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APPLICATION OF THREE-WAY CROSSES IN COTTON (*G.barbadense*)

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ABSTRACT

Sixty, three-way cross combinations produced by using triallel mating system of six parents, were evaluated in a randomized complete blocks design to estimate two types of general combining ability and three types of specific combining ability effects for some quantitative characters in *G.barbadense*. Analysis of variance revealed highly significant differences among crosses for most studied characters. Also, highly significant two types of general combining ability and three types of specific combining ability were detected. The parents Karshenky$_2$, G.86 and G.88 were observed as high good general combiners being grand parents and also were considered as good combiner and intermediate parent in three-way crosses for earliness, yield and fiber characters, respectively. The combinations (Pima S$_6$ x G.70) x Kar.$_2$, (Suvin x G.70) x G.86, (Kar.2 x G.86) x Pima S$_6$ and (Kar.2 x G.88) x G.86 appeared to be the best promising three way crosses for breeding toward two earliness characters, yield, yield components and fiber properties, respectively. Additive with epistatic gene effects were operative in the inheritance of all studied characters, except boll maturation period and boll weight which were controlled predominantly by epistatic gene effects (dominance x dominance) for all yield characters, and additive x dominance for the remaining characters. Therefore; the population improvement programme adopted for the improvement of the studied characters would be recurrent selection with concurrent intermating before selection in early segregating generations.

INTRODUCTION

Cotton improvement requires the ability to select higher performing individuals from a population. Identification of superior individuals requires variation in the population. This is usually overcome by crossing unrelated strains to create the genetic variation through recombinations followed by selection. Parental selection for creating genetic variability for cotton improvement programme depends on combining ability which depends on the type of gene effects and amount of potential genetic variability involved. The amount of genetic control is influential because improvement of a trait with very small genetic control relative to environmental influences will be difficult. Several genetic mating designs exist to facilitate seperation of environmental and genetic effects underlying quantitative traits in plants. Among the most common mating designs in crop improvement is the triallel analysis. The theoretical aspects of triallel analysis has been dealt with by Rawlings and Cockerham (1962) and Ponnuswamy (1972). This analysis provides information of two types of general combining ability effects and three types of specific combining ability effects in addition to information regarding components of epistatic variance, in addition to additive and dominance components of genetic variance. Thus, such information provides basis for selecting lines as grand parents, i.e. in single crosses, or immediate parent, i.e. in three way crosses, or as both for obtaining superior segregants (Singh and Narayanan, 2000). The review of its use in cotton is scant. Abd El-Bary (2003), Yehia (2005) and Hemaida *et al.* (2006) by using three way crosses found major role of epistasis in the inheritance of yield and fiber characters.

The research reported herein was conducted to provide further information about different types of general and specific combining ability as well as assessment and quantifying the components of genetic variance controlling yield and its attributes and important fiber properties by using triallel mating design. Such information is considerable value to cotton breeders.

MATERIALS AND METHODS

A. Genetic materials and experimental procedures:

Six cotton cultivars of *G.barbadense* (Table 1), representing a wide range of earliness, yield, yield components and fiber properties, were hand crossed to form 15 F_1 diallel crosses during 2005 growing season. The parents and 15 crosses were sown and crossed using triallel mating system to obtain 60 three-way crosses [n (n-1) (n-2)/2] during 2006 summer season. The six parents and their 60 three-way crosses were evaluated in a randomized complete blocks design with three replicates in 2007 growing season at Sakha Agricultural Research Station. Experimental plot was of single row 4.0 meter long with 25 cm hill to hill distance, while row to row distance was kept 65 cm. Two plants were left per hill at thinning time. Data were recorded from 10 guarded hills (20 guarded plants). The studied characters were:

1. Days to the anthesis of first flower (DFF)-days elapsing before anthesis of first flower were determined for each plant.
2. Boll maturation period (BMP)-days elapsing from anthesis of flower to boll first cracking.
3. Boll weight (BW)-the average weight in grams of 25 bolls.
4. Seed index (SI)-the weight in grams of 100-seeds.
5. Lint percent (L%)-ratio of lint cotton to seed cotton expressed as percentage.
6. Lint index (LI)-the weight in grams of lint per 100-seeds.
7. Seed cotton yield (SCY/P) the weight in grams of seed cotton yield per plant.
8. 2.5% span length (2.5% SL)-expressed in (mm).
9. Uniformity ratio (UR %)-expressed as percentage.
10. Fiber strength (FS)-expressed in (g/tex).
11. Fiber elongation (E%)-expressed as percentage.
12. Fiber fineness (MR)-assessed in micronaire reading.
13. Reflectance (Rd%)-expressed as percentage.
14. Yellowness degree (+b).

Fiber properties were measured by HVI system at the Cotton Research Institute in Giza.

Table (1): The name, original source and pedigree of the parent genotypes.

No.	Name	Original source	Pedigree
1	Karshenky$_2$	Russian	-
2	Pima S_6	USA	-
3	Suvin	India	Sujata x Vincent
4	Giza 70	Egypt	Giza 59 A x Giza 51 B
5	Giza 86	Egypt	Giza 75 x Giza 81
6	Giza 88	Egypt	Giza 77 x Giza 45 B

B. Statistical and genetic analysis:

The data for each character was tabulated and analyzed according to Steel and Torrie (1960). Mean data were subjected to triallel analysis according to Ponnuswamy *et al.* (1974), with modification by (Singh and Chaudhary, 1985). The following formula was used.

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

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} = Two-line specific effect where i is half parent and k is the parent. Hence specific effect of second kind.

s_{jk} = Two-line specific effect where j is half parent and k is the parent. Hence specific effect of second kind.

t_{ijk} = Three-line specific effect.

e_{ijkl} = Error effect.

The genetic variance components were estimated according to Singh and Chaudhary (1985).

RESULTS AND DISCUSSION

The analysis of variance for three-way crosses (Table 2) showed highly significant differences among crosses for all the studied characters, except uniformity ratio indicating the presence of considerable amount of genetic variability. Further partitioning of crosses mean squares to their components exhibited that mean squares due to h_i adjusted for g_i and g_i adjusted for h_i were highly significant for most studied characters, indicating the role of additive gene effect in the inheritance of these characters. Both mean squares due to s_{ij} adjusted for d_{ij} and d_{ij} adjusted for s_{ij} were significant for all traits, except uniformity ratio (UR%), fiber strength (FS) and micronaire reading (MR). Also, mean squares due to t_{ijk} were significant for all characters, except 2.5% SL, UR%, E% and MR, indicating the contribution of non-additive gene effects to the expression of these characters.

The previous results, indicate that the experimental materials possessed considerable variability. And the two types of general combining ability with three types of specific combining ability were involved in the genetic expression of these characters. Higher proportions of variance for various kinds of general combining ability than specific combining ability, suggest that additive genetic effect played the major role in the genetic control of these characters, thus could lead to the development of new promising genotypes by the use of efficient selection techniques. The findings support those obtained by Ahuja and Tuteja (2000) and Tuteja *et al.* (2003).

The ultimate choice of parents with high estimates of general combining ability (GCA) and specific combining ability (SCA) help plant breeders to devise breeding and selection strategies. The general line effects of first kind (h_i) and second kind (g_i) (Table 3) were negative and significant for Karshenky$_2$ having two earliness characters and Giza 86 (+b) suggested that the two lines were good general combiners for these traits. On the other hand, the general line effects of first and second kind (h_i and g_i) were positive and significant for Suvin (SI and LI), Giza 86 (yield and yield components and Rd%) and Giza 88 (LI, 2.5% SL and FS). Thus, from the general line effects, these parents were found to be good general combiners and can be used as grand as well as intermediate parents.

The two-line specific combining ability effects of the first kind (d_{ij}), (Table 4) these were negative and significant for four crosses (Kar.$_2$ x G.86), (Kar.$_2$ x G.88), (Pima S$_6$ x Suvin) and (Pima S$_6$ x G.86) for two earliness traits. These crosses included one good and one poor general combiners, could produce desirable transgressive segregation if fixable gene complexes in good combiners and complementary epistatic effect in poor combiners acted in the same direction to maximize desirable attributes. Three crosses (Pima S$_6$ x Suvin), (Suvin x G.70) and (G.70 x G.86) were observed as good specific combiners for seed cotton yield/plant, as they exhibited positive and significant "d_{ij}" effects. The combinations (Kar.$_2$ x G.70), (Pima S_6 x G.86) and (G.70 x G.88) gave high performance compared with any other combinations for yield components. The improvement in fiber properties may be achieved by the crosses (Kar.2 x Suvin) and (Pima S_6 x Suvin) for 2.5% LS, (Pima S_6 x G.86) for E%, MR and Rd%, as they have showed positive and significant "d_{ij}" effects. On the other hand, the crosses (Kar.$_2$ x G.70), (Pima S_6 x Suvin), (Suvin x G.88) and (G.70 x G.86) exhibited negative and significant "d_{ij}" effects for yellowness degree. This indicates that the breeder can depend on (Pima S_6 x G.86) for improving yield components, fiber properties with earliness characters through using recurrent selection. The crosses showing good specific combining ability "d_{ij}" were having the parental combinations of either good x good or good x poor general combiners, as reported by Ram *et al.* (1994) in rice and Ramalingam and Sivasamy (2003).

The estimates of two-line specific effect of second kind (s_{ik}) are presented in Table 5. The results showed that three combinations (Kar.$_2$ x G.70), (Pima S_6 x Suvin) and (G.88 x Kar.$_2$) were negative and significant for two earliness characters. No combinations exhibited positive and significant values for yield and yield components. However, the combination with Line 4 (G.70) used as one of the grand parents (in single cross) and line 1 (Kar.$_2$) as parent (s_{41}) gave high performance for seed cotton yield/plant followed by s_{23}, s_{61}, s_{56} and s_{15}. Meanwhile, the combinations s_{14}, s_{45} and s_{53} showed positive and significant values for most yield components. Meanwhile, the reciprocal effects (s_{ik}) were relatively in the same trend. Also, good specific combiner (s_{ik}) for boll weight was relatively associated with good specific combiner for seed index. This trend also apparent found for seed index with lint index. Concerning fibre properties, the combination s_{45} (G.70 as one of the grand parents and G.86 as parent) gave the best performance as compared to any other crosses followed by the combinations s_{25} and s_{61}. Similar results have also been reported in barley by Chaudhary and Singh (1976) and Joshi (1990) in wheat.

Three-line specific effect (t_{ijk}) are presented in Table 6. Negative and significant three line effects (t_{ijk}) were observed in 3 combinations (t_{241}, t_{256} and t_{346}) for the two earliness traits. While, (t_{ijk}) were positive and significant in 5 combinations (t_{165}, t_{246}, t_{251}, t_{345} and t_{361}) superior for seed cotton yield/plant. Four combinations (t_{152}, t_{245}, t_{263} and t_{462}) showed positive and significant t_{ijk} effects for most yield components. Also, four combinations (t_{132}, t_{156}, t_{346} and t_{361}) showed positive and significant t_{ijk} values for 2.5% span length. The combination (Kar.$_2$ x G.88) x G.86 appeared to be the best promising three way crosses for breeding toward most fiber properties. These combinations also showed high per se performance, hence they deserve consideration in heterosis breeding.

On the basis of various kind of specific combining ability effects, it is clear that most the combinations having high SCA were between geographically diverse parents which may be related to their genetic diversity, as stated by Nirania *et al.* (1991) and Tutega *et al.* (2003). It is worth noting that most lines showing high values in general line effects in the first and second kinds gave high values for different kinds of specific line effects, when brought together in one combination or involved in three way crosses as grand parent or immediate parent. This indicates the equal importance of non-additive gene effects along with additive effects. Similar conclusions were found by Singh and Singh (1978) and Verma *et al.* (1991).

Assessment of components of genetic variation using three-way crosses analysis are presented in Table 7. The results indicated that most studied characters were governed by additive and epistatic gene effects, except boll age and boll weight which were governed by additive and non-additive gene effects with predominant non-additive gene effects for the two characters. Partitioning of the component of variances thorough triallel analysis showed predominance of dominance x dominance type of epistasis for all yield characters, except lint percentage. With respect to the remaining characters, large magnitude of additive x dominance type of epistasis is responsible for the genetic control of such characters. Present findings are in agreement with those obtained by Kumar and Raveendran (2001), El-Mansy (2005), El-Akhedar and El-Lawendey (2006) and Hemaida *et al.* (2006).

Table (2): Analysis of variance of three-way crosses for the fourteen cotton characters.

S.O.V.	d.f.	DFF	BMP	BW	SI	L%	LI	SCY/P	2.5%SL	UR%	S(g/t)	E%	MR	Rd%	+b
Replications	2	3.51*	2.04	0.02	0.06	1.39	0.17	2175.15**	1.43	2.82	15.14	0.05	0.09	3.73	3.87**
Crosses	(59)	45.86**	22.93**	0.29**	1.86**	7.02**	1.36**	145.96**	2.70**	2.93	16.65**	0.21**	0.19**	21.30**	1.85**
hi adjusted for gi	5	259.01**	148.06**	1.12**	6.19**	17.59**	6.02**	517.04**	3.27**	2.76	23.81**	0.10	0.04	63.67**	4.81**
sjj adjusted for dij	19	4.19**	13.07**	0.21**	0.69**	1.73**	0.22**	61.68**	2.10**	2.62	11.19	0.22*	0.11	10.54**	0.56
tijk	21	8.72**	5.25**	0.17**	1.08**	1.50**	0.41**	82.43**	1.54	3.59	13.67*	0.17	0.06	8.50*	0.76*
gi adjusted for hi	5	322.93**	90.50**	0.88**	8.73**	57.29**	9.60**	317.07**	11.89**	3.03	59.81**	0.43**	1.37**	112.1**	12.34**
dij adjusted for sij	9	17.14**	11.15**	0.33**	1.51**	3.70**	0.66**	160.54**	2.09*	1.36	10.05	0.26*	0.07	16.64**	1.34**
Error	118	1.07	0.88	0.04	0.19	0.60	0.09	28.36	0.93	3.01	7.46	0.11	0.08	4.44	0.38

Table (3):General line effects of the first kind hi (general parents) and second kind gi for the fourteen cotton characters.

Parents	Kind	DFF	BMP	BW	SI	L%	LI	SCY/P	2.5%SL	UR%	S(g/tex)	E%	MR	Rd%	+b
Kar.2	hi	*-4.64*	*-3.44*	*-0.30*	*-0.52*	*-0.99*	*-0.56*	*-4.75*	0.01	0.30	-0.03	-0.01	-0.01	*-1.40*	0.05
	gi	*-5.94*	*-3.37*	*-0.34*	*-0.71*	*-2.24*	*-0.95*	-0.78	0.05	-0.03	0.05	*-0.13	*-0.34*	*-3.01*	*0.36*
Pima S6	hi	0.25	*-0.61*	-0.04	-0.11	-0.03	-0.07	-0.54	0.06	0.04	-0.43	-0.06	0.03	-0.29	0.15
	gi	0.01	*-0.64*	0.04	*0.24*	-0.14	0.10	*-4.11*	*0.49*	0.10	*1.01	0.02	-0.03	0.45	-0.04
Suvin	hi	0.23	*0.49*	0.04	*0.28*	*0.22	*0.23*	-0.05	-0.10	0.12	-0.65	-0.01	-0.01	-0.01	-0.05
	gi	*-1.40*	0.17	*0.10*	*0.58*	*-0.52*	*0.21*	*3.36*	*-1.18*	*-0.64	*-2.83*	*-0.14	0.06	*1.21*	*-0.36*
Giza70	hi	0.11	*1.03*	*0.06	*-0.29*	-0.18	*-0.21*	*-2.51*	*-0.29	-0.46	-0.32	-0.04	-0.02	-0.09	-0.05
	gi	*1.79*	*1.42*	-0.03	*-0.69*	*0.39*	*-0.33*	*-1.85	0.31	0.23	0.89	0.09	-0.01	0.53	-0.17
Giza86	hi	*2.25*	*0.81*	*0.17*	*0.49*	*0.99*	*0.53*	*3.96*	-0.18	0.05	0.00	0.05	0.04	*2.26*	*-0.56*
	gi	*4.18*	*1.13*	*0.18*	*0.48*	*2.25*	*0.84*	*4.92*	-0.30	0.30	-0.20	*0.18*	*0.36*	*2.58*	*-0.89*
Giza88	hi	1.82*	*1.73*	*0.07*	*0.16*	-0.01	*0.09	*3.89*	*0.50*	-0.04	*1.43*	0.07	-0.03	-0.48	*0.46*
	gi	*1.37*	*1.30*	0.06	0.11	*0.27	*0.13	-1.54	*0.62*	0.03	*1.09	-0.02	-0.04	*-1.76*	*1.10*
LSD 5%	hi	0.29	0.26	0.05	0.12	0.21	0.08	1.47	0.27	0.48	0.75	0.09	0.08	0.58	0.17
	gi	0.36	0.33	0.07	0.15	0.27	0.11	1.85	0.34	0.60	0.95	0.12	0.10	0.73	0.21
LSD1%	hi	0.38	0.34	0.07	0.16	0.28	0.11	1.94	0.35	0.63	0.99	0.12	0.10	0.77	0.22
	gi	0.48	0.43	0.09	0.20	0.36	0.14	2.45	0.44	0.80	1.26	0.16	0.13	0.97	0.28

*, ** Significant and highly significant at 0.05 and 0.01 probability levels, respectively.

Table (4): Two-line specific effects of first kind (dij) for the fourteen cotton characters.

Cross	DFF	BMP	BW	SI	L%	LI	SCY/P	2.5%SL	UR%	S(g/tex)	E%	MR	Rd%	+b
d12	1.83**	1.35**	-0.24**	-0.25*	0.00	-0.15*	1.19	-0.62**	-0.51	-1.42*	-0.23**	-0.11	1.16*	-0.02
d13	-0.93**	0.57*	0.03	0.27*	-0.26	0.09	0.66	0.65**	0.37	0.93	0.14	0.05	-1.61**	0.51**
d14	0.78**	0.42	0.25**	0.37**	0.18	0.27**	-0.70	-0.04	-0.10	1.15	0.10	0.00	0.77	-0.36*
d15	-0.58*	-0.78**	0.09*	0.08	-0.03	0.01	-0.91	-0.16	-0.08	-0.48	-0.08	-0.04	-0.46	-0.02
d16	-1.10**	-1.55**	-0.13**	-0.46**	0.10	-0.22**	-0.25	0.16	0.31	-0.18	0.07	0.10	0.14	-0.12
d23	-1.03**	-0.87**	0.07	0.36**	-0.45*	0.09	5.21**	0.50*	0.18	0.24	-0.02	-0.01	0.49	-0.34*
d24	0.18	0.28	-0.04	0.05	-0.30	-0.02	-7.14**	-0.11	0.08	-0.42	-0.06	-0.01	-1.38**	0.22
d25	-0.65*	-0.88**	0.20**	-0.15	1.07**	0.18*	0.47	0.10	0.28	1.03	0.32**	0.16*	1.17*	0.00
d26	-0.33	-0.80**	0.01	0.00	-0.32	-0.09	0.26	0.14	-0.03	0.57	-0.01	-0.03	-1.44**	0.14
d34	-0.82**	0.30	-0.12**	-0.52**	-0.05	-0.34**	2.72*	-0.44	0.13	-1.37*	-0.06	0.02	-0.17	0.28
d35	2.18**	0.80**	0.02	0.13	0.28	0.18*	-4.80**	-0.13	-0.60	-0.04	-0.11	-0.04	-0.55	0.07
d36	0.60*	-0.58*	0.01	-0.24*	0.48*	-0.02	-3.80**	-0.58*	-0.09	0.24	0.05	-0.03	1.83**	-0.52**
d45	-0.97**	0.68**	-0.25**	-0.33**	-0.45*	-0.30**	3.28*	0.25	0.24	0.38	0.00	-0.03	0.58	-0.35*
d46	0.82**	0.95**	0.16**	0.44**	0.62**	0.40**	1.83	0.34	-0.35	0.26	0.01	0.02	0.21	0.21
d56	0.02	0.23	-0.05	0.27*	-0.88**	-0.06	1.95	-0.06	0.16	-0.89	-0.13	-0.06	-0.75	0.30*
LSD 5%	0.50	0.46	0.09	0.21	0.38	0.15	2.58	0.47	0.84	1.33	0.16	0.13	1.02	0.30
LSD 1%	0.66	0.60	0.12	0.28	0.50	0.19	3.42	0.62	1.11	1.75	0.22	0.18	1.35	0.40

*, ** Significant and highly significant at 0.05 and 0.01 probability levels, respectively. 1=Kar.2;2=Pima S6;3=Suv.;4=G.70;5=G.86;6=G.88

Table (5): Two-line specific effects of second kind (Sik) for the fourteen cotton characters.

Crosses	DFF	BMP	BW	SI	L%	LI	SCY /P	2.5%SL	(UR%)	S(g/t)	E%	MR	Rd %	+b
S1.2.	-0.33	2.28**	-0.27**	-0.20*	0.70**	0.08	-0.01	-0.12	-0.27	-1.88**	-0.18*	0.08	1.00*	-0.14
S1.3.	0.06	0.98**	0.03	0.23*	-0.35*	0.03	0.19	0.56**	0.24	-0.15	0.01	0.00	0.86	-0.05
S1.4.	-0.77**	-1.45**	0.21**	0.44**	-0.20	0.23**	-0.81	0.20	0.22	1.03	0.03	0.00	-0.25	-0.19
S1.5.	0.31	-1.21**	0.02	-0.40**	-0.16	-0.32**	2.28*	-0.57**	-0.15	0.42	0.01	-0.07	-1.52**	0.05
S1.6.	0.73**	-0.60**	0.00	-0.07	0.01	-0.03	-1.66	-0.07	-0.04	0.58	0.13	0.00	-0.10	0.34*
S2.1.	0.98**	2.70**	-0.16**	0.18*	0.10	0.14*	-5.57**	-0.75**	-0.48	-0.94	-0.17*	-0.02	0.25	0.13
S2.3.	-0.97**	-1.11**	0.05	-0.11	-0.17	-0.10	4.15**	-0.13	0.13	1.73**	0.22**	0.02	-1.11*	-0.03
S2.4.	-0.29	-0.43*	-0.13**	-0.12	0.01	-0.07	-0.82	0.35	0.36	-0.83	0.07	0.09	-0.25	-0.14
S2.5.	0.40	-0.40*	0.24**	0.11	0.16	0.10	1.17	0.56**	0.83*	-0.16	0.04	0.06	1.26**	0.03
S2.6.	-0.12	-0.76**	-0.01	-0.05	-0.10	-0.07	1.07	-0.04	-0.85*	0.20	-0.17*	-0.15*	-0.15	0.01
S3.1.	-0.14	0.12	-0.04	-0.05	-0.56**	-0.15*	-1.42	0.49*	-0.08	0.89	0.06	-0.05	0.65	-0.01
S3.2.	-0.26	-1.28**	0.04	0.04	0.23	0.08	0.81	0.53*	1.06**	-0.28	0.09	0.08	-0.07	-0.26*
S3.4.	0.39	0.44*	-0.08	-0.34**	0.50**	-0.11	1.59	-0.62**	-0.52	0.46	0.06	0.02	0.06	0.38**
S3.5.	-0.19	0.67**	-0.04	0.25**	-0.29	0.09	0.28	0.05	-0.55	-1.35*	-0.23**	-0.04	-1.88**	0.33*
S3.6.	0.21	0.04	0.11**	0.10	0.11	0.09	-1.27	-0.45*	0.08	0.28	0.03	-0.01	1.24**	-0.44**
S4.1.	0.55*	0.20	0.28**	0.37**	-0.80**	0.06	4.47**	0.01	-0.07	-0.81	-0.13	-0.17**	-0.87	0.30*
S4.2.	0.26	-1.10**	0.06	-0.26**	-0.32	-0.25**	-0.31	0.11	-0.16	1.80**	0.04	-0.14*	-0.29	0.14
S4.3.	-0.42	-0.73**	-0.09*	-0.18*	0.32	-0.03	-1.72	-0.74**	-0.57	-1.52*	-0.25**	-0.06	-0.03	-0.07
S4.5.	-0.34	1.06**	-0.28**	0.18*	0.38*	0.20**	-1.63	0.45*	0.51	1.43*	0.23**	0.16**	1.09*	-0.33*
S4.6.	-0.04	0.57**	0.04	-0.10	0.42*	0.01	-0.81	0.16	0.30	-0.89	0.11	0.21**	0.10	-0.05
S5.1.	-0.16	-1.43**	-0.02	-0.38**	0.70**	-0.10	-0.88	-0.19	-0.07	0.07	0.00	0.11	1.67**	-0.45**
S5.2.	0.40	-0.38	0.12**	-0.04	-0.04	-0.02	-2.42*	-0.30	-0.13	1.14	0.19**	-0.03	0.02	0.25
S5.3.	0.99**	0.19	0.14**	0.38**	0.10	0.25**	0.86	-0.23	-0.30	-0.74	-0.06	0.05	-0.57	0.10
S5.4.	-0.46*	0.86**	-0.09*	-0.08	-0.32	-0.12	-0.24	0.33	-0.01	-0.29	-0.03	-0.07	-0.03	-0.05
S5.6.	-0.78**	0.76**	-0.14**	0.12	-0.45**	-0.01	2.67*	0.40	0.51	-0.18	-0.10	-0.05	-1.09*	0.14
S6.1.	-1.23**	-1.60**	-0.05	-0.11	0.55**	0.05	3.39**	0.44*	0.69	0.79	0.24**	0.13*	-1.70**	0.02
S6.2.	-0.06	0.48*	0.05	0.46**	-0.56**	0.11	1.93	-0.22	-0.50	-0.78	-0.14	0.02	-0.66	0.01
S6.3.	0.34	0.66**	-0.13**	-0.31**	0.10	-0.15*	-3.49**	0.54**	0.49	0.68	0.08	0.00	0.86	0.05
S6.4.	1.13**	0.58**	0.08	0.10	0.01	0.06	0.27	-0.26	-0.05	-0.36	-0.13	-0.04	0.46	0.00
S6.5	-0.17	-0.13	0.05	-0.14	-0.09	-0.07	-2.11	-0.49*	-0.64	-0.34	-0.05	-0.11	1.04*	-0.08
LSD5%	0.440	0.40	0.08	0.18	0.33	0.13	2.27	0.41	0.74	1.16	0.15	0.12	0.90	0.26
LSD1%	0.582	0.53	0.11	0.24	0.44	0.17	3.00	0.54	0.98	1.54	0.19	0.16	1.19	0.35

*, ** Significant and highly significant at 0.05 and 0.01 probability levels, respectively. 1=Kar.2; 2=Pima S6;3=Suv. ;4=G.70;5=G.86;6=G.88

Table (6): Three-line specific effects (tijk) for the fourteen cotton characters.

Cross	DFF	BMP	BW	SI	L%	LI	SCY/P	2.5%SL	UR%	S(g/tex)	E%	MR	Rd%	+b
t123	-0.62	0.31	0.03	-0.10	0.28	0.01	0.39	0.56	0.77	1.34	0.24*	0.07	0.70	-0.29
t124	-0.99**	0.14	0.09	-0.06	0.18	0.01	-0.80	-0.32	-0.81	0.47	-0.07	-0.04	-0.62	0.10
t125	1.86**	-1.18**	-0.04	-0.05	-0.17	-0.07	3.52	0.26	0.03	-0.65	-0.11	-0.07	0.83	-0.09
t126	-0.24	0.74*	-0.08	0.21	-0.30	0.04	-3.11	-0.49	0.02	-1.16	-0.06	0.04	-0.90	0.28
t132	1.11**	0.66*	-0.01	-0.13	-0.12	-0.12	3.03	0.70*	0.81	2.28*	0.25*	0.07	1.26	-0.26
t134	1.11**	-1.05**	0.10	0.61**	-0.26	0.31**	0.73	0.37	-0.25	-0.80	-0.10	-0.02	0.96	0.02
t135	-1.10**	0.09	-0.14*	-0.08	0.56*	0.10	-6.75**	-0.48	-0.35	-0.99	-0.12	-0.02	-2.41**	0.21
t136	-1.12**	0.29	0.05	-0.39**	-0.17	-0.29**	2.99	-0.59	-0.20	-0.49	-0.03	-0.02	0.19	0.03
t142	0.32	-0.24	-0.27**	0.01	-0.42	-0.10	-0.43	0.56	0.88	0.13	-0.01	0.02	0.12	-0.15
t143	1.02**	-0.45	0.09	0.07	0.46	0.16	3.25	-0.90**	-1.11	0.10	-0.03	-0.08	-0.12	-0.15
t145	-0.88*	1.32**	-0.04	-0.10	-0.35	-0.15	-2.02	0.10	0.54	-1.48	-0.08	0.11	-0.31	0.24
t146	-0.47	-0.63*	0.22**	0.02	0.31	0.08	-0.80	0.24	-0.30	1.25	0.12	-0.05	0.31	0.05
t152	-1.92**	-0.21	0.35**	0.66**	0.10	0.42**	-0.56	-0.53	-1.25*	-1.20	-0.12	0.02	-1.51*	0.58**
t153	-0.17	-0.28	0.07	-0.19	-0.31	-0.20*	0.62	-0.10	0.82	0.15	0.10	0.00	1.23	-0.24
t154	0.26	0.89**	-0.22**	-0.64**	0.05	-0.38**	-0.98	-0.23	-0.05	0.65	0.05	-0.05	-0.12	0.03
t156	1.83**	-0.41	-0.19**	0.16	0.15	0.16	0.92	0.85*	0.49	0.40	-0.04	0.03	0.40	-0.37
t162	0.49	-0.22	-0.06	-0.54**	0.44	-0.20*	-2.04	-0.73*	-0.44	-1.21	-0.12	-0.11	0.13	-0.17
t163	-0.23	0.43	-0.18**	0.21	-0.44	0.03	-4.26*	0.44	-0.47	-1.60	-0.30**	0.01	-1.80*	0.68**
t164	-0.38	0.02	0.03	0.09	0.03	0.06	1.05	0.17	1.12	-0.31	0.12	0.12	-0.22	-0.15
t165	0.12	-0.23	0.21**	0.23	-0.04	0.11	5.25**	0.12	-0.21	3.12**	0.30**	-0.02	1.89**	-0.36
t231	-0.16	0.17	-0.03	0.25	-0.20	0.08	-3.89*	0.25	0.90	1.37	0.15	0.05	-1.23	0.00
t234	-0.48	-0.46	-0.11	-0.26	0.24	-0.11	0.42	-0.30	0.52	-0.28	-0.04	-0.01	0.41	-0.09
t235	-0.31	0.56	0.07	0.22	-0.16	0.12	0.30	0.04	-0.46	0.12	0.09	0.03	0.82	0.11
t236	0.94**	-0.27	0.06	-0.21	0.12	-0.10	3.17	0.02	-0.96	-1.21	-0.20	-0.07	0.00	-0.02
t241	-1.94**	-0.93**	-0.07	-0.56**	0.02	-0.30**	1.57	0.25	-0.79	0.40	-0.05	-0.17	-0.16	0.20
t243	0.43	0.27	0.03	0.05	-0.16	-0.03	-1.50	-0.02	0.31	-2.30*	-0.17	0.10	-0.35	0.05
t245	-0.26	-0.18	0.17**	0.67**	0.02	0.40**	-5.24**	-0.40	-0.17	2.60**	0.23*	-0.06	-0.36	0.01
t246	1.77**	0.84**	-0.14*	-0.16	0.12	-0.07	5.17**	0.16	0.65	-0.70	-0.01	0.13	0.86	0.26
t251	2.12**	0.08	-0.18**	-0.24	1.27**	0.14	4.37*	-0.46	0.22	-1.89*	-0.12	0.21*	2.11**	-0.49*
t253	0.71*	-0.26	-0.16*	-0.26	-0.68*	-0.31**	-0.60	-0.41	-1.08	-0.43	-0.20	-0.14	-1.02	0.34

*, ** Significant and highly significant at 0.05 and 0.01 probability levels, respectively. 1=Kar.2;2=Pima S6;3=Suv.;4=G.70;5=G.86;6=G.88

Table(6):Cont.

Cross	DFF	BA	BW	SI	L%	LI	SCY/P	2.5%SL	UR%	S(g/tex)	E%	MR	Rd%	+b
t254	-0.37	1.48**	0.18**	0.34*	-0.64*	0.05	1.45	0.56	0.57	-0.76	0.05	0.04	-1.14	0.15
t256	-2.47**	-1.31**	0.16*	0.16	0.05	0.12	-5.23**	0.31	0.29	3.07**	0.27*	-0.11	0.05	0.00
t261	-0.02	0.67*	0.28**	0.55**	-1.08**	0.07	-2.05	-0.04	-0.33	0.12	0.02	-0.08	-0.72	0.29
t263	-0.52	-0.32	0.10	0.31*	0.55*	0.33**	1.71	-0.13	0.01	1.39	0.14	-0.03	0.67	-0.10
t264	1.83**	-1.16**	-0.17**	-0.02	0.23	0.05	-1.07	0.06	-0.28	0.57	0.06	0.01	1.34	-0.16
t265	-1.29**	0.81*	-0.21**	-0.84**	0.31	-0.45**	1.41	0.11	0.60	-2.07*	-0.21	0.10	-1.29	-0.03
t341	1.20**	0.97**	0.13*	0.27	0.08	0.20*	-2.24	-0.09	0.65	-1.32	0.07	0.13	-0.41	0.31
t342	-1.01**	0.61	0.02	-0.14	-0.09	-0.11	-0.53	-1.06**	-1.87**	-1.39	-0.22	-0.11	-0.56	0.25
t345	0.69	-0.61	-0.04	-0.66**	0.10	-0.41**	10. 2**	0.49	0.42	0.40	-0.02	0.02	1.43*	-0.48*
t346	-0.88*	-0.97**	-0.12	0.53**	-0.09	0.32**	-7.42**	0.67*	0.80	2.31*	0.17	-0.04	-0.45	-0.08
t351	-1.57**	-0.28	0.01	-0.22	-0.40	-0.23*	0.16	0.19	-1.04	0.58	-0.03	-0.12	-1.02	0.58**
t352	0.04	0.34	0.03	0.14	-0.18	0.05	-0.59	-0.01	0.65	-0.68	-0.13	-0.08	0.26	-0.44*
t354	0.47	-1.01**	-0.04	0.01	0.44	0.12	-0.82	-0.08	0.03	0.73	0.11	0.08	0.50	-0.21
t356	1.06**	0.95**	0.00	0.07	0.14	0.06	1.25	-0.09	0.36	-0.62	0.05	0.13	0.26	0.07
t361	0.52	-0.86**	-0.11	-0.31*	0.53*	-0.05	5.97**	-0.34	-0.51	-0.62	-0.19	-0.05	2.67**	-0.89**
t362	-0.14	-1.61**	-0.04	0.14	0.39	0.19	-1.91	0.38	0.41	-0.21	0.11	0.12	-0.95	0.44*
t364	-1.10**	2.52**	0.05	-0.36*	-0.41	-0.32**	-0.32	0.01	-0.29	0.35	0.03	-0.05	-1.88*	0.28
t365	0.72*	-0.05	0.10	0.52**	-0.50	0.18	-3.74*	-0.05	0.40	0.47	0.05	-0.02	0.16	0.16
t451	0.34	-0.02	0.14*	0.49**	-0.76**	0.11	0.03	-0.13	0.06	0.86	-0.02	-0.09	0.72	-0.60**
t452	1.46**	-1.16**	-0.12	-0.53**	0.70**	-0.14	-0.92	0.34	0.78	0.86	0.23*	0.08	0.43	0.02
t453	-1.38**	0.42	-0.05	0.43**	0.40	0.37**	-2.16	0.86**	0.30	1.13	0.07	0.05	-0.44	0.29
t456	-0.42	0.76*	0.03	-0.39**	-0.34	-0.34**	3.05	-1.07**	-1.14	-2.86**	-0.28*	-0.05	-0.71	0.29
t461	0.40	-0.03	-0.21**	-0.21	0.67*	0.00	0.64	-0.03	0.08	0.06	0.01	0.14	-0.15	0.09
t462	-0.77*	0.79*	0.37**	0.66**	-0.20	0.34**	1.88	0.16	0.21	0.40	0.00	0.01	0.01	-0.12
t463	-0.08	-0.24	-0.06	-0.55**	-0.70**	-0.50**	0.41	0.05	0.50	1.07	0.14	-0.08	0.91	-0.20
t465	0.44	-0.53	-0.10	0.09	0.23	0.16	-2.93	-0.18	-0.79	-1.52	-0.14	-0.06	-0.77	0.23
t561	-0.90*	0.22	0.03	-0.04	-0.11	-0.02	-4.56*	0.41	0.76	0.44	0.17	0.00	-1.80*	0.51*
t562	0.42	1.03**	-0.26**	-0.27	-0.63*	-0.33**	2.07	0.20	-0.18	1.02	0.02	-0.02	0.81	-0.15
t563	0.83*	0.13	0.14*	0.02	0.58*	0.15	2.14	-0.36	-0.03	-0.86	0.03	0.09	0.22	-0.39
t564	-0.36	-1.37**	0.08	0.29*	0.16	0.21*	0.35	-0.25	-0.55	-0.61	-0.21	-0.07	0.76	0.03
1%	0.93	0.84	0.17	0.39	0.69	0.27	4.77	0.86	1.55	2.44	0.30	0.25	1.89	0.55

*, ** Significant and highly significant at 0.05 and 0.01 probability levels, respectively. 1=Kar.2;2=Pima S6;3=Suv.;4=G.70;5=G.86;6=G.88

Table (7): Estimation of genetic and environmental variances for the fourteen cotton characters.

Parameters	DFF	BMP	BW(g)	SI (g)	L%	LI(g)	SCY/P(g)	2.5%SL	UR%	S(g/tex)	E%	MR	Rd%	+b
σ2A	37.314	10.676	0.051	0.663	2.832	0.811	17.202	0.152	0.049	1.197	-0.001	0.007	7.121	0.693
σ2D	5.046	16.442	0.051	-0.115	-3.901	-0.278	-56.034	-4.449	-5.900	-37.717	-0.573	-0.248	-4.211	-0.544
σ2AA	-21.371	-10.801	0.009	-0.153	2.341	-0.223	3.141	0.951	-0.090	2.694	0.020	0.140	1.277	0.328
σ2AD	13.362	23.925	0.156	0.300	5.216	1.132	74.005	13.742	24.099	134.283	2.228	0.550	0.866	0.000
σ2DD	17.100	12.742	0.406	2.500	1.365	0.637	129.653	-1.063	-3.189	-9.830	-0.285	-0.174	10.297	1.004
Env.	0.357	0.294	0.012	0.062	0.201	0.030	9.454	0.308	1.002	2.487	0.038	0.025	1.480	0.126

It could be concluded that those parents could be used in the three way crosses system followed by selection for the improvement of earliness, yield components and fiber quality.

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تطبيق الهجن الثلاثية فى القطن البربادنس

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يهدف هذا البحث إلى دراسة:

١- تباينات القدرة على الائتلاف ، أفضل الأباء ذات التأثيرات المرغوبة للقدرة العامة على الائتلاف (بنوعيها الأول والثانى) ، أفضل التوليفات ذات التأثيرات المرغوبة للقدرة الخاصة على الائتلاف (بأنواعها الثلاثة):

٢- مكونات التباين الوراثية (الإضافى ، السيادى ، الإضافى × الإضافى ، الإضافى × السيادى ، السيادى × السيادى) لأربعة عشر صفة كمية فى القطن.

ولتحقيق هذه الأهداف تم تقييم ٦٠ هجين ثلاثى مع ٦ أباء فى تجربة قطاعات كاملة العشوائية موسم ٢٠٠٧م. ويمكن تلخيص أهم النتائج المتحصل عليها كما يلى:

١- أظهر تحليل التباين اختلافات عالية المعنوية بين الهجن لكل الصفات المدروسة عدا صفة الانتظام%.

٢- كانت التباينات الوراثية الراجعة للقدرة العامة على الائتلاف من النوع الأول والثانى (أباء الهجن الفردية ، الأب الثالث) عالية المعنوية لمعظم الصفات المدروسة. كما أظهرت الطرز الثلاثة للقدرة الخاصة على الائتلاف معنوية عدا معظم صفات التيلة.

٣- كانت الأباء كارشنكى٢ ، جيزه ٨٦ ، جيزه ٨٨ ذات تأثيرات مرغوبة للقدرة العامة على الائتلاف بنوعيها ويمكن استخدامها فى برامج التربية لتحسين صفات التبكير ، المحصول ، التيلة على التوالى.

٤- أعطت الهجن الثلاثية كارشنكى٢ × (بيماس٦ × جيزه ٧٠) ، جيزه ٨٦ × (سوفين × جيزه ٧٠) ، بيماس٦ × (كارشنكى٢ × جيزه ٨٦) ، جيزه ٨٦ × (كارشنكى٢ × جيزه ٨٨) افضل تأثير مرغوب للقدرة الخاصة على الائتلاف بطرزها الثلاث لصفتى التبكير ، المحصول ، مكونات المحصول وصفات التيلة على التوالى.

٥- كانت التأثيرات الراجعة للفعل الجينى المضيف والتفوقى على قدم المساواة فى الأهمية فى وراثة معظم الصفات المدروسة.

وعلى ضوء هذه النتائج سيتم بمشيئة الله زراعة بعض هذه الهجن المتميزة فى العام القادم لتحسين صفاتها باستخدام طريقة الانتخاب الدورى