kar. X G.93) x G.85, (G.85 x Pima S7) x Kar., (G.85 x Pima S7) x G.86, (Kar. X G.86) x Aust.12, (G.93 x Pima S7) x Aust. 12, (Pima S7 x G.86) x G.85, (Pima S7 x Aust.12) x Kar. And (G.93 x Pima S7) x Kar., appeared to be the best promising combinations for breeding toward yield and its component traits, which the crosses (G.85 x Kar.) x G.86, (G.85 x G.93) x Kar., (Pima S7 x G.86) x G.85 and (Aust.12 x G.86) x G.85 would be the best for fiber fineness and (Kar. x G.93) x G.86 appeared to be the best for fiber strength. Most of these combinations had involved at least one of the best general combiners for yield. Which would be utilized in a breeding programs to improve yield traits through the selection in the segregating generations of these crosses.

The results indicated that yield components as well as fiber traits were mainly controlled by additive variance and additive x dominance and dominance by dominance epistatic variances. These results also revealed that the calculated values of heritability in broad sense ranged from 77.01% for Upper half mean to 97.38% for lint cotton yield per plant. In the same time the heritability in narrow sense ranged from 3.63% for seed index to 37.79% fiber strength.

Keywords: Cotton, Triallel analysis, General and specific combining abilities, Heritability.

INTRODUCTION

Triallel cross analysis provides additional information about the components of epistatic variance, viz., additive X additive, additive X dominance and dominance X dominance, besides additive and dominance components of genetic variance. This technique also gives information on the order in which parents would be crossed to obtain superior recombination (singh and narayanan. 2000). Triallel cross system assists and enables plant breeders to obtain estimates for general combining ability (G.C.A) and specific combining ability (S.C.A). These estimates could be translated into additive and non-additive genetic variance (dominance and epistatic genetic variances).

Two type of general combining ability effects are worked out through triallel crosses viz, general line effect of first kind (hi) and general line effect of second kind (gi). The first refers to the general combining ability effects of a line used as one of the grandparents. The latter one refers to the general combining ability effect of a line used as a parent, crossed to the single cross hybrid.

Triallel crosses included three kinds of specific combining ability effects. They are two line specific effect of first kind (d_{ij}) refers to specific combining ability effect of a line used as one of the grandparents i.e. parents involved in signal cross; two line specific effect of second kind (s_{ik}) which refers to the specific combining ability of line when crossed as a parent to the single cross; which the third kind is the three-line specific effect (t_{ijk}), which refers to specific combining ability effect of lines in three-way cross. These three kinds of specific combining ability effects were determined for all studied traits. Many investigations studied general and specific combining abilities among them, Hassan *et al* (2000), Khongade *et al* (2000), Abd EL-Maksoud *et al* (2003a-b) Ahmed *et al* (2003), Murtaza et al (2004), Abd EL-Hadi *et al* (2005 a-b),), Bhatti *et al* (2006), Hemaid *et al* (2006), Samreen (2007), EL-Mansy and EL-Lawendy (2008), and yehia *et al* (2009),)

They revealed that the magnitude of additive genetic variance (σ^2A) was positive and large than that of dominance genetic variance (σ^2D) with respect to all studied yield components traits. In addition to, the results revealed that the three types of epistatic variance (σ^2AA, σ^2AD, σ^2DD) were involved in the genetic expression of most studied traits with a few exception.

The main objectives of this study were to determined genetic parameters obtained from the performances of the three-way crosses such as, general and specific combining ability, heritability in both broad and narrow senses.

MATERIALS AND METHODS

Six cotton varieties belong to *Gossypium barbadense* L. representing a range for yield components and fiber properties were the genetic materials of this investigation. Three of these varieties were new germplasm materials which were : Kar. (P_2) Russian variety, Pima S_7 (P_4) an American cotton variety and Aust.12 (P_5) an Australian cotton variety. In addition, G.85 (P_1) and G. 86 (P_6) were long staple varieties. as well as G. 93 (P_5) which was extra long staple variety

In the growing season of 2011, the sex parents were planted and mated in a half diallel crosses to obtained 15 F_1 single crosses. The parental varieties were also self- pollinated to obtain enough seeds for further investigations.

In 2012 growing season, the six parents and their fifteen single crosses were planted and mated in three- way crosses to obtain 60 combinations. In the same time the six parents were planted and mated in half diallel crosses to obtained 15 F_1 hybrids again.

In the growing season of 2013, all genetic materials which included 60 three way crosses were evaluated in field trail experiments at Sakha Agriculture Research Station. The experimental design used was a randomized complete blocks design with three replications as outlined by Cochran and Cox (1957). The significance between means was determined using the least significant differences value (L.S.D.), which was calculated as suggested by Steel and Torrie (1980). Each plot was one row 4.0 m long and 60 cm wide. Hills were 40 cm apart and thinned to keep a constant stand of one plant per hill at seedling stage. Ordinary cultural practices were followed as usual for the cotton field.

The data were recorded on five plants from each plot on the following traits.

A- yield and yield components traits :-

1-Boll weight (B.W.)
2-Seed cotton yield per plant (S.C.Y./P.)
3-Lint cotton yield per plant (L.C.Y./P.)
4-Lint percentage (L.%)
5-Number of bolls per plant (No.B./P.)
6-Seed index (S.I.)

B- Fiber traits :-

1-Fiber Strength (F.S.)
2-Fiber fineness (F.F.)
3-Upper half mean (UHM)
4- Uniformity ratio %(U.R.%)

A three – way crosses or triallel is a product of three parents for example : (P_1 x P_2) x P_3. Thus the number of all possible three – way crosses would be (P (P-1) (P-2)) / 2 as outlined by Rawling and Cockerham (1962), Hinkelmann (1965), Ponnuswamy (1972) and Ponnusway *et al* (1974)., who had dealt with the theoretical aspect of triallel analysis.

Triallel crosses analysis provides additional information about the components of episistatic variance viz. additive x additive, additive x dominance and dominance x dominance besides additive and dominance components of genetic variance. The technique also gives information about the order in which parents would be crossed to obtain superior recombination.

Analysis of triallel crosses data is carried out according to the procedure outlined by Singh and Chaudhary (1985). where the form the analysis of variance are presented in Table (1).

Considering Y_{ijkl} as the measurement recorded on a triallel cross $G_{(ij)\,k}$, the mathmetical 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_{ijkl}: Phenotypic value in the l^{th} replication on ij^{th} cross (grand parents) mated to k^{th} parent.

m: general mean

b_l: effects of l^{th} replication

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 (specific effects of second kind)

t_{ijk}: three-line specific effect

e_{ijkl}: error effect

Estimation of the various effects:

(i)h_i: General line effect of first kind (grand parent). This is the general combining ability effect of a line used as one of the grand parents and it would be obtained as follows :

h_i = [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 as follows :

g_i = [(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 parents)where:

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

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

$$S_{ik} = \frac{D}{D_2}\left[Y_{i.k.} + \frac{1}{D}\ Y_{k.i.} + \left(\frac{V-3}{D}\right)Y_{ik..} - \left(\frac{2(P-3)}{PD}\right)Y_{....} - r\,(P-2)\,h_i - \left(\frac{P-2}{D}\right)rhi - \frac{rg_i}{D} - \frac{D_1}{D}rg_j\right]$$

Where: $D = P^2 - 5P + 5$ $D_1 = P^3 - 7P^2 + 14P - 7$

and D_2 = r (P-1) (P-3) (P-4).

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

$$t_{ijk} = \bar{y}_{ijk} - \bar{y} - h_i - h_j - g_k - d_{ij} - S_{ik} - S_{jk}$$

Ponnuswamy *et al.* (1974) investigated that the variances and co-variances components of general effects i.e., σ^2h, σ^2g, σgh are the function of additive and additive x additive type of epistasis, whereas, σ^2_d and σds are the functions of additive x additive type of epistasis only. σ^2s and σss involve dominance components while σ^2t and σtt account for epistatic components other than additive x additive.

Estimates of genetic variances:

The genetic variance components could be calculated from the previous variances using the following manner if the breeding coefficient assumed to be equal to one (F = 1).

$$\sigma^2A = \frac{1}{227F}\left[448\ \sigma^2h + 40\,\sigma^2g + 604\sigma gh - 292\sigma^2d - 584\,\sigma ds\right]$$

$$\sigma^2D = \frac{1}{127\,F^2}\left[416\,\sigma^2h - 352\,\sigma^2g + 496\,\sigma gh - 336\,\sigma^2d - 672\sigma ds - \frac{1816}{3}\sigma^2s + \frac{4540}{3}\sigma ss - 254\sigma^2t - \frac{3556}{3}\sigma tt\right]$$

$$\sigma^2AA = \frac{1}{227F^2}\left[-832\,\sigma^2h + 704\sigma^2g - 992\,\sigma gh + 672\,\sigma^2d + 13446\,ds\right]$$

$\sigma^2AD = 32/3F^3\ [\sigma^2 S - \sigma^2 S + 4\sigma tt\ ]$

$$\sigma^2DD = \frac{1}{3F^4}\left[-16\sigma^2 s + 16\,\sigma ss + 24\,\sigma^2 t - 32\,\sigma tt\right]$$

Table1: Form of the analysis of variances of the triallel crosses and the expectation of mean squares

S.O.V.	d.F	M.S	E.M.S
Replications	r-1		
Due to crosses	(P (P-1) (P-2))/2		σ^2e + [2r /P (P-1) (P-2)-2] $\sum\sum\sum C^2_{ijK}$
Due to *h* eliminating *g*	P-1	M (h/g)	σ^2e + [rp (P-2) (P-3)/(P-1)^2] $\sum h^2_i$
Due to *g* eliminating *h*	P-1	M (g/h)	σ^2e + [rp (P-3)/(P-1)] $\sum g^2_i$
Due to *s* eliminating *d*	P^2 -3P +1	M (s/d)	σ^2e + [r/(P^2-3P + 1)] $\sum\sum S_{ij}$ [(P^2-5 P + 5) S_{ij} - S_{ji}]
Due to *d* eliminating *s*	P(P-3)/2	M (d/s)	σ^2e + [2 (P-1)(P-4)/P(P-3)^2]$\sum\sum d^2_{ij}$
Due to *t*	P(P^2-6 P + 7)/2	M (t)	σ^2e + [2r/P (P^2 – 6 P + 7)] $\sum\sum\sum t^2_{ijk}$
Error	(r-1) (C-1)	ME	σ^2e

Where: C, P and r are number of crosses, parents and replications, respectively

Heritability was computed in both broad (H^2_b) and narrow senses (H^2_n) as follows:

H^2_b % = (σ^2g / σ^2 Ph) x 100

H^2_n % = (σ^2A / σ^2 Ph) x 100

RESULTS AND DISCUSSION

The results of three-way crosses analyses of variance and the mean square for yield, yield components and fiber traits were calculated and are presented in Table 2.

The results indicated that the mean squares of crosses were highly significant indicating the presence of real genetic differences among them. The same results were noticed for all the studied traits. This finding suggested that the planned comparison between means and the determination of gene action for these studied traits are valid and would be made. The results also showed that the mean squares due to h were either significant or highly significant for most traits except for seed index and fiber strength. Similarly, the mean squares of g eliminating h indicated the significance for most traits. Therefore, this finding revealed the importance of additive (σ^2A) as well as, additive by additive (σ^2AA) epistasis variances in the genetic expression of yield components and fiber traits. Also, the mean squares due to s eliminating d were significant or highly significant for all traits except for fiber strength, UHM and uniformity ratio. In the same time, the mean squares due to d eliminating s were significant or highly significant for studied traits, while the mean squares due to t were highly significant for all traits except fiber strength and UHM. These results indicated the importance of dominance, dominance by dominance, as well as, additive by additive by dominance epistatic variance, for the inheritance of all traits. The results of this study in agreement were with the reported by Abd EL-Maksoud *et al* (2003 a-b), Abd EL-Hadi *et al* (2005 a-b),Hemida *et al* (2006), Abd EL-Bary (2003) and EL-Mansy and EL-Lawendy (2008).

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The mean performance of the 60 three-way cresses were estimated for all traits and the results are presented in Table 3. The means showed that no specific cross was superior for all traits. The cross (P1 x P2) x P6 showed high values for boll weight (B.W) and lint percentage (L%) with mean values of 3.89and 41.03%, respectively. On the other hand, the lowest values for the same traits obtained from the crosses (P3 x P4) x p2 and (P3 x P5) x P6 with mean values of 2.63 and 34.58%, respectively.

For seed cotton yield per plant (S.C.Y. /P), lint cotton yield per plant (L.C.Y./P) and number of bolls per plant (No. B. /P), the results cleared that the highest mean values obtained from the crosses (P1 x P6) x P5, (P2 x P3) x P6 and (P2 x P4) x P3 with mean performance values of 260.25, 102.41 and 81.99, respectively. But, the results indicated that the lowest values for the above three traits were obtained from the cross (P2 x P4) X P1 with the mean values of 92.17, 32.11 and 31.01, respectively.

Table 3 : The mean performance of the 60 triallel crosses for yield component traits and fiber properties

Geno.	B.W	S.C.Y./P.	L.C.Y./P.	L.%	No.B./P	S.I.	F.F.	F.S.	UHM	U.R.%
(P1 x P2) x P3	3.61	153.69	56.14	36.34	42.49	7.74	4.00	10.80	36.17	87.93
(P1 x P2) x P4	3.56	164.53	62.55	38.02	46.62	7.07	3.87	10.57	34.60	87.70
(P1 x P2) x P5	3.40	167.37	63.15	37.70	49.38	8.69	4.17	10.60	34.27	87.20
(P1 x P2) x P6	3.89	228.80	93.89	41.03	58.93	7.99	3.93	10.33	34.33	87.40
(P1 x P3) x P2	3.08	155.01	57.15	36.93	50.70	9.07	3.67	10.33	34.70	87.73
(P1 x P3) x P4	3.27	146.08	57.17	39.21	44.88	8.84	4.00	10.57	33.70	86.37
(P1 x P3) x P5	3.15	126.18	45.84	36.32	40.05	8.51	3.87	10.40	33.83	86.43
(P1 x P3) x P6	3.84	227.43	90.78	39.85	59.71	8.53	4.03	10.27	35.00	87.07
(P1 x P4) x P2	3.11	194.48	76.78	39.48	62.62	8.17	4.00	10.43	36.33	88.53
(P1 x P4) x P3	3.52	177.83	62.64	35.23	50.56	7.54	3.87	10.27	35.07	87.77
(P1 x P4) x P5	3.16	123.61	45.17	36.56	38.97	8.96	4.33	10.53	34.63	86.97
(P1 x P4) x P6	3.34	248.35	100.03	40.28	74.50	9.38	3.70	10.50	34.93	87.47
(P1 x P5) x P2	3.29	144.22	55.09	38.29	44.01	8.45	3.77	10.73	34.27	87.43
(P1 x P5) x P3	3.36	249.12	93.17	37.41	74.28	7.69	4.10	10.10	33.60	86.47
(P1 x P5) x P4	3.58	192.11	71.45	36.95	53.66	7.93	4.03	10.53	33.40	85.90
(P1 x P5) x P6	3.77	164.26	63.57	38.65	43.69	8.04	4.53	10.30	35.20	87.57
(P1 x P6) x P2	3.34	241.40	92.91	38.49	73.29	8.40	5.00	10.53	34.53	86.97
(P1 x P6) x P3	3.63	192.45	70.94	36.87	53.19	8.09	4.37	10.90	34.43	86.60
(P1 x P6) x P4	3.31	121.63	49.84	41.02	36.79	7.94	4.40	10.20	32.97	85.70
(P1 x P6) x P5	3.13	260.25	94.21	36.29	83.38	8.76	4.33	10.47	33.17	86.30
(P2 x P3) x P1	3.45	220.78	82.03	37.14	64.34	9.48	4.43	10.43	34.13	86.73
(P2 x P3) x P4	2.86	133.94	50.87	37.99	46.98	8.34	4.47	10.67	35.63	87.40
(P2 x P3) x P5	3.05	142.92	51.90	36.30	47.63	7.15	4.33	10.17	34.37	87.60
(P2 x P3) x P6	3.48	256.33	102.41	40.04	73.79	8.34	4.40	11.13	34.10	86.17
(P2 x P4) x P1	2.99	92.17	32.11	34.63	31.01	7.40	4.40	10.87	34.60	87.60
(P2 x P4) x P3	3.09	252.77	100.43	39.80	81.99	8.52	4.47	10.67	34.30	87.07
(P2 x P4) x P5	3.23	200.29	79.13	39.52	62.10	8.56	4.23	10.80	34.73	86.77
(P2 x P4) x P6	3.21	161.91	60.07	37.21	50.32	8.05	4.57	10.40	33.30	86.87

(P1) G.85 , (P2) Kar. , (P3) G.93 , (P4) Pima S7 , (P5) Aust.12 and (P6) G.86 .

Continue Table 3

Geno.	B.W	S.C.Y./P.	L.C.Y./P.	L.%	No.B./P	S.I.	F.F.	F.S.	UHM	U.R.%
(P2 x P5) x P1	2.85	143.05	52.82	36.91	50.11	8.81	4.47	10.53	33.60	86.97
(P2 x P5) x P3	3.36	203.95	77.33	37.99	61.58	7.87	4.33	10.67	35.20	86.97
(P2 x P5) x P4	2.77	141.01	50.85	35.96	51.36	8.91	4.57	10.90	33.77	87.43
(P2 x P5) x P6	3.15	149.07	55.66	37.05	48.48	8.83	4.50	10.83	34.40	87.27
(P2 x P6) x P1	3.11	99.81	34.23	34.31	32.12	9.21	4.50	10.50	34.03	86.87
(P2 x P6) x P3	3.05	173.87	65.36	37.48	58.12	9.77	4.50	10.63	34.20	87.50
(P2 x P6) x P4	2.87	166.89	62.94	37.76	58.57	8.76	4.43	10.47	32.87	86.20
(P2 x P6) x P5	3.24	234.33	95.03	40.52	72.93	8.49	4.67	10.80	34.97	86.57
(P3 x P4) x P1	2.88	132.59	50.98	38.43	46.20	8.28	4.97	11.10	34.90	87.63
(P3 x P4) x P2	2.63	106.88	37.58	35.06	40.42	8.64	4.43	10.73	34.10	86.97
(P3 x P4) x P5	3.15	173.03	64.05	37.02	55.10	7.89	4.80	11.07	35.13	87.50
(P3 x P4) x P6	3.09	224.37	91.18	40.74	73.49	8.08	4.23	11.03	33.90	87.03
(P3 x P5) x P1	3.06	159.45	56.77	35.58	52.12	8.63	4.73	10.97	35.43	87.10
(P3 x P5) x P2	2.75	102.69	35.46	34.60	37.81	7.66	4.73	10.17	34.97	87.43
(P3 x P5) x P4	3.01	169.87	59.93	35.33	56.35	7.39	4.83	10.70	35.30	87.87
(P3 x P5) x P6	2.72	136.35	47.11	34.58	50.12	7.72	4.70	10.30	35.10	87.23
(P3 x P6) x P1	3.31	151.19	54.37	36.05	45.82	7.30	4.67	10.63	34.37	87.73
(P3 x P6) x P2	2.87	186.13	76.15	40.93	64.82	7.47	4.53	10.60	34.63	87.43
(P3 x P6) x P4	2.98	209.31	85.45	40.78	70.06	8.46	4.73	10.73	34.17	86.77
(P3 x P6) x P5	2.52	156.60	55.60	35.37	63.28	7.86	5.13	10.07	35.00	87.63
(P4 x P5) x P1	3.01	162.98	61.10	37.35	55.34	7.99	4.07	10.37	34.53	87.20
(P4 x P5) x P2	3.05	215.53	86.14	39.95	70.69	7.85	3.53	10.33	33.63	87.07
(P4 x P5) x P3	2.91	188.59	72.17	38.29	64.67	8.89	3.83	10.00	33.67	86.40
(P4 x P5) x P6	3.30	216.05	86.69	40.06	65.40	7.91	3.73	10.07	33.67	85.87
(P4 x P6) x P1	3.39	146.40	52.67	35.98	43.38	7.98	3.33	10.17	33.63	86.13
(P4 x P6) x P2	3.17	123.64	43.45	35.29	38.99	7.93	4.03	10.33	33.57	86.63
(P4 x P6) x P3	3.17	164.55	61.24	37.13	52.60	8.72	4.17	10.37	33.57	86.87
(P4 x P6) x P5	3.01	164.55	60.78	36.90	54.69	8.54	4.03	9.90	33.00	85.43
(P5 x P6) x P1	2.64	138.21	49.21	35.52	51.85	7.55	4.63	10.30	32.77	85.10
(P5 x P6) x P2	2.59	169.83	62.52	36.79	66.33	8.80	3.00	10.03	33.23	84.53
(P5 x P6) x P3	3.01	221.02	87.53	39.61	73.65	7.96	4.20	10.17	33.37	85.20
(P5 x P6) x P3	2.84	144.65	55.90	38.71	50.58	8.51	4.73	10.20	34.07	84.93
LSD 5%	0.412	36.70	14.45	1.913	14.28	0.820	0.548	0.840	1.947	1.383
LSD1%	0.545	48.51	19.10	2.529	18.87	1.083	0.725	1.110	2.573	1.828

(P1) G.85 , (P2) Kar. , (P3) G.93 , (P4) Pima S7 , (P5) Aust.12 and (P6) G.86 .

For seed index, the cross (P2 x P6) x P3 gave the highest mean values with values of 9.77 and the lowest mean performance recorded by the cross (P1 x P2) x P4 with mean value of 7.07.

For UHM and uniformity ratio (U.R%), the cross (P1 x P4) x P2 exhibited the highest mean performance values of 36.33 and 88.53%, respectively. On the other hand, the crosses (P5 xP6)xP1 and (P5xP6)xP2 recorded the lowest mean values for the two traits, giving mean values of 32.77 and 84.53%, respectively.

The cross (P5 xP6) x P2 gave the lowest mean value (desirable) for fiber finances (micronaire value) with the a value of 3.00, Also the cross (P3 xP6) xP5 gave the highest micronaire value (undesirable) with the mean 5.13. For fiber strength, the cross (P2 x P3) x P6 showed the mean of 11.13, while, the lowest value was obtained from the cross (P4 x P6) x P5 with the mean value of 9.90.

The estimates of general combining ability effects for the first kind (hi) for parental varieties were obtained for yield, yield components and fiber traits and the results are presented in Table 4. Positive estimates which would indicate that a given variety is much better than the average of the group involved with it in the triallel crosses were obtained for all studied traits except fiber finances. Comparison of the general combining ability effect (hi) of individual parent showed that no single parent was the best combiner as a grandparent for all yield traits and fiber properties. The variety (P1) was the best combiner for boll weight (B.W) and fiber finenesses (micronaire value), the variety (P6) had the best positive and highly significant values for the seed cotton yield per plant(S.C.Y./P), lint cotton yield per plant (L.C.Y./P) and number of bolls per plant (No. B./P). The variety (P2) was good combiner for seed index (S.I.) and fiber strength (F.S). Furthermore, the results revealed that the variety (P3) was the best combiner for uniformity ratio (U.R.) which showed positive (desirable) and significant value. Moreover, the variety P3 was good combiner for upper half means (U.H.M).

Table 4:General combining ability effect (h_i) of parental varieties for yield component traits and fiber properties

Parents	B.W	S.C.Y./P.	L.C.Y./P.	L.%	No.B./P	S.I.	F.F.	F.S.	UHM	U.R.%
P_1	0.343**	6.312*	2.300	0.184	-3.897**	0.022	-0.220**	-0.025	0.217	0.268*
P_2	0.034	-1.605	-0.116	0.070	-1.253	0.170*	0.049	0.166*	0.163	0.363**
P_3	-0.098**	-4.047	-1.965	-0.300	0.149	-0.122	0.251**	0.127	0.492**	0.422**
P_4	-0.058	-4.165	-0.882	0.317	-0.511	-0.26	-0.170**	0.006	-0.099	0.070
P_5	-0.154**	-3.810	-2.602*	-0.587**	1.550	-0.122	-0.015	-0.135	-0.167	-0.415**
P_6	-0.068	7.315*	3.266**	0.316	3.961**	0.078	0.106*	-0.139	-0.605**	-0.708**
S.E.	0.035	3.153	1.241	0.164	1.227	0.070	0.047	0.072	0.167	0.119

(P1) G.85 , (P2) Kar. , (P3) G.93 , (P4) Pima S7 , (P5) Aust.12 and (P6) G.86 .

The estimates of general combining ability effect of the second kind (gi) of the parental varieties were obtained for all traits and the are presented in Table 5. The results cleared that no variety was the superior and best combiner for all traits. The variety(P6) was the best combiner as the third parent and exhibited positive and highly significant (gi) values for boll weight (B.W), seed cotton yield per plant (S.C.Y./P), lint cotton yield per plant (L.C.Y./P), lint percentage (L%) and number of bolls per plant (No. B./P). The variety (P2) was good combiner for fiber finenesses (F.F.) uniformity ratio (U.R.). These findings suggested that these parental varieties would be utilized in a breeding program for improving those traits through the selection in the segregating generations.

Table 5: General combining ability effect (g_i) of parental varieties for yield component traits and fiber properties

Parents	B.W	S.C.Y./P.	L.C.Y./P.	L.%	No.B./P	S.I.	F.F.	F.S	UHM	U.R.%
P_1	0.053	-26.417**	-12.278**	-1.363**	-9.610**	0.0001	0.048	0.074	0.003	0.128
P_2	-0.150**	-10.267*	-3.551*	-0.018	-0.816	0.0410	-0.194**	-0.013	0.170	0.332*
P_3	0.079	22.559*	8.080**	-0.132	6.091**	-0.0400	0.001	0.005	0.269	0.159
P_4	-0.071	-16.269**	-5.486**	0.674**	-3.901*	-0.0680	0.055	0.053	-0.277	-0.231
P_5	-0.111*	-0.217	-1.383	-0.611**	2.090	0.0200	0.100	-0.077	-0.041	-0.212
P_6	0.199**	30.611**	14.617**	1.450**	6.146**	0.0470	-0.008	-0.042	-0.132	-0.176
S.E.	0.045	3.988	1.570	0.208	1.552	0.0890	0.060	0.091	0.212	0.150

(P1) G.85 , (P2) Kar. , (P3) G.93 , (P4) Pima S7 , (P5) Aust.12 and (P6) G.86 .

Two line specific effects of first kind (d_{ij})

It refers to the specific combining ability effects of a line used as one parent involved in single cross for three way crosses. The specific combining ability effects of first kin (d_{ij}) when i and j are grandparents for all combinations, were obtained and the results are presented in Table 6.

Table 6: Specific combining ability effects (d_{ij}) of the 15 single crosses for yield components traits and fiber properties

Crosses	B.W	S.C.Y./P.	L.C.Y./P.	L.%	No.B./P	S.I.	F.F.	F.S.	UHM	U.R.%
d_{12}	0.035	-6.723	-2.099	0.077	-2.263	-0.469**	-0.100	-0.083	0.313	0.252
d_{13}	0.024	-9.879	-3.717	0.059	-3.463	0.560**	-0.433**	-0.167	-0.607*	-0.690**
d_{14}	-0.166**	-6.823	-2.690	-0.262	0.746	0.026	0.045	-0.035	0.818**	0.408
d_{15}	0.076	4.972	1.943	0.122	0.288	0.018	0.137	0.135	-0.470	-0.022
d_{16}	0.032	18.453**	6.564**	0.004	4.691*	-0.135	0.352**	0.150	-0.055	0.052
d_{23}	0.088	19.165**	7.529**	0.438	4.067	0.059	-0.212*	-0.235	-0.232	-0.647**
d_{24}	-0.096	0.353	-0.715	-0.560	1.631	-0.415**	0.250**	0.013	-0.117	-0.105
d_{25}	-0.013	-9.738	-3.519	0.276	-2.561	0.276*	-0.002	0.203	-0.042	0.338
d_{26}	-0.014	-3.057	-1.196	-0.231	-0.874	0.549**	0.063	0.102	0.077	0.162
d_{34}	-0.080	-0.993	0.196	0.421	1.097	0.211	0.280**	0.380**	-0.167	-0.063
d_{35}	-0.033	-21.797**	-11.392**	-2.079**	-6.817**	-0.397**	0.252**	-0.083	0.612*	0.533*
d_{36}	0.002	13.504*	7.385**	1.161**	5.116*	-0.434**	0.113	0.105	0.393	0.867**
d_{45}	0.166**	31.462**	14.465**	1.509**	7.275**	0.130	-0.217**	-0.128	-0.110	-0.005
d_{46}	0.176**	-24.00**	-11.256**	-1.108**	-10.749**	0.047	-0.358**	-0.230	-0.425	-0.235
d_{56}	-0.196**	-4.900	-1.497	0.173	1.816	-0.027	-0.170*	-0.127	0.010	-0.845**
S.E.	0.062	5.561	2.189	0.290	2.163	0.124	0.083	0.127	0.295	0.210

(1) G.85 , (2) Kar. , (3) G.93 , (4) Pima S7 , (5) Aust.12 and (6) G.86 .

The results indicated that no hybrids exhibited desirable and significant values for all traits. However, 2, 4, 5, 2, 3, 2, 5, 1, 2 and 5 of 15 combinations showed desirable and significant specific combining ability effects (d_{ij}) values for boll weight (B.W.), seed cotton yield per plant (S.C.Y./P), lint cotton yield per plant (L.C.Y./P), lint percentage (L%), number of bolls per plant (No. B./P), seed index (S.I), fiber finenesses (F.F.), fiber strength (F.S.), upper half mean (UHM) and uniformity ratio (U.R%), respectively. Similar results were obtained by Abd EL-Maksoud et al (2003-a-b), Abd El-Hadi et al (2005 a-b), Hemaida et al (2006), Samreen (2007), Abd EL- Bary et al (2008), Sajid and Malik (2008) and Yehia et al (2009).

Two- line specific effects of second kind (S_{ik}):

It refers to the specific combining ability effect of a line when crossed as a parent to the single cross. The specific combining ability effects of second kind (S_{ik}) were obtained for all traits and the results are presented in Table 7.

Table 7: Two-line specific effect of second kind (S_{ik}) for yield components traits and fiber properties

	B.W	S.C.Y./P.	L.C.Y./P	L.%	No.B./P	S.I.	F.F.	F.S.	UHM	U.R.%
$S_{1.2.}$	-0.049	18.163**	7.905**	0.786**	6.979**	0.155	0.228**	0.077	0.604*	0.534**
$S_{1.3.}$	0.029	-14.811**	-8.442**	-1.641**	-5.528**	-0.495**	-0.108	0.024	0.096	-0.162
$S_{1.4.}$	0.045	-11.642*	-3.611	0.499	-3.881*	-0.368**	-0.173*	-0.104	-0.431	-0.426*
$S_{1.5.}$	-0.145**	-11.309*	-5.5656**	-0.735**	-1.391	0.527**	-0.018	0.123	-0.787**	-0.346
$S_{1.6.}$	0.121*	19.599**	9.804**	1.091**	3.822*	0.181	0.072	-0.120	0.517*	0.400*
$S_{2.1.}$	-0.053	-9.511	-4.151*	-0.670*	-2.501	0.287**	0.002	-0.194	-0.246	-0.153
$S_{2.3.}$	0.024	6.517	3.179	0.519*	2.221	0.134	0.019	0.043	0.475	-0.010
$S_{2.4.}$	-0.176**	-7.320	-5.135**	-1.305**	0.961	-0.227*	-0.029	-0.034	0.045	0.330
$S_{2.5.}$	0.160**	14.208**	8.551**	1.821**	1.768	-0.215*	-0.099	0.078	0.221	0.091
$S_{2.6.}$	0.045	-3.895	-2.444	-0.365	-2.448	0.021	0.107	0.107	-0.496	-0.259
$S_{3.1.}$	0.179**	27.945**	11.478**	1.095**	5.996**	0.517**	0.021	0.085	-0.059	-0.181
$S_{3.2.}$	-0.088	-24.315**	-9.819**	-0.504*	-7.253**	0.063	0.031	-0.192	-0.330	-0.285
$S_{3.4.}$	-0.015	12.278*	5.753**	0.584*	4.295*	0.254*	0.012	0.150	0.344	0.174
$S_{3.5.}$	-0.063	-36.096**	-16.160**	-1.605**	-9.714**	-0.635**	0.027	-0.201	0.110	0.441*
$S_{3.6.}$	-0.013	20.189**	8.748**	0.430	6.676**	-0.200	-0.090	0.158	-0.064	-0.149
$S_{4.1.}$	-0.067	-14.212**	-5.027*	0.102	-2.787	-0.437**	-0.075	0.039	0.617*	0.326
$S_{4.2.}$	0.020	-0.529	-1.114	-0.699**	-1.078	-0.274*	0.151*	0.012	0.043	0.125
$S_{4.3.}$	-0.080	2.178	0.572	-0.118	2.372	0.306**	0.080	-0.080	-0.330	0.022
$S_{4.5.}$	0.188**	2.691	1.953	0.634*	-2.756	0.290**	0.048	0.105	0.183	-0.220
$S_{4.6.}$	-0.061	9.873	3.615	0.081	4.250*	0.116	-0.204**	-0.077	-0.513*	-0.253
$S_{5.1.}$	-0.125*	12.552*	5.916**	0.791**	6.159**	0.099	0.178*	0.125	-0.188	-0.066
$S_{5.2.}$	0.054	-6.998	-1.912	0.434	-2.499	0.109	-0.411**	0.028	-0.375	-0.154
$S_{5.3.}$	0.013	21.204**	9.671**	0.899**	5.790**	-0.221*	-0.040	-0.216	-0.258	-0.316
$S_{5.4.}$	0.149**	19.007**	6.048**	-0.888**	2.849	0.130	0.157	0.131	0.266	0.275
$S_{5.6.}$	-0.091	-45.765**	-19.723**	-1.237**	-12.299**	-0.118	0.115	-0.068	0.556*	0.261
$S_{6.1.}$	0.066	-16.774**	-8.216**	-1.319**	-6.867**	-0.466**	-0.127	-0.055	-0.124	0.074
$S_{6.2.}$	0.063	13.679**	4.939*	-0.017	3.850*	-0.053	0.001	0.075	0.058	-0.220
$S_{6.3.}$	0.014	-15.087**	-4.980*	0.340	-4.854*	0.276*	0.049	0.229*	0.017	0.466*
$S_{6.4.}$	-0.003	-12.323*	-3.055	1.110**	-4.223*	0.211	0.034	-0.143	-0.224	-0.353
$S_{6.5.}$	-0.140*	30.560**	11.312**	-0.115	12.094**	0.033	0.043	-0.105	0.273	0.034
S E	0.055	4.881	1.922	0.254	1.899	0.109	0.073	0.112	0.259	0.184

(1) G.85 , (2) Kar. , (3) G.93 , (4) Pima S7 , (5) Aust.12 and (6) G.86 .

The results indicated that no combination exhibited desirable significant values for all traits. However, it would be concluded that the combination with line 4 (Pima S7) which was used as one of the grand parent gave high performance when compared with any other combinations for boll weight (B.W.). Meanwhile, the combination with line 6 (G. 86) used as one of the grand parent and line 5 (Aust.12) as parent gave positive (desirable) and highly significant estimates for seed cotton yield per plant (S.C.Y./P.) and number of bolls per plant (No.B./P.). On the other hand, G.85 as parent for S31 appeared to be the best specific combination for lint cotton yield per plant (L.C.Y./P.), but the combination with line 2 (Kar.) used as one of grand parent and lines (Aust.12) as parent gave positive (desirable) and significant estimates for lint percentage (L.%). For seed index (S.I.) the combination between line 1 (G.85) as one of grand parent and line 5 (Aust.12) as a parent showed positive and highly significant two- line specific combining ability effect with the specific value of 0.527.

The results also cleared that the combination with line 5 (Aust.12) used as one of the grand parent (in single hybrid) and line 2 (Kar.) as a parent in the cross S_{52} gave negative and highly significant (desirable) two-line specific combining ability effects as compared to any other combinations for fiber fineness (F.F.), Whereas, the combination between line 6 (G.86) and line 3 (G.93) as a parent in the hybrid S_{63} gave positively desirable and Significant estimate for fiber strength (F.S.). Moreover, the combination of line 4 (Pima S7) and line 1 (G.85) for hybrid S_{41} appeared to be the best specific combination for Upper half mean (UHM). The combination between line 1 (G.85) and line 2 (Kar.) for S_{12} showed positively desirable and highly significant specific combining ability effect of second kind (Sik) for Uniformity ratio (U.R%).

Three – line specific effect (t_{ijk}):

It refers to specific combining ability effect of a line in three – way cross. The specific combining ability effects (t_{ijk}) for all possible combinations, with respect to all traits were obtained and the results are presented in Table 8. The results illustrated that no single three – way cross exhibited desirable significant values for all. However, crosses 6, 19, 19, 11, 10, 11, 7 and 1 out of 60 thee – way crosses showed desirable and significant t_{ijk} values for (B.W.), (S.C.Y./P.), (L.C.Y./P.), (L.%), (No. B./P.), (S.I.), (F.F.) and (F.S.), respectively, These three – crosses involved { (poor x poor) x Poor } or { (good x good) x good } or { (poor x good) x Poor } or { (poor x poor) x good } or { (good x good) x poor} as general combiner varieties, indicating to the presence of important epistatic gene action. In general : the combinations (Kar. X Aust. 12) x G.93, (Kar. X Pima S7) x G.93, (G.85 x Pima S7) x Kar., (Kar. X Pima S7) x Aust. 12, (Kar. X G.93) x G.85, (G.85 x Pima S7) x Kar., (G.85 x Pima S7) x G.86, (Kar. X G.86) x Aust.12, (G.93 x Pima S7) x Aust. 12, (Pima S7 x G.86) x G.85, (Pima S7 x Aust.12) x Kar. And (G.93 x Pima S7) x Kar., appeared to be the best promising for breeding potentiality toward all traits.

Meanwhile, (G.85 x Kar.) x G.86, (G.85 x G.93) x Kar., (Pima S7 x G.86) x G.85 and (Aust.12 x G.86) x G.85 would to be the best for fiber fineness and the combination (Kar. X G.93) x G.86 appeared to be the best promising for fiber strength. Most of these combinations had included at least one of the best general combiners for yield. This indicates that the predication of superior crosses based on the general combining ability effects of the parents would be generally valid and the contribution of non- allelic interaction in inheritance of these traits would be important. These finding may explain the superiority of the three – way crosses over their single crosses.

Table 8: Three-line specific effect (t_{ijk}) for yield components traits and fiber properties

	B.W	S.C.Y./P.	L.C.Y./P.	L.%	No.B./P	S.I.	F.F.	F.S	UHM	U.R.%
t_{123}	-0.084	-32.167**	-12.593**	-0.364	-8.158**	0.149	0.076	0.167	0.349	0.177
t_{124}	0.195*	28.174**	10.872**	0.195	5.570	-0.259	0.002	0.091	0.286	0.258
t_{125}	-0.071	-6.904	-4.278	-0.729	-0.957	0.361*	0.172	-0.085	-0.104	-0.102
t_{126}	-0.040	10.897	5.999	0..899*	3.546	-0.250	-0.249*	-0.173	-0.532	-0.334
t_{132}	-0.052	5.436	0.172	-0.902*	3.717	0.076	-0.274*	0.023	-0.137	0.266
t_{134}	-0.110	-4.282	-1.934	-0.115	0.296	0.288	0.225	0.029	-0.322	-0.036
t_{135}	0.051	7.808	6.599*	1.706**	0.992	-0.132	-0.124	0.116	0.165	-0.336
t_{136}	0.111	-8.962	-4.837	-0.688	-5.005	-0.232	0.178	-0.168	0.294	0.106
t_{142}	0.014	18.180*	8.988**	1.550**	5.916	-0.048	-0.123	-0.092	0.288	-0.091
t_{143}	0.220*	-1.029	-2.128	-0.742	-3.990	-0.522**	-0.044	-0.131	-0.188	0.115
t_{145}	-0.043	-36.484**	-14.297**	-0.596	-10.590**	-0.169	0.265*	-0.067	0.058	0.112
t_{146}	-0.191*	19.334*	7.436*	-0.211	8.664**	0.740**	-0.098	0.289	-0.158	-0.136
t_{152}	0.021	-37.755**	-14.822**	-0.253	-12.876**	-0.047	-0.042	0.164	-0.004	0.003
t_{153}	-0.180*	39.092**	16.393**	0.934*	14.708**	0.259	0.063	-0.191	-0.371	0.068
t_{154}	0.039	19.931*	7.027*	-0.681	5.373	0.045	-0.191	-0.025	-0.022	-0.435
t_{156}	0.120	-21.268**	-8.599**	0.001	-7.205*	-0.257	0.169	0.052	0.396	0.364
t_{162}	0.016	14.140	5.662	-0.395	3.243	0.018	0.444**	-0.095	-0.147	-0.178
t_{163}	0.045	-5.896	-1.673	0.173	-2.560	0.115	-0.095	0.154	0.209	-0.361
t_{164}	-0..124	-43.823	-15.965**	0.602	-11.238**	-0.074	-0.036	-0.095	0.057	0.213
t_{165}	0.063	35.580**	11.975**	-0.380	10.555**	-0.059	-0.313*	0.036	-0.119	0.326
t_{231}	0.091	41.650**	15.710**	0.243	12.211**	0.300	-0.011	-0.093	-0.271	-0.085
t_{234}	-0.056	-41.864**	-15.537**	0.207	-12.620**	0.005	0.057	-0.063	0.815	0.103
t_{235}	-0.111	-22.091**	-10.383**	-1.141**	-4.757	-0.401*	-0.066	-0.194	-0.631	0.256
t_{236}	0.076	22.305**	10.212**	0.690	5.166	0.096	0.019	0.349*	0.086	-0.274
t_{241}	0.021	-25.882**	-10.546**	-0.894*	-9.237**	-0.448**	0.013	0.259	-0.005	0.085
t_{243}	0.032	53.326**	24.482**	2.078**	16.159**	0.121	-0.045	0.011	-0.345	-0.319
t_{245}	-0.043	15.422*	5.897	0.222	5.852	0.460**	-0.227*	0.006	0.139	-0.106
t_{246}	-0.009	-42.866**	-19.833	-1.406**	-12.773**	-0.132	0.259*	-0.276	0.211	0.341
t_{251}	-0.046	7.977	3.739	0.766	3.048	-0.170	-0.077	-0.209	-0.206	-0.115
t_{253}	0.222*	-4.782	-3.191	-0.682	-5.544	-0.598**	0.038	0.097	0.476	-0.039
t_{254}	-0.150	-12.859	-4.172	0.099	-1.565	0.481**	0.068	0.013	-0.505	-0.113
t_{256}	-0.027	9.664	3.623	-0.183	4.062	0.287	-0.029	0.099	0.235	0.267
t_{261}	-0.065	-23.745**	-8.903**	-0.115	-6.022*	0.318	0.075	0.043	0.482	0.115
t_{263}	-0.170*	-16.377*	-8.698**	-1.032**	-2.456	0.329	-0.069	-0.275	-0.481	0.182
t_{264}	0.010	26.548**	8.837**	-0.500	8.615**	-0.227	-0.127	-0.041	-0.596	-0.248
t_{265}	0.225*	13.357	8.763**	1.648**	-0.138	-0.419*	0.122	0.273	0.595	-0.048
t_{341}	-0.198*	-19.131	-6.372	0.529	-3.411	-0.138	0.327**	-0.113	-0.171	0.046
t_{342}	-0.072	-22.411**	-11.113**	-1.784**	-6.452*	0.477**	-0.198	-0.089	-0.301	-0.519
t_{345}	0.217*	42.249**	16.461**	0.538	9.460**	-0.118	-0.019	0.224	0.372	0.176
t_{346}	0.053	-0.707	1.024	0.717	0.402	-0.221	-0.109	-0.022	0.099	0.297
t_{351}	0.089	1.420	1.784	0.399	-0.592	0.385*	-0.286*	0.272	0.458	-0.207
t_{352}	0.070	0.316	0.869	0.024	-1.791	-0.182	0.536**	-0.067	0.274	0.114
t_{354}	0.081	10.899	3.744	0.296	2.947	-0.560**	-0.162	-0.045	-0.253	0.223
t_{356}	-0.240**	-12.635	-6.398*	-0.719	-0.564	0.357*	-0.088	-0.159	-0.479	-0.129
t_{361}	0.018	-23.939**	-11.122**	-1.171**	-8.209**	-0.547**	-0.031	-0.066	-0.017	0.246
t_{362}	0.055	16.659*	10.072**	2.662**	4.526	-0.372*	-0.058	0.134	0.164	0.139
t_{364}	0.084	35.246**	13.727**	-0.388	9.378**	0.267	-0.121	0.078	-0.241	-0.289

(1) G.85 , (2) Kar. , (3) G.93 , (4) Pima S7 , (5) Aust.12 and (6) G.86 .

Continue Table 8

	B.W	S.C.Y./P.	L.C.Y./P.	L.%	No.B./P	S.I.	F.F.	F.S	UHM	U.R.%
t_{365}	-0.157	-27.967**	-12.677**	-1.103**	-5.695	0.651**	0.209	-0.146	0.094	-0.096
t_{451}	0.044	-6.034	-4.315	-1.043**	-2.019	0.071	0.034	-0.116	0.194	0.227
t_{452}	0.019	36.235**	15.905**	1.365**	11.486**	-0.277	0.106	0.062	-0.121	-0.002
t_{453}	-0.210*	-54.440**	-22.963**	-1.223**	-13.174**	0.593**	-0.088	0.046	0.078	-0.502
t_{456}	0.147	24.239**	11.373**	0.901*	3.707	-0.387*	-0.52	0.008	-0.152	-0.407
t_{461}	0.134	51.047**	21.233**	1.408**	14.667**	0.515**	-0.374**	-0.031	-0.018	0.383
t_{462}	0.039	-32.003**	-13.781**	-1.132**	-10.950**	-0.152	0.215	0.119	0.133	0.206
t_{463}	-0.42	2.144	0.609	-0.113	1.006	-0.190	0.177	0.074	0.455	-0.182
t_{465}	-0.131	-21.187**	-8.062**	-0.164	-4.722	-0.172	-0.018	-0.163	-0.569	0.046
t_{561}	-0.087	-3.363	-1.209	-0.122	-0.437	-0.286	0.329**	0.054	-0.446	-0.344
t_{562}	-0.110	1.204	-1.953	-1.136**	3.181	0.506**	-0.601**	-0.158	-0.149	-0.027
t_{563}	0.167*	20.130**	9.761**	0.972*	4.010	-0.253	-0.013	0.047	-0.184	0.325
t_{564}	0.030	17.971*	-6.600*	0.286	-6.755*	0.034	0.284**	0.057	0.779	0.224
S E	0.087	7.754	3.053	0.404	3.017	0.173	0.116	0.177	0.411	0.292

(1) G.85 , (2) Kar. , (3) G.93 , (4) Pima S7 , (5) Aust.12 and (6) G.86 .

Genetic parameters :

The genetic parameters were estimated and the results are presented in Table 9. The results indicated that the magnitudes of additive genetic variances (σ^2A) were positive and larger than those of dominance genetic variances (σ^2D), with respect to boll weight (B.W.). These results indicated the predominance of additive genetic variance (σ^2A) in the inheritance of this trait.

Table 9: The estimates of genetic parameters from the three – way crosses analysis for yield and yield components traits and some fiber properties

Geno.	B.W	S.C.Y./P.	L.C.Y./P.	L.%	No.B./P	S.I.	F.F	F.S...	UHM	U.R.%
σ^2A	0.0731	1677.82	303.33	2.219	231.08	0.178	0.092	0.800	0.6681	0.4515
σ^2D	0.1373	-1490.79	-601.68	-15.437	-296.61	-1.2940	-0.1217	-0.0788	-1.0910	-1.1760
σ^2AA	-0.0927	-801.20	-138.14	-1.576	-253.32	-0.4245	-0.0808	-0.1846	-1.5012	-0.7371
σ^2AD	0.0701	-19560.46	-2811.67	11.120	-980.75	3.5189	0.1476	1.0470	4.1884	3.6066
σ^2DD	0.1699	16324.38	2663.21	8.221	1049.25	0.9441	0.6131	-0.5034	-3.1985	-2.0723
h^2b.s.%	87.39	97.22	97.38	93.90	94.26	94.75	88.12	87.25	77.01	84.72
h^2 n.s.%	14.18	9.06	9.96	9.66	17.01	3.63	9.51	37.79	10.59	9.43

Concerning epistatic variances, additive by additive (σ^2AA) showed negative values for all traits. While, additive by dominance variances (σ^2AD) were positive and of considerable magnitudes for most of traits. it would be concluded that fiber properties and yield components traits were mainly controlled by additive variances and / or additive by dominance epistatic variances. Dominance by dominance genetic variance (σ^2DD) was positive for most of studied traits. Therefore, the breeder would design breeding programs which make use of these types of genetic variances to select superior lines from the advanced segregating generations of the high yielding three – way crosses.

The estimates of heritability values in broad sense ($h^2_{b.s.}$) were larger than their corresponding values in the narrow sense ($h^2_{n.s.}$) for all traits. The results cleared that the calculated values of heritability in broad sense ranged from 77.01 % to 97.38% for Upper half mean (UHM) and lint cotton yield per plant (L.C.Y./P.), respectively. While, narrow sense ($h^2_{n.s.}$) ranged from 3.63% to 37.79% for seed index (S.I.) and fiber strength, (F.S.), respectively. These results were in common agreement with the results obtained by many authers among them Abd EL-Maksoud et al (2003-a-b), Abd El-Hadi *et al* (2005 a-b), Hemaida *et al* (2006), Samreen (2007), Abd EL- Bary *et al* (2008), Sajid and Malik (2008) and Yehia *et al* (2009).

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تقدير المكونات الوراثية باستخدام نظام تزاوج الهجن الثلاثية

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الهدف الرئيسي من هذه الدراسة هو دراسة القدرة علي التآلف وكذلك تقدير الفعل الجيني لصفات المحصول ومكوناته بالإضافة لبعض صفات جودة التيلة باستخدام تحليل الهجن الثلاثية. ولقد استخدم في هذه الدراسة ستة أصناف من القطن وهي : G.85، Kar. ، G.93، Pima S4 و Aust.12 والصنف G.86 وجميع هذه الأصناف تابعة للنوع باربادنس. في موسم 2011 تم التهجين بين الستة أصناف بنظام التهجين نصف الدائري للحصول علي 15 هجين فردي وفي موسم 2012 تم زراعة الهجن الفردية والإباء وتم التهجين فيما بينهم بنظام الهجن الثلاثية للحصول علي 60 هجين ثلاثي. في موسم 2013 تم زراعة الهجن المتحصل عليها وهي 60 هجين ثلاثي في تجربة تقييم بمحطة البحوث الزراعي بسخا في تصميم قطاعات كاملة العشوائية من ثلاث مكررات وكانت الصفات التي تم دراستها : هي وزن اللوزة، محصول القطن الزهر للنبات، محصول القطن الشعر للنبات، تصافي الحليج، عدد اللوز المتفتح علي النبات، معامل البذرة، النعومة، متانة التيلة،، متوسط الطول بالإضافة لمعامل الانتظام.

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي :-

- أشارت نتائج اختبارات تحليل التباين إلي وجود اختلافات عالية المعنوية بين كل التراكيب الوراثية المستخدمة لكل الصفات الموجودة تحت الدراسة.
- أظهرت الهجن الثلاثية : (Kar. X Aust. 12) x G.93, (Kar. X Pima S7) x G.93, (G.85 x Pima S7) x Kar., (Kar. X Pima S7) x Aust. 12, (Kar. X G.93) x G.85, (G.85 x Pima S7) x Kar., (G.85 x Pima S7) x G.86, (Kar. X G.86) x Aust.12, (G.93 x Pima S7) x Aust. 12, (Pima S7 x G.86) x G.85, (Pima S7 x Aust.12) x Kar. And (G.93 x Pima S7) x Kar. إمكانية استخدامهم في تحسين صفات المحصول ومكوناته.
- اظهر الهجين الثلاثية : (G.85 x Kar.) x G.86, (G.85 x G.93) x Kar.,(Pima S7 x G.86) x G.85, (Aust.12 x G.86) x G.85 إمكانية استخدامهم في تحسين صفة النعومة.
- أظهرت الهجين الثلاثي : (Kar. x G.93) x G.86 إمكانية استخدامه في تحسين صفة متانة التيلة.
- اظهر الصنف جيزة 86 انه ذو قدرة علي التآلف لصفات المحصول ومكوناته في حين اظهر الصنفان جيزة 93 و كارشنكي قدرة علي التآلف لصفات جودة التيلة.
- أظهرت النتائج أن التباين التجميعي والتباين التفوقي من النوع التجميعي x السيادي والسيادي x السيادي لهم دورا هاما في توارث جميع الصفات المدروسة ولذلك يمكن من خلال برامج انتخاب في الأجيال الانعزالية لهذه الهجن الثلاثية استنباط أصناف وسلالات متفوقة.
- أظهرت قيم معامل التوريث أن معامل التوريث بالمدى الواسع كانت اكبر من قيم معامل التوريث بالمدى الضيق وكانت تتراوح بين 77.01% لصفة متوسط الطول إلي 99.38% لصفة محصول القطن الشعر في حين تراوحت في المدى الضيق بين 3.63% لصفة معامل البذرة إلي 37.79% لصفة متانة التيلة.
- للحصول عل نتائج ذات قيمة وأكثر أهمية من تحليل الهجن الثلاثية يجب تصميم برنامج انتخاب من الأجيال الانعزالية للهجن المتفوقة سواء في صفات المحصول ومكوناته أو في صفات الجودة.

Table2: The results of the analyses of variances and the mean squares of the 60 triallel crosses for yield component traits and fiber properties

S O V	d f	B.W	S.C.Y./P.	L.C.Y./P.	L.%	No.B./P	S.I.	F.F.	F.S.	UHM	U.R.%
Rep.	2	0.086	316.60	60.71	0.809	7.516	5.729**	0.145	0.108	1.881	0.092
Crosses	59	0.275**	5479.05**	1008.70**	10.691**	465.84**	1.037**	0.518**	0.665**	2.868**	1.918**
Due to h eliminating g	5	1.384**	1245.58*	236.54*	5.816**	303.60**	0.569	1.333**	0.708	6.207**	9.154**
Due to s eliminating d	19	0.113*	4650.52**	863.69**	10.641**	421.26**	1.112**	0.202*	0.182	1.697	0.992
Due to t	21	0.113*	5586.74**	977.56**	7.297**	471.61**	0.928**	0.335**	0.171	0.967	0.485
Due to g eliminating h	5	0.479**	13575.20**	2561.21**	25.944**	1012.39**	0.057	0.287*	0.087	1.080	1.521
Due to d eliminating s	9	0.176**	3638.27**	739.83**	11.234**	346.56**	1.686**	0.903**	0.479	2.427	3.431**
Error	118	0.065	515.38	79.88	1.401	78.01	0.257	0.115	0.270	1.450	0.732

*** & ** significant at 0.05 and .01 levels of probability, respectively.**