

LINE X TESTER ANALYSIS FOR YIELD COMPONENTS AND FIBER PROPERTIES IN SOME COTTON CROSSES OF (*Gossypium barbadense* L.)

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ABSTRACT: *The present study was carried out at Sakha Agricultural Research Station, Cotton Research Institute, Agricultural Research Center, Egypt, during 2017 and 2018 seasons. This investigation was carried out to estimate heterosis, combining ability, proportional contributions, genetic components and heritability estimates of some characters for six Egyptian cotton varieties as lines i.e, Giza 90, Giza 95, Giza 86, Giza 94, Giza 92 and Giza 96, while, the other five genotypes used as testers were Karshenky, Suvin, Australy 13, Pima S₇ and Pima S₆, using line x tester analysis. In 2018 season a randomized complete blocks design with three replications was carried to evaluate all genotype (eleven parents and their 30 F₁s crosses) for some genetic parameters. The results indicated that mean squares due to the genotypes, parents, crosses and parents vs. crosses were significant and highly significant for all traits studied, except No. of bolls/plant in the parents, lint percentage in the crosses and fiber strength in the crosses and parents vs. crosses. The mean squares due to lines were significant for all studied traits. Mean square for testers and Line x Tester were significant for most traits studied. The following crosses demonstrated the best heterosis relative to mid- and better-parent, i.e, Giza 95 x Karshenky, Giza 95 x Australy 13 and Giza 95 x Pima S₇ for most traits studied, while the following crosses demonstrated the best heterosis relative to mid- and better-parent for most studied yield traits, i.e. Giza 90 x Australy 13 and Giza 86 x Karshenky. The crosses Giza 92 x Karshenky, Giza 92 x Australy 13, Giza 92 x Pima S₇, Giza 96 x Suvin and Giza 96 x Pima S₇ were the best heterosis relative to mid-parent for most studied fiber traits. The results revealed that the line Giza 95 was significant and positive desirable GCA effects for all yield traits. Giza 92 had significant and positive desirable GCA effects for seed index and fiber strength and negative desirable for micronaire reading Giza 96 had significant and positive desirable GCA effects for fiber strength and negative desirable for micronaire reading. In this respect, the results of testers showed that Australy13 had significant and positive desirable for No. of bolls/plant, seed cotton yield/plant and lint cotton yield/plant. However, estimates of specific combining ability (SCA) effects for the crosses Giza 90 x Karshenky, Giza 95 x Pima S₇, Giza 92 x Karshenky and Giza 96 x Suvin were significant desirable SCA effects for some yield traits. Proportion contribution of testers contribution was higher than lines contribution for all traits studied except No. of bolls/plant. However proportion contribution of lines x testers interaction was higher than of lines and testers for most traits studied. The non-additive of genetic parameters were larger than additive genetic variance with respect to all studied traits. Broad sense heritability (h^2_b %) estimates were larger than the corresponding values of narrow sense heritability (h^2_n %) for all traits studied. The highest broad sense heritability estimates was observed in case of lint percentage with values of 71.70% and the lowest was for uniformity index with value of 27.55%, while for narrow sense heritability, it ranged from zero to 4.37% for boll weight and lint index, respectively. Generally, Giza 95 and Australy13 could be used in breeding programs for improving high yielding varieties, while Giza 92 and Giza 96 could be*

considered as excellent parents for breeding programs to produce new varieties characterized with best fiber properties.

Key words: Cotton, Combining ability, Heterosis, Heritability, Gene action.

INTRODUCTION

Large number of cultivars was developed from closely related parents, indicating the presence of sufficient variability or mechanisms to create variability and achieve breeding progress in a narrow germplasm base. Unless improved methods suggested to transfer useful genes from diverse to adapted germplasm, cotton germplasm resources will remain limited and variability will be exhausted. Breeders rely on genetic variation between parents to create unique genetic combination necessary for new developing superior cultivars. So, the understanding of the genetic architecture of each breeding material is matter of a great interest for selecting the most desirable cotton germplasm in order to establish the most efficient breeding program for quick and maximum genetic improvement.

The concept of combining ability is important in designing and choose the plan of plant breeding programmes. It is especially useful in testing procedures, where it is desired to study and compare the performance of lines in hybrid combinations. Two types of combining ability, general and specific, have been recognized in quantitative genetics. Specific combining ability (SCA) is defined as the deviation in the performance of hybrids from the expected productivity based upon the average performance of lines involved in the hybrid combination, whereas general combining ability (GCA) is defined as average performance of a line in a series of crosses. Recent cotton improvement programmes primarily emphasize on development of hybrids which have contributed a lot in escalating the productivity of cotton. Kempthorne

(1957) reported that, using broad base genotypes as a tester; the general combining of lines is tested as in the top cross method. He added that the line x tester analysis is an extension of this method in which several testers are used. In order to evaluate the materials used in this study, means and variance of genotypes for the studied traits were calculated. Statistical procedures used in this study were done according to Cochran and Cox (1957). Al-Hibbiny (2011) found that proportional contribution of line x tester interaction was higher than that of lines and testers for all studied characters, except lint percentage. Lines contribution was higher than testers contribution for most studied traits. Wajid *et al.*, (2011) cleared that the general combining ability (GCA) and specific combining ability (SCA) mean squares for bolls per plant, seed cotton yield and lint percentage were significant. The GCA variances were higher than SCA variances indicating greater importance of additive against non-additive genes, especially dominant ones in advocating these traits. Linga swamy *et al.*, (2013) noticed that the magnitude of GCA and SCA variances revealed that pre-dominance of additive as well as non-additive gene action was important for inheritance of seed cotton yield and its yield attributes. Amein *et al.*, (2013) found that the parent Giza 86 showed maximum and significant GCA effects for fiber strength, and it was also the 2nd best combiner for seed cotton yield and lint yield. The parent 10229 was the 2nd best combiner for fiber strength, boll weight and lint percentage. The parent (Giza 89 x Giza 86) was the best combiner for boll weight, while the parent (Giza 89 x Sea) was the best combiner for

upper half mean. EL-Seoudy *et al.*, (2014) found that significant heterotic values over the mid- and the better-parent varied between positive and negative for most of the studied traits. The estimates of variance due to SCA were positive and higher in magnitude than the variance of GCA for all studied traits indicating that the non-additive genetic effect played a major role in the genetic expression of these traits. While, additive effects had a minor role in the inheritance of these traits indicating that the hybridization program would be effective in improving yield and its components traits. Comparing the GCA effects of individual parent revealed that G83xG75x5844 was the best combiner for all studied traits. Dominance estimates were higher than the additive estimates for all studied traits indicating more importance for dominant gene effect in the inheritance of these traits. Estimates of heritability in both broad and narrow senses for yield and its components showed high heritability values in broad sense for all traits under investigation.

The main objective of this study was to evaluate heterosis, combining ability, gene action and heritability for yield, yield components and fiber properties in some crosses of *Gossypium barbadense* L.

MATERIALS AND METHODS

In 2017 growing season the single crosses between eleven parental genotypes were made by using the six Egyptian cotton varieties, Giza 90, Giza 95, Giza 86, Giza 94, Giza 92 and Giza 96 as lines (Females). While, the five remaining varieties were used as testers (males) namely Karshenky (Russian variety), Suvin (Indian variety), Australy 13(Australian variety), Pima S₇ and Pima S₆ (American Egyptian varieties) to produce 30 F₁'s and the parental varieties were also selfed to increase their seeds.

Thirty crosses and eleven parents were evaluated in 2018 growing season at Sakha Agricultural Research Station in an experiment randomized complete block design with three replications to evaluate genotypes. Each block therefore, contained 24 plots. Each plot was two rows 4 m long and 0.60 m wide. Hills were spaced 0.40 m apart which thinned to keep constant stand of one plant/hill.

The traits studied were.

- Number of bolls per plant (NB/P)
- Lint cotton yield per plant (LCY/P.g)
- Boll weight (BW.g)
- Lint index (LI.g)
- Micronaire reading (MIC).
- Uniformity index (UI).
- Seed cotton yield per plant (SCY/P.g)
- Lint percentage (L%)
- Seed index (SI g)
- Upper half mean (UHM).
- Fiber strength (FS).

All fiber properties were measured in the laboratories of the Cotton Technology Research Division, Cotton Research Institute, Giza.

Statistical analysis:

The first step in the line x tester analysis is to perform analysis of variance and test the significance of differences among the genotypes including crosses and parents. If these differences are found significant, line x tester analysis was performed (Singh and Chaudhary 1979). The significance of means was determined using the least significant difference value (L.S.D) at 0.05 and 0.01 levels of significance, according to the equation, which outlined by Steel and Torrie (1985). Heritability was estimated in both broad ($h^2_b\%$) and narrow ($h^2_n\%$) senses from two formulas given by Allard (1960) and Mather (1949).

Line x tester analysis for yield components and fiber properties

RESULTS AND DISCUSSION

Analysis of variance

Results of the analysis of variance and the mean squares of all traits studied for the eleven parents and their 30 F₁'s crosses are presented in Table (1). The results showed that the mean squares due to the genotypes, parents, crosses and parents vs. crosses were significant and highly significant for all studied traits, except No. of bolls/plant in the parents, lint percentage and lint index in the crosses and fiber strength in the crosses and parents vs. crosses. The mean squares due to lines were significant for all studied traits. Mean square for testers and Line x Tester were significant for most studied traits.

Samreen *et al* (2008) found that the GCA variances due to lines and testers and SCA due to lines x testers interaction were significant for all studied characters. However, the magnitude of GCA variance for lines (females) and testers (pollinators) were higher than the SCA variance indicating preponderance of additive genes in the expression of all traits. Baloch *et al* (2014) found that mean squares due to general combining ability (GCA) of lines and testers and specific combining ability (SCA) of lines x tester interactions were significant. The significance of GCA and SCA variances suggested that both additive and dominant genes were controlling the studied characters.

Table 1. Mean squares of line x tester analysis for yield, yield components and fiber properties.

SOV	df	NB/P	SCY/P	LCY/P	L.%	BW	SI.
Replications	2	31.71	679.79	86.44	1.13	0.038	0.035
Genotypes	40	88.09**	1300.37**	195.63**	3.77**	0.151**	1.084**
Parents	10	54.85	1220.79**	182.26**	3.48**	0.269**	1.405**
Crosses	29	680.83**	10203.15**	1418.52**	2.66	0.368**	1.442*
P. vs. C	1	79.12**	1020.83**	158.07**	3.91**	0.103**	0.961**
Lines	5	96.24*	1883.52**	368.14**	7.68**	0.123*	1.892**
Tester	4	149.84**	1536.81**	230.75**	0.53	0.026	2.007**
Line x Tester	20	60.69*	701.96*	91.02*	3.64*	0.113**	0.519
Error	80	29.83	337.35	49.96	1.26	0.050	0.314

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

Table 1. Cont.

SOV	df	LI	UHM	FS	MIC	UI
Replications	2	0.134	1.21	0.0251	0.057	0.19
Genotypes	40	0.624**	3.94**	0.2343**	0.164**	1.97**
Parents	10	0.945**	4.84**	0.2745**	0.115**	2.82**
Crosses	29	0.057	36.87**	0.0002	0.231*	8.17**
P. vs. C	1	0.533**	2.50**	0.2285	0.178**	1.47*
Lines	5	1.473**	4.55**	0.6180**	0.560**	3.38**
Tester	4	0.808**	4.19**	0.1979*	0.055	1.32
Line x Tester	20	0.243*	1.65	0.1372	0.107**	1.02
Error	80	0.140	1.01	0.0672	0.045	0.81

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

The mean performance of genotypes

Mean performances for parents (lines and testers) and crosses are presented in Table (2). The lines Giza 94 had the highest values for lint percentage, seed index, lint index and best micronaire reading, Giza 96 had the best means for No. of bolls/plant, seed cotton yield/plant, lint cotton yield/plant, boll weight, upper half mean and uniformity index, while for testers. Suvin had the highest values for all studied traits except lint percentage and micronaire reading, Australy 13 recorded the highest values for lint percentage and micronaire reading. The results also showed that the best mean performances were found for Giza 95 x karshenky for boll weight, Giza 95 x Australy 13 for No. of bolls/plant, Giza 95 x pima s₇ for seed cotton yield/plant, lint cotton yield/plant, seed index and lint index, Giza 86 x Karchenky for lint percentage, Giza 92 x Karchenky for uniformity index, Giza 92 x pima s₇ for micronaire reading, Giza 92 x pima s₆ for Uper half mean and micronaire reading and Giza 96 x Australy 13 for fiber strength.

Heterosis:

The diversity of genetic distance and different of originated was the important source for variability which lead to create new recombinations differently about the parent consequently finding heterosis. Heterosis expressed as the percentage deviation of F₁ mean performance relative to both mid and better-parents. Heterosis refers to the superiority of the F₁ hybrid in one or more characters over its parents, and lead to superiority in adaptation. In general, positive heterosis is considered as desirable for all traits studied, except micronaire reading.

The magnitude of heterosis for all traits studied over the mid-parents (MP) and better parent (BP) was presented in Tables (3) and (4). For No. of bolls/plant 25 out of 30 crosses studied showed significant and highly significant positive heterosis relative to mid-parent which ranged from 8.82% for Giza 96 x Australy 13 to 82.15% for Giza 95 x Australy 13, sixteen crosses showed desirable heterosis relative to better-parent which ranged from 12.00% for Giza 92 x Suvin to 76.73% for Giza 95 x Australy13. For seed cotton yield/plant relative heterosis versus mid-parent, fifteen crosses out of 30 F₁ crosses possessed significant and highly significant positive heterosis which ranged from 27.89% for Giza 92 x Australy13 to 97.34% for Giza 95 x pima S₇, while eleven crosses showed significant and positive heterosis relative to better-parent which ranged from 38.64% for Giza 86 x karshenky to 87.98% for Giza 95 x Australy13.

For lint cotton yield/plant the results of heterosis versus mid-parent revealed that 21 crosses out of 30 F₁ crosses was found to be significant and positive heterosis which ranged from 13.04% for Giza 92 x pima S₇ to 97.34 for Giza 95 x pima S₇, while fifteen crosses showed significant positive heterosis relative to better-parent which ranged from 14.85% for Giza 95 x Suvin to 87.58% for Giza 95 x pima S₇. In this respect, for lint percentage, the results showed that six crosses out of 30 F₁ crosses relative heterosis versus mid-parent were significant and positive which ranged from 1.66% for Giza 86 x Suvin to 6.09% for Giza 86 x Karshenky, Whereas, heterosis versus better-parent showed that Giza 86 x Karshenky was exhibited significant positive heterosis with value of 4.33%.

Table 2. The mean performances of six parental lines, five testers and 30 F₁ hybrids for yield, yield components and fiber properties.

Genotypes		NB/P	SCY/P	LCY/P	L. %	BW	SI.
Lines :							
Giza 90		18.28	60.47	23.67	39.16	3.31	10.67
Giza 95		22.00	68.47	26.73	39.19	3.09	10.23
Giza 86		20.78	72.03	27.92	38.85	3.47	10.67
Giza 94		27.42	85.78	33.76	39.36	3.16	11.87
Giza 92		28.07	99.13	36.17	36.48	3.54	10.80
Giza 96		30.95	122.27	47.63	39.02	3.96	10.83
Testers :							
Karshenky		19.67	61.37	23.01	37.56	3.13	10.30
Suvin		28.89	98.73	39.50	40.04	3.45	11.00
Australy 13		23.39	73.20	29.33	40.12	3.12	10.67
Pima S ₇		23.85	82.00	31.30	38.08	3.43	10.43
Pima S ₆		19.97	56.40	22.28	39.30	2.84	9.00
LSD	0.05	8.74	29.39	11.31	1.79	0.36	0.90
	0.01	11.42	38.39	14.77	2.34	0.47	1.17
F₁ hybrids							
Giza 90 x Karshenky		31.54	110.93	41.53	37.52	3.53	10.77
Giza 90 x Suvin		27.33	85.96	33.89	39.40	3.17	10.43
Giza 90 x Australy 13		27.53	96.07	37.67	39.37	3.50	11.00
Giza 90 x Pima S ₇		25.21	84.50	32.67	38.68	3.36	11.47
Giza 90 x Pima S ₆		24.38	87.53	34.54	39.42	3.59	10.83
Giza 95 x Karshenky		26.75	101.30	39.13	38.72	3.79	10.83
Giza 95 x Suvin		31.27	116.13	45.37	39.01	3.73	11.40
Giza 95 x Australy 13		41.33	137.60	54.97	39.96	3.33	11.17
Giza 95 x Pima S ₇		41.24	148.47	58.71	39.59	3.59	11.83
Giza 95 x Pima S ₆		27.70	96.90	37.10	38.34	3.49	11.53
Giza 86 x Karshenky		28.10	99.87	40.50	40.53	3.57	10.13
Giza 86 x Suvin		29.68	100.60	40.32	40.09	3.39	10.07
Giza 86 x Australy 13		31.20	111.67	44.40	39.75	3.58	10.57
Giza 86 x Pima S ₇		32.37	114.10	42.33	37.28	3.53	11.53
Giza 86 x Pima S ₆		31.94	107.87	41.63	38.69	3.37	10.13
Giza 94 x Karshenky		27.45	88.10	34.61	39.21	3.21	10.03
Giza 94 x Suvin		33.15	106.47	41.47	38.65	3.19	10.30
Giza 94 x Australy 13		28.73	104.67	39.83	37.92	3.63	11.33
Giza 94 x Pima S ₇		28.72	100.93	39.33	38.89	3.52	11.27
Giza 94 x Pima S ₆		26.74	97.27	36.00	36.99	3.63	10.40
Giza 92 x Karshenky		19.14	71.27	25.70	36.27	3.73	11.43
Giza 92 x Suvin		32.35	104.93	39.17	37.30	3.25	10.93
Giza 92 x Australy 13		32.63	110.20	41.60	37.72	3.39	10.80
Giza 92 x Pima S ₇		31.81	103.70	38.13	36.89	3.26	11.20
Giza 92 x Pima S ₆		19.92	67.20	26.27	39.06	3.36	11.20
Giza 96 x Karshenky		23.19	69.30	27.00	39.01	2.99	9.33
Giza 96 x Suvin		36.86	128.97	46.19	35.88	3.53	11.07
Giza 96 x Australy 13		29.57	97.80	36.85	37.72	3.32	10.47
Giza 96 x Pima S ₇		22.45	76.10	29.13	38.42	3.39	10.73
Giza 96 x Pima S ₆		27.04	89.87	34.71	38.71	3.35	10.77
LSD	0.05	7.57	25.46	9.80	1.55	0.31	0.78
	0.01	9.89	33.25	12.80	2.03	0.41	1.01

Table 2. Cont.

Genotypes		LI	UHM	FS	MIC	UI
Lines :						
Giza 90		6.87	32.53	10.53	4.37	86.10
Giza 95		6.61	30.87	9.73	4.70	83.40
Giza 86		6.78	33.73	10.27	4.20	85.07
Giza 94		7.70	34.33	10.50	4.00	85.97
Giza 92		6.20	34.37	10.67	4.17	85.17
Giza 96		6.93	35.07	10.53	4.40	86.30
Testers :						
Karshenky		6.21	32.70	9.87	4.60	84.20
Suvin		7.34	33.50	10.30	4.40	86.40
Australy 13		7.15	33.00	10.07	4.33	84.67
Pima S ₇		6.42	31.33	10.00	4.47	84.33
Pima S ₆		5.76	33.17	10.17	4.40	85.43
LSD	0.05	0.60	1.61	0.41	0.34	1.44
	0.01	0.78	2.11	0.54	0.44	1.88
F ₁ hybrids						
Giza 90 x Karshenky		6.47	34.20	10.03	4.27	86.43
Giza 90 x Suvin		6.78	33.03	9.60	4.97	85.57
Giza 90 x Australy 13		7.15	33.40	9.93	4.57	84.07
Giza 90 x Pima S ₇		7.23	34.90	10.23	4.57	86.13
Giza 90 x Pima S ₆		7.04	33.87	10.43	4.87	86.17
Giza 95 x Karshenky		6.84	33.73	10.03	4.67	85.97
Giza 95 x Suvin		7.28	35.57	10.53	4.57	86.43
Giza 95 x Australy 13		7.43	35.00	10.40	4.50	86.03
Giza 95 x Pima S ₇		7.76	34.50	10.17	4.43	85.47
Giza 95 x Pima S ₆		7.17	34.60	10.10	4.37	85.73
Giza 86 x Karshenky		6.91	32.30	9.87	4.87	84.23
Giza 86 x Suvin		6.74	31.73	9.57	4.80	84.43
Giza 86 x Australy 13		6.97	35.13	9.97	4.90	84.70
Giza 86 x Pima S ₇		6.85	33.93	10.20	4.47	85.10
Giza 86 x Pima S ₆		6.39	34.57	10.13	4.50	85.83
Giza 94 x Karshenky		6.22	33.53	10.07	4.47	85.20
Giza 94 x Suvin		6.49	34.13	10.37	4.30	85.73
Giza 94 x Australy 13		6.93	34.57	10.30	4.57	86.03
Giza 94 x Pima S ₇		7.17	35.17	10.57	4.43	86.33
Giza 94 x Pima S ₆		6.10	35.03	10.57	4.13	86.17
Giza 92 x Karshenky		6.51	34.67	10.30	4.30	86.93
Giza 92 x Suvin		6.50	34.60	10.37	4.30	85.63
Giza 92 x Australy 13		6.54	34.73	10.47	4.17	85.73
Giza 92 x Pima S ₇		6.55	34.80	10.60	4.10	86.03
Giza 92 x Pima S ₆		7.18	35.60	10.37	4.10	86.17
Giza 96 x Karshenky		5.97	33.73	10.33	4.23	85.43
Giza 96 x Suvin		6.20	35.30	10.50	4.33	86.17
Giza 96 x Australy 13		6.34	34.90	10.67	4.20	85.93
Giza 96 x Pima S ₇		6.69	34.93	10.20	4.40	86.53
Giza 96 x Pima S ₆		6.81	35.27	10.40	4.60	86.67
LSD	0.05	0.52	1.40	0.36	0.29	1.25
	0.01	0.68	1.82	0.47	0.38	1.63

Line x tester analysis for yield components and fiber properties

Table 3. Heterosis relative to the mid-parent (MP) for yield, yield components and fiber properties.

Crosses	NB/P	SCY/P	LCY/P	L.%	BW	SI.	
Giza 90 x Karshenky	66.23**	82.11**	77.96**	-2.17**	9.52**	2.70**	
Giza 90 x Suvin	15.87**	7.99	7.32	-0.48	-6.11**	-3.69**	
Giza 90 x Australy 13	32.13**	43.74**	42.14**	-0.68	8.92**	3.13**	
Giza 90 x Pima S ₇	19.69**	18.62	18.86**	0.15	-0.30	8.69**	
Giza 90 x Pima S ₆	27.46**	49.80**	50.37**	0.48	16.70**	10.17**	
Giza 95 x Karshenky	28.37**	56.05**	57.34**	0.91	21.76**	5.52**	
Giza 95 x Suvin	22.89**	38.92**	36.99**	-1.53	14.17**	7.38**	
Giza 95 x Australy 13	82.15**	94.26**	96.08**	0.76	7.41**	6.86**	
Giza 95 x Pima S ₇	79.93**	97.34**	97.34**	2.47**	10.22**	14.52**	
Giza 95 x Pima S ₆	32.03**	55.21**	51.40**	-2.32**	17.66**	19.93**	
Giza 86 x Karshenky	38.89**	49.73**	59.04**	6.09**	7.97**	-3.34**	
Giza 86 x Suvin	19.50**	17.82	19.60**	1.66*	-2.21**	-7.08**	
Giza 86 x Australy 13	41.27**	53.78**	55.10**	0.67	8.59**	-0.94*	
Giza 86 x Pima S ₇	45.06**	48.15**	42.97**	-3.08**	2.32**	9.32**	
Giza 86 x Pima S ₆	56.74**	67.97**	65.88**	-0.98	6.86**	3.05**	
Giza 94 x Karshenky	16.57**	19.75	21.93**	1.97**	2.12**	-9.47**	
Giza 94 x Suvin	17.74**	15.40	13.20**	-2.64**	-3.63**	-9.91**	
Giza 94 x Australy 13	13.10**	31.68*	26.26**	-4.58**	15.50**	0.59	
Giza 94 x Pima S ₇	12.03**	20.32	20.91**	0.43	6.77**	1.05**	
Giza 94 x Pima S ₆	12.85**	36.83**	28.49**	-5.94**	21.11**	-0.32	
Giza 92 x Karshenky	-19.82**	-11.19	-13.14**	-2.02*	11.69**	8.37**	
Giza 92 x Suvin	13.61**	6.06	3.52	-2.51**	-7.15**	0.31	
Giza 92 x Australy 13	26.83**	27.89*	27.02**	-1.52	1.90**	0.62	
Giza 92 x Pima S ₇	22.53**	14.50	13.04**	-1.05	-6.50**	5.49**	
Giza 92 x Pima S ₆	-17.07**	-13.59	-10.11*	3.08**	5.33**	13.13**	
Giza 96 x Karshenky	-8.40*	-24.52	-23.56**	1.88*	-15.60**	-11.67**	
Giza 96 x Suvin	23.18**	16.71	6.02	-9.23**	-4.68**	1.37**	
Giza 96 x Australy 13	8.82*	0.07	-4.25	-4.67**	-6.21**	-2.64**	
Giza 96 x Pima S ₇	-18.05**	-25.49*	-26.18**	-0.34	-8.39**	0.94*	
Giza 96 x Pima S ₆	6.19	0.60	-0.69	-1.15	-1.57**	8.57**	
LSD	0.05	7.57	25.46	9.80	1.55	0.31	0.78
	0.01	9.89	33.25	12.80	2.03	0.41	1.01

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

Table 3. Cont.

Genotypes		LI	UHM	FS	MIC	UI
Giza 90 x Karshenky		-1.02**	4.85**	-1.63**	-4.83**	1.51*
Giza 90 x Suvin		-4.49**	0.05	-7.84**	13.31**	-0.79
Giza 90 x Australy 13		1.99**	1.93**	-3.56**	4.98**	-1.54*
Giza 90 x Pima S ₇		8.87**	9.29**	-0.32**	3.40**	1.08
Giza 90 x Pima S ₆		11.51**	3.09**	0.81**	11.03**	0.47
Giza 95 x Karshenky		6.77**	6.14**	2.38**	0.36*	2.59**
Giza 95 x Suvin		4.41**	10.51**	5.16**	0.37*	1.81**
Giza 95 x Australy 13		8.01**	9.60**	5.05**	-0.37*	2.38**
Giza 95 x Pima S ₇		19.02**	10.93**	3.04**	-3.27**	1.91**
Giza 95 x Pima S ₆		15.94**	8.07**	1.51**	-4.03**	1.56*
Giza 86 x Karshenky		6.39**	-2.76**	-1.99**	10.61**	-0.47
Giza 86 x Suvin		-4.59**	-5.60**	-6.97**	11.63**	-1.52*
Giza 86 x Australy 13		0.02	5.29**	-1.97**	14.84**	-0.20
Giza 86 x Pima S ₇		3.85**	4.30**	0.66**	3.08**	0.47
Giza 86 x Pima S ₆		1.88**	3.34**	-0.82**	4.65**	0.68
Giza 94 x Karshenky		-10.57**	0.05	-1.15**	3.88**	0.14
Giza 94 x Suvin		-13.77**	0.64	-0.32	2.38**	-0.52
Giza 94 x Australy 13		-6.72**	2.67**	0.16	9.60**	0.84
Giza 94 x Pima S ₇		1.48**	7.11**	3.09**	4.72**	1.39*
Giza 94 x Pima S ₆		-9.41**	3.80**	2.26**	-1.59**	0.54
Giza 92 x Karshenky		4.95**	3.38**	0.32	-1.90**	2.66**
Giza 92 x Suvin		-3.99**	1.96**	-1.11**	0.39**	-0.17
Giza 92 x Australy 13		-1.99**	3.12**	0.96**	-1.96**	0.96
Giza 92 x Pima S ₇		3.76**	5.94**	2.58**	-5.02**	1.51*
Giza 92 x Pima S ₆		20.01**	5.43**	-0.48**	-4.28**	1.02
Giza 96 x Karshenky		-9.08**	-0.44	1.31**	-5.93**	0.22
Giza 96 x Suvin		-13.18**	2.97**	0.80**	-1.52**	-0.21
Giza 96 x Australy 13		-9.91**	2.55**	3.56**	-3.82**	0.53
Giza 96 x Pima S ₇		0.13	5.22**	-0.65**	-0.75**	1.43*
Giza 96 x Pima S ₆		7.28**	3.37**	0.48**	4.55**	0.93
LSD	0.05	0.52	1.40	0.36	0.29	1.25
	0.01	0.68	1.82	0.47	0.38	1.63

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

Line x tester analysis for yield components and fiber properties

Table 4. Heterosis relative to the better-parents (BP) for yield, yield components and fiber properties.

Crosses	NB/P	SCY/P	LCY/P	L.%	BW	SI.	
Giza 90 x Karshenky	60.34**	80.77**	75.49**	-4.17**	6.65**	0.94*	
Giza 90 x Suvin	-5.40	-12.94	-14.19*	-1.58	-8.11**	-5.15**	
Giza 90 x Australy 13	17.70**	31.24*	28.41**	-1.88	5.85**	3.13**	
Giza 90 x Pima S ₇	5.71	3.05	4.37	-1.22	-2.14**	7.50**	
Giza 90 x Pima S ₆	22.06**	44.76**	45.95**	0.30	8.47**	1.56**	
Giza 95 x Karshenky	21.59**	47.96**	46.38**	-1.20	20.85**	5.18**	
Giza 95 x Suvin	8.23	17.62	14.85**	-2.57**	8.11**	3.64**	
Giza 95 x Australy 13	76.73**	87.98**	87.39**	-0.41	6.84**	4.69**	
Giza 95 x Pima S ₇	72.94**	81.06**	87.58**	1.01	4.66**	13.42**	
Giza 95 x Pima S ₆	25.95**	41.53**	38.78**	-2.45**	22.77**	12.70**	
Giza 86 x Karshenky	35.19**	38.64**	45.05**	4.33**	2.69**	-5.00**	
Giza 86 x Suvin	2.74	1.89	2.08	0.15	-2.50**	-8.48**	
Giza 86 x Australy 13	33.40**	52.55**	51.36**	-0.94	3.07**	-0.94*	
Giza 86 x Pima S ₇	35.74**	39.15**	35.25**	-4.03**	1.73**	8.12**	
Giza 86 x Pima S ₆	53.67**	49.75**	49.11**	-1.55	-2.88**	-5.00**	
Giza 94 x Karshenky	0.11	2.71	2.52	-0.36	1.69**	-15.45**	
Giza 94 x Suvin	14.74**	7.83	4.98	-3.47**	-7.72**	-13.20**	
Giza 94 x Australy 13	4.79	22.02	17.98**	-5.50**	14.77**	-4.49**	
Giza 94 x Pima S ₇	4.74	17.67	16.50**	-1.19	2.52**	-5.06**	
Giza 94 x Pima S ₆	-2.47	13.40	6.63	-6.00**	14.98**	-12.36**	
Giza 92 x Karshenky	-31.81**	-28.11	-28.94**	-3.42**	5.27**	5.86**	
Giza 92 x Suvin	12.00**	5.85	-0.84	-6.83**	-8.29**	-0.61	
Giza 92 x Australy 13	16.25**	11.16	15.02**	-5.99**	-4.14**	0.00	
Giza 92 x Pima S ₇	13.32**	4.61	5.44	-3.12**	-7.91**	3.70**	
Giza 92 x Pima S ₆	-29.03**	-32.21*	-27.37**	-0.62	-5.08**	3.70**	
Giza 96 x Karshenky	-25.09**	-43.32**	-43.32**	-0.03	-24.41**	-13.85**	
Giza 96 x Suvin	19.07**	5.48	-3.03	-10.38**	-10.77**	0.61	
Giza 96 x Australy 13	-4.48	-20.01	-22.64**	-5.99**	-16.16**	-3.38**	
Giza 96 x Pima S ₇	-27.46**	-37.76*	-38.84**	-1.54	-14.48**	-0.92*	
Giza 96 x Pima S ₆	-12.65**	-26.50	-27.12**	-1.51	-15.49**	-0.62	
LSD	0.05	8.74	29.39	11.31	1.79	0.36	0.90
	0.01	11.42	38.39	14.77	2.34	0.47	1.17

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

Table 4. Cont.

Genotypes		LI	UHM	FS	MIC	UI
Giza 90 x Karshenky		-5.77**	4.59**	-4.75**	-2.29**	0.39
Giza 90 x Suvin		-7.58**	-1.39	-8.86**	13.74**	-0.96
Giza 90 x Australy 13		-0.04	1.21	-5.70**	5.38**	-2.36**
Giza 90 x Pima S ₇		5.34**	7.27**	-2.85**	4.58**	0.04
Giza 90 x Pima S ₆		2.56**	2.11**	-0.95**	11.45**	0.08
Giza 95 x Karshenky		3.50**	3.16**	1.69**	1.45**	2.10**
Giza 95 x Suvin		-0.78**	6.17**	2.27**	3.79**	0.04
Giza 95 x Australy 13		3.94**	6.06**	3.31**	3.85**	1.61*
Giza 95 x Pima S ₇		17.31**	10.11**	1.67**	-0.75**	1.34
Giza 95 x Pima S ₆		8.51**	4.32**	-0.66**	-0.76**	0.35
Giza 86 x Karshenky		1.90**	-4.25**	-3.90**	15.87**	-0.98
Giza 86 x Suvin		-8.25**	-5.93**	-7.12**	14.29**	-2.28**
Giza 86 x Australy 13		-2.58**	4.15**	-2.92**	16.67**	-0.43
Giza 86 x Pima S ₇		1.11**	0.59	-0.65**	6.35**	0.04
Giza 86 x Pima S ₆		-5.76**	2.47**	-1.30**	7.14**	0.47
Giza 94 x Karshenky		-19.25**	-2.33**	-4.13**	11.67**	-0.89
Giza 94 x Suvin		-15.78**	-0.58	-1.27**	7.50**	-0.77
Giza 94 x Australy 13		-10.05**	0.68	-1.90**	14.17**	0.08
Giza 94 x Pima S ₇		-6.95**	2.43**	0.63**	10.83**	0.43
Giza 94 x Pima S ₆		-20.81**	2.04*	0.63**	3.33**	0.23
Giza 92 x Karshenky		4.92**	0.87	-3.44**	3.20**	2.07**
Giza 92 x Suvin		-11.43**	0.68	-2.81**	3.20**	-0.89
Giza 92 x Australy 13		-8.49**	1.07	-1.87**	0.00	0.67
Giza 92 x Pima S ₇		1.99**	1.26	-0.62**	-1.60**	1.02
Giza 92 x Pima S ₆		15.75**	3.59**	-2.81**	-1.60**	0.86
Giza 96 x Karshenky		-13.83**	-3.80**	-1.90**	-3.79**	-1.00
Giza 96 x Suvin		-15.60**	0.67	-0.32	-1.52**	-0.27
Giza 96 x Australy 13		-11.30**	-0.48	1.27**	-3.08**	-0.42
Giza 96 x Pima S ₇		-3.55**	-0.38	-3.16**	0.00	0.27
Giza 96 x Pima S ₆		-1.76**	0.57	-1.27**	4.55**	0.42
LSD	0.05	0.60	1.61	0.41	0.34	1.44
	0.01	0.78	2.11	0.54	0.44	1.88

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

Line x tester analysis for yield components and fiber properties

Regarding to boll weight the results of heterosis versus mid-parent revealed that nineteen crosses out of 30 F_1 exhibited highly significant and positive heterosis, which ranged from 1.90% for Giza 92 x Australy13 to 21.11% for Giza 94 x Pima S_6 , whereas, heterosis relative to better-parent showed that sixteen crosses had positive and significant heterosis, which ranged from 1.69% for Giza 94 x Karshenky to 22.77% for Giza 95 x Pima S_6 .

Concerning seed index the results of heterosis versus mid-parent revealed that 18 of 30 crosses were exhibited highly significant positive heterosis which ranged from 1.05% for Giza 94 x Pima S_7 to 19.93% for Giza 95 x Pima S_6 , whereas, heterosis versus better-parent showed that thirteen crosses were positive and significant which ranged from 0.94% for Giza 90 x Karshenky to 13.42% for Giza 95 x Pima S_7 . For lint index the results of heterosis versus mid-parent revealed that 16 crosses out of 30 F_1 crosses were found to be significant and positive heterosis which ranged from 1.48% for Giza 94 x Pima S_7 to 20.01% for Giza 92 x Pima S_6 , but for heterosis versus better-parent showed that 10 out of 30 crosses were significantly positive and the largest amount of heterosis were found for Giza 92 x Pima S_6 and Giza 95 x Pima S_7 with amounts of 15.75% and 17.31% respectively.

Regarding to upper half mean the results of heterosis versus mid-parent revealed that 24 crosses out of 30 F_1 crosses were found to be significant and positive heterosis which ranged from 1.93% for Giza 90 x Australy13 to 10.93% for Giza 95 x Pima S_7 , whereas, heterosis versus better-parent showed that 13 crosses out of 30 F_1 crosses were found to be significant and positive heterosis

which ranged from 2.04% for Giza 94 x Pima S_6 to 10.11% for Giza 95 x Pima S_7 .

Concerning fiber strength the results of heterosis versus mid-parent revealed that 15 of 30 crosses were exhibited highly significant positive heterosis which ranged from 0.48% for Giza 96 x Pima S_6 to 5.16% for Giza 95 x Suvin, whereas, heterosis versus better-parent showed that seven crosses were exhibited significant positive heterosis which ranged from 0.63% for Giza 94 x Pima S_6 to 3.31% for Giza 95 x Australy13. Regarding to micronaire reading the results of heterosis versus mid-parent revealed that 13 of 30 crosses were exhibited highly significant negative direction which is a desirable direction for the trait which ranged from -0.37% for Giza 95 x Australy13 to -5.93% for Giza 96 x Karshenky, whereas, heterosis versus better-parent showed that eight crosses were negative and significant which ranged from -0.76% for Giza 95 x Pima S_6 to -3.79% for Giza 96 x Karshenky. For uniformity index the results of heterosis versus mid-parent revealed that 10 out of 30 crosses were exhibited significant positive heterosis which ranged from 1.39% for Giza 94 x Pima S_7 to 2.66% for Giza 92 x Karshenky, whereas, heterosis versus better-parent showed that Giza 95 x Karshenky, Giza 95 x Australy13 and Giza 92 x Karshenky were exhibited significant positive heterosis with values of 2.10%, 1.61 and 2.07 respectively. El-Disouqi and Ziena (2001) reported that, heterosis versus mid-parents exhibited negative significant for seed index in the cross Giza 45 x Karshenky. They added that, the heterosis relative to better-parent was negative and significant for yield and yield components traits, except boll weight in the cross Giza 45 x Karshenky.

Combining ability

The estimates of general combining ability and specific combining ability are presented in Table (5) and Table (6). The results revealed that the line Giza 95 was significant and positive desirable for all yield traits studied. Giza 86 had significant and positive desirable GCA effects for lint percentage. Giza 94 had significant and positive desirable GCA effects for fiber strength. Giza 92 had significant and positive desirable GCA effects for seed index and fiber strength and negative desirable for micronaire reading, Giza 96 had significant and positive desirable GCA effects for fiber strength and negative desirable for micronaire reading. In this respect, the results of testers showed that Suvin had significant and positive desirable GCA effects for No. of bolls/plant. Australy13 had significant and positive desirable for No. of bolls/plant, seed cotton yield/plant and lint cotton yield/plant. Pima S₇ showed significant and positive desirable GCA effects for seed index and lint index.

The results of specific combining ability effects for crosses Giza 90 x Karshenky, Giza 95 x Pima S₇, Giza 92 x Karshenky and Giza 96 x Suvin were significant desirable SCA effects for some yield traits, while, the other crosses showed non significant but desirable SCA effects for some fiber traits. Abdel-Hafez *et al* (2007) reported significant and positive general combining ability effects for both lint percentage and seed index, the crosses Giza 86 x Karshneseki-2 and Giza 45 x Karshneseki-2 exhibited highly significant specific combining ability effects for yield and yield components, respectively.

Proportional contribution

Relative percentages of contribution of lines, testers and lines x testers interaction are shown in Table (7). The results showed that lines contribution was higher than testers contribution for

all traits studied except No. of bolls/plant. However proportion contribution of lines x tester interaction was higher than of lines and testers for most traits studied. Al-Hibbiny (2011) found that proportion contribution of lines x tester interaction was higher than of lines and testers for all studied characters, except lint percentage. Lines contribution was higher than testers contribution for most studied traits.

Genetic parameters

Knowledge of gene action helps in the selection of parents for using in the hybridization programs and also in the choice of appropriate breeding procedure for the genetic improvement of various quantitative characters. Hence, insight into the nature of gene action involved in the expression of various quantitative characters is essential to a plant breeder for starting a judicious breeding program. The genetic variance component and dominance degree ratio were calculated for all traits studied are presented in Table (8). The results indicated that the non-additive of genetic parameters were larger than additive genetic variance with respect to all studied traits.

These results indicated that non-additive effects play a major role in the expression of these traits, while additive effects had a minor role. This indicated that the hybridization program would be effective in improvement of most studied traits. The importance of non-additive genetic variances was verified by the average degree of dominance which is more than one for all traits. This indicated that the overdominance played an important role of the dominance component. Basal *et al*, (2009) cleared that the predominance of non-additive gene action was found for all traits, except for the upper half mean fiber length (UHM) and fiber strength, which were controlled by an additive type gene action due to the high GCA variance.

Line x tester analysis for yield components and fiber properties

Table 5. Estimates of general combining ability effects of the parental genotypes for yield, yield components and fiber traits.

Parents		NB/P	SCY/P	LCY/P	L. %	BW	SI.
Lines :							
Giza 90		-2.05	-7.54	-2.632	0.379	-0.013	0.068
Giza 95		4.42**	19.54**	8.364**	0.624*	0.144*	0.521**
Giza 86		1.41	6.28	3.145	0.769**	0.046	-0.346*
Giza 94		-0.29	-1.06	-0.443	-0.168	-0.006	-0.166
Giza 92		-2.07	-9.08	-4.519*	-1.051**	-0.045	0.281*
Giza 96		-1.42	-8.14	-3.915*	-0.553	-0.126*	-0.359*
LSD	0.05	2.76	9.30	3.58	0.57	0.11	0.28
	0.01	3.61	12.14	4.67	0.74	0.15	0.37
Testers :							
Karshenky		-3.22*	-10.41*	-3.946*	0.044	0.027	-0.410
Suvin		2.53*	6.63	2.375	-0.111	-0.066	-0.132
Australy 13		2.59*	9.12*	3.860*	0.242	0.017	0.057
Pima S ₇		1.06	4.09	1.360	-0.210	0.000	0.507**
Pima S ₆		-2.96*	-9.44*	-3.649*	0.035	0.022	-0.021
LSD	0.05	2.52	8.49	3.27	0.52	0.10	0.26
	0.01	3.30	11.08	4.27	0.68	0.14	0.34

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

Table 5. Cont.

Parents		LI	UHM	FS	MIC	UI
Lines :						
Giza 90		0.162	-0.501	-0.196**	0.182**	-0.093
Giza 95		0.524**	0.299	0.004	0.042	0.160
Giza 86		-0.003	-0.848**	-0.296**	0.242**	-0.907**
Giza 94		-0.195*	0.106	0.131*	-0.084	0.127
Giza 92		-0.116	0.499	0.178**	-0.271**	0.333
Giza 96		-0.372**	0.446	0.178**	-0.111*	0.380
LSD	0.05	0.19	0.51	0.13	0.11	0.45
	0.01	0.25	0.67	0.17	0.14	0.59
Testers :						
Karshenky		-0.286**	-0.687**	-0.137*	0.002	-0.067
Suvin		-0.109	-0.320	-0.087	0.080	-0.106
Australy 13		0.120	0.241	0.047	0.019	-0.350
Pima S ₇		0.267**	0.324	0.086	-0.064	0.167
Pima S ₆		0.008	0.441	0.091	-0.037	0.356
LSD	0.05	0.17	0.47	0.12	0.10	0.42
	0.01	0.23	0.61	0.16	0.13	0.54

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

Table 6. Estimates of specific combining ability effects of the 30 F₁ crosses for yield, yield components and fiber traits.

Crosses	NB/P	SCY/P	LCY/P	L.%	BW	SI.	
Giza 90 x Karshenky	7.56*	28.349**	9.419*	-1.400*	0.071	0.277	
Giza 90 x Suvin	-2.40	-13.676	-4.542	0.637	-0.190	-0.334	
Giza 90 x Australy 13	-2.26	-6.056	-2.254	0.251	0.054	0.043	
Giza 90 x Pima S ₇	-3.04	-12.589	-4.754	0.008	-0.069	0.060	
Giza 90 x Pima S ₆	0.14	3.972	2.130	0.505	0.135	-0.046	
Giza 95 x Karshenky	-3.70	-8.366	-3.977	-0.445	0.173	-0.110	
Giza 95 x Suvin	-4.92	-10.581	-4.064	-0.006	0.212	0.179	
Giza 95 x Australy 13	5.09	8.395	4.051	0.597	-0.270*	-0.243	
Giza 95 x Pima S ₇	6.53*	24.295**	10.297*	0.675	0.007	-0.027	
Giza 95 x Pima S ₆	-3.00	-13.744	-6.306	-0.821	-0.122	0.201	
Giza 86 x Karshenky	0.66	3.461	2.608	1.215	0.052	0.057	
Giza 86 x Suvin	-3.51	-12.854	-3.893	0.937	-0.036	-0.288	
Giza 86 x Australy 13	-2.05	-4.278	-1.298	0.239	0.075	0.023	
Giza 86 x Pima S ₇	0.66	3.189	-0.864	-1.779**	0.045	0.540	
Giza 86 x Pima S ₆	4.24	10.483	3.445	-0.612	-0.137	-0.332	
Giza 94 x Karshenky	1.71	-0.973	0.308	0.836	-0.249*	-0.223	
Giza 94 x Suvin	1.66	0.346	0.842	0.427	-0.184	-0.234	
Giza 94 x Australy 13	-2.81	-3.945	-2.276	-0.654	0.174	0.610	
Giza 94 x Pima S ₇	-1.30	-2.645	-0.276	0.764	0.084	0.093	
Giza 94 x Pima S ₆	0.74	7.216	1.401	-1.373*	0.175	-0.246	
Giza 92 x Karshenky	-4.81	-9.779	-4.528	-1.221	0.303*	0.730*	
Giza 92 x Suvin	2.65	6.839	2.618	-0.038	-0.085	-0.048	
Giza 92 x Australy 13	2.87	9.615	3.566	0.033	-0.021	-0.370	
Giza 92 x Pima S ₇	3.58	8.149	2.600	-0.348	-0.137	-0.420	
Giza 92 x Pima S ₆	-4.29	-14.824	-4.257	1.574*	-0.060	0.108	
Giza 96 x Karshenky	-1.42	-12.693	-3.831	1.016	-0.349**	-0.730*	
Giza 96 x Suvin	6.51*	29.926**	9.038*	-1.958**	0.283*	0.726*	
Giza 96 x Australy 13	-0.84	-3.731	-1.789	-0.465	-0.013	-0.063	
Giza 96 x Pima S ₇	-6.42*	-20.398	-7.003	0.680	0.071	-0.247	
Giza 96 x Pima S ₆	2.18	6.896	3.586	0.727	0.008	0.314	
LSD	0.05	6.18	20.78	8.00	1.27	0.25	0.63
	0.01	8.07	27.15	10.45	1.66	0.33	0.83

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

Line x tester analysis for yield components and fiber properties

Table 6. Cont.

Genotypes		LI	UHM	FS	MIC	UI
Giza 90 x Karshenky		-0.180	1.007	0.123	-0.382**	0.827
Giza 90 x Suvin		-0.042	-0.527	-0.360*	0.240*	-0.001
Giza 90 x Australy 13		0.093	-0.721	-0.160	-0.099	-1.257*
Giza 90 x Pima S ₇		0.031	0.696	0.101	-0.016	0.293
Giza 90 x Pima S ₆		0.098	-0.454	0.296*	0.257*	0.138
Giza 95 x Karshenky		-0.169	-0.260	-0.077	0.158	0.107
Giza 95 x Suvin		0.095	1.207*	0.373*	-0.020	0.612
Giza 95 x Australy 13		0.015	0.079	0.107	-0.026	0.457
Giza 95 x Pima S ₇		0.191	-0.504	-0.166	-0.009	-0.627
Giza 95 x Pima S ₆		-0.132	-0.521	-0.238	-0.103	-0.549
Giza 86 x Karshenky		0.423*	-0.547	0.057	0.158	-0.560
Giza 86 x Suvin		0.074	-1.480*	-0.293*	0.013	-0.321
Giza 86 x Australy 13		0.076	1.359*	-0.027	0.174	0.190
Giza 86 x Pima S ₇		-0.183	0.076	0.168	-0.176	0.073
Giza 86 x Pima S ₆		-0.390	0.592	0.096	-0.170	0.618
Giza 94 x Karshenky		-0.074	-0.267	-0.170	0.084	-0.627
Giza 94 x Suvin		0.015	-0.033	0.080	-0.160	-0.054
Giza 94 x Australy 13		0.228	-0.161	-0.120	0.168	0.490
Giza 94 x Pima S ₇		0.320	0.356	0.108	0.118	0.273
Giza 94 x Pima S ₆		-0.489*	0.106	0.102	-0.210	-0.082
Giza 92 x Karshenky		0.141	0.473	0.017	0.104	0.900
Giza 92 x Suvin		-0.046	0.040	0.033	0.027	-0.361
Giza 92 x Australy 13		-0.233	-0.388	0.000	-0.046	-0.017
Giza 92 x Pima S ₇		-0.375	-0.404	0.094	-0.029	-0.233
Giza 92 x Pima S ₆		0.514*	0.279	-0.144	-0.057	-0.289
Giza 96 x Karshenky		-0.142	-0.407	0.050	-0.122	-0.647
Giza 96 x Suvin		-0.096	0.793	0.167	-0.100	0.126
Giza 96 x Australy 13		-0.178	-0.168	0.200	-0.172	0.137
Giza 96 x Pima S ₇		0.017	-0.218	-0.306*	0.111	0.220
Giza 96 x Pima S ₆		0.400	-0.001	-0.111	0.283*	0.164
LSD	0.05	0.42	1.14	0.29	0.24	1.02
	0.01	0.55	1.49	0.38	0.31	1.33

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

Table 7. Proportional contributions of lines, testers and their interaction for yield, yield components and fiber traits.

Traits	Lines	Testers	Lines x Testers
No. of bolls/plant	20.97	26.12	52.90
Seed cotton yield/plant	31.81	20.76	47.42
Lint cotton yield/plant	40.15	20.13	39.71
Lint percentage	33.90	1.87	64.23
Boll weight	20.68	3.49	75.83
Seed index	33.96	28.81	37.23
Lint index	47.62	20.90	31.48
Fiber length	31.42	23.15	45.43
Fiber strength	46.64	11.95	41.41
Fiber fineness	54.19	4.27	41.54
Uniformity index	39.68	12.34	47.98

Table 8. The partitioning of the genetic variance for yield, yield components and fiber traits.

Genetic parameters And heritability	NB/P	SCY/P	LCY/P	L. %	BW	SI.	LI	UHM	FS	MIC	UR
GCA	0.40	6.99	1.47	0.01	0.00	0.01	0.01	0.02	0.002	0.002	0.01
SCA	10.29	121.53	13.69	0.79	0.02	0.07	0.03	0.21	0.02	0.02	0.07
σ^2A	0.80	13.98	2.94	0.02	0.00	0.02	0.02	0.04	0.004	0.004	0.02
σ^2D	10.29	121.53	13.69	0.79	0.02	0.07	0.03	0.21	0.02	0.02	0.07
$(\sigma^2D./\sigma A)^{1/2}$	3.59	2.95	2.16	6.28	0.00	1.87	1.22	2.29	2.24	2.24	1.87
$\sigma^2G.$	11.09	135.51	16.63	0.81	0.02	0.09	0.05	0.25	0.024	0.024	0.09
$\sigma^2E.$	21.03	247.96	33.28	1.23	0.04	0.19	0.10	0.59	0.044	0.034	0.36
σ^2Ph	32.12	383.47	49.91	2.04	0.06	0.28	0.15	0.84	0.07	0.06	0.45
H^2_b	58.44	59.72	53.59	71.70	62.20	48.19	51.70	46.40	59.16	65.77	27.55
H^2_n	1.13	1.67	2.73	0.26	0.00	3.20	4.37	1.97	2.43	2.37	1.76

Heritability

The results of heritability in broad and narrow senses are illustrated in Table (8). The results revealed that broad sense heritability ($h^2_b\%$) estimates were larger than the corresponding values of narrow sense heritability ($h^2_n\%$) for all studied traits. The highest broad sense heritability estimates was observed in case of lint percentage with values of 71.70% and the lowest was for uniformity index with value of 27.55%, while for narrow sense heritability, it was ranged from zero to 4.37% for boll weight and lint index, respectively. Al-Hibbiny (2004) noticed that heritability value in broad sense was 90% and 83% for boll weight and seed index respectively. Said (2005) found that the relative high values of heritability in broad sense (over 50%) were noticed for boll weight and lint percentage in three crosses, seed index in crosses I and III. High heritability estimates in narrow sense were found for boll weight, lint percentage and seed index in crosses I and III.

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تحليل السلالة X الكشاف لبعض صفات المحصول والجودة في بعض هجن أقطان الباربادنس

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المُلخَص العربي

أجريت هذه الدراسة في محطة البحوث الزراعية بسخا - معهد بحوث القطن - مركز البحوث الزراعية - مصر خلال موسمي الزراعة 2017 و 2018 وتهدف هذه الدراسة الي تقدير قوة الهجين والقدرة علي التألف ونسبة المساهمة ومكونات التباين الوراثي ودرجة التورث لبعض الصفات لستة أصناف مصرية من القطن كسلالات وهي جيزة 90، جيزة 95، جيزة 86، جيزة 94، جيزة 92، جيزة 96 وخمسة تراكيب وراثية ككشافات وهي كارشنكي وسيوفين واسترالي 13 وببما س6 وببما س7 باستخدام طريقة تحليل السلالة X الكشاف. وفي موسم 2018 .

تم تقييم إحدي وأربعون تركيب وراثي (إحدي عشر صنفاً وثلاثون هجين للجيل الأول) في تجربة قطاعات كاملة عشوائية في ثلاث مكررات.

وكانت اهم النتائج المتحصل عليها مايلي:

أشارت نتائج تحليل التباين لكل من التراكيب الوراثية والأباء والهجن والاباء X الهجن وجود فروق معنوية لكل الصفات المدروسة ماعدا صفة عدد النوز/النبات بالنسبة للاباء وصفة معدل الحليج بالنسبة للهجن وصفة متانة التيلة بالنسبة للهجن والاباء X الهجن.

أشارت دراسة قوة الهجين الي وجود قوة هجين مفيدة محسوبة بالنسبة لمتوسطات الابوين وأفضل الأباء وذلك لمعظم الصفات المدروسة، وقد أظهرت الهجن جيزة 95 X كارشنكي وجيزة 95 X استرالي 13 وجيزة 95 X ببما س7 أعلى قيم لقوة الهجين بالنسبة لمتوسط الابوين وأفضل الأباء لمعظم الصفات المدروسة. بينما أظهر الهجينين جيزة 90 X استرالي 13 وجيزة 86 X كارشنكي أعلى قيم لقوة الهجين بالنسبة لمتوسط الابوين لكل الصفات المحصولية المدروسة. كذلك أظهرت الهجن جيزة 92 X كارشنكي وجيزة 92 X استرالي 13 وجيزة 92 X ببما س7 وجيزة 96 X سيوفين وجيزة 96 X ببما س7 أعلى قيم لقوة الهجين بالنسبة لأفضل الأباء لمعظم صفات التيلة.

أظهر الصنف جيزة 95 (كسلالة) أفضل قدرة عامة علي التألف لكل الصفات المحصولية المدروسة بينما أظهر الصنف جيزة 92 (كسلالة) أفضل قدرة عامة علي التألف لصفات معامل البذرة ومتانة التيلة وقراءة الميكرونيير كما أظهر الصنف جيزة 96 (كسلالة) أفضل قدرة عامة علي التألف لصفتي متانة التيلة وقراءة الميكرونيير. كذلك أظهر الصنف استرالي 13 (ككشاف) أفضل قدرة عامة علي التألف لصفات عدد اللوز علي النبات ومحصول القطن الزهر ومحصول القطن الشعر.

أظهرت الهجن جيزة 90 X كارشنكي وجيزة 95 X ببما س7 وجيزة 92 X كارشنكي وجيزة 96 X ببما س7 أعلى قدرة خاصة علي التألف لبعض الصفات المحصولية.

Line x tester analysis for yield components and fiber properties

أظهر تقدير نسبة المساهمة الي أن مساهمة تفاعل السلالة x الكشاف أعلي من مساهمة كل من السلالات و الكشافات لمعظم الصفات المدروسة.

كانت قيم المكونات الوراثية تدل علي أن التباين الراجع للسيادة كان أعلي من التباين الإضافي لكل الصفات المدروسة. قيم درجة التوريث بالمعني الواسع كانت أعلي من قيم درجة التوريث بالمعني الضيق لكل الصفات المدروسة وكانت أعلي قيمة لدرجة التوريث بالمعني الواسع لصفة معدل الحليج (71.70%) بينما كانت أقل قيمة لصفة درجة الانتظام (27.55%). كانت درجة التوريث بالمعني الضيق تتراوح بين صفر لصفة وزن اللوزة و4.37% لصفة معامل الشعر.

عموما فانه يوصي باستخدام الصنف جيزة 95 والصنف استرالي 13 في برامج التربية لتحسين وزيادة القدرة الإنتاجية للأصناف الجديدة بينما يمكننا اعتبار الصنفين جيزة 92 وجيزة 96 كأباء متفوقة في برامج التربية للحصول علي أصناف جديدة عالية الجودة.

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