MENOUFIA JOURNAL OF PLANT PRODUCTION

https://mjppf.journals.ekb.eg/

ESTIMATION OF COMBINING ABILITY, HETEROSIS, AND HERITABILITY FOR SOME YIELD, YIELD COMPONENTS AND FIBER QUALITY TRAITS IN COTTONS (*Gossypium barbadense* L.)

M. F. Hamed; A. E. I. Darwesh; F. E. Elfeki; Badeaa A. Mahmoud and Rania M. Abd El - Twab

Cotton Research Institute, Agricultural Research Center, Giza, Egypt

Received: May 29 , 2024 Accepted: Aug. 15 , 2024

ABSTRACT: The present studied carried out at Sakha Agricultural Research Station, Cotton Research Institute, Agricultural Research Center, Egypt, during 2022 and 2023 growing summer, during 2022 growing season, six cotton varieties of cotton belong to (*Gossypium barbadense* L.) were sowing and crossed in a half diallel mating design produce 15 F_1 hybrids. The F_1 hybrids and parents growing in 2023 season at randomized complete blocks design with three replications. The results showed that the squares of the genotypes, parents as well as crosses were highly significant for all traits studied with boll weight trait parents. The parental genotypes Giza 88 and Giza 92 gave significant (desirable) GCA effects for most fiber properties. Karshenky and Australy 13 showed GCA positive significant effects of most yield traits, this direction is desirable. Both of Giza 88 x Giza 86 and Australy 13 x Karshenky crosses recorded significant (desirable) SCA effects for most yield and fiber properties. Desirable relative to mid- and better-parent for some yield traits were found for the crosses, Giza 88 x Giza 86 and Australy 13 x Karshenky while, the crosses Giza 92 x Pima S_7 and Giza 92 x Karshenky indicated desirable for some studied fiber properties. Non-additive genetic variances were larger than the additive genetic variance with respect to all traits studied. The broad sense heritability of seed cotton yield per plant was the highest value (93.91%) while the lowest value was recorded to boll weight (50.51%). Generally, Karshenky and Australy 13 could be used in breeding programs for improving high yielding varieties, while Giza 88 and Giza 92 could be considered as excellent parents for breeding programs to produce new varieties characterized with best fiber properties.

Keywords: Cotton, half diallel analysis, combining ability, Heterosis, Heritability, Gene action and fiber quality.

INTRODUCTION

The improvement productivity primarily depends upon genetic variation yield related traits. So, the choice of suitable selection method is very important to increase heterosis as well as combining ability of the genotypes for traits consideration (Shafique *et al.*, 2023). The program dependent majorly on the selection of parents (Babar *et al.*, 2022). Choose competent parents lead to a successful breeding program and then, selection of the best hybrid crosses (Riaz *et al.*, 2023). On the other side, plant breeders have extensively used diallel analysis to identify parental varieties and hybrid crosses in the initial generations (Bhutta *et al.*, 2023). It provides an efficient and organized method for identifying suitable parental genotypes and hybrid combinations, allowing the farmer to select genotypes of interest (Fatima *et al.*, 2022).

Knowledge linked to different forms of gene action, heterotic effects and estimation of combining ability can aid in shaping the genetic constitution of cotton crop (Ali *et al.*, 2014, Abbas *et al.*, 2015, Abbas *et al.*, 2016, Zafar *et al.*, 2022 and Babar *et al.*, 2023). Whereas, the widely used to improve important traits in various crops. It has also been proposed as a method for starting cotton hybrids (Chaudhry *et al.*, 2022). Many hybrids with superior performance have been developed as a result of heterosis (Riaz *et al.*, 2023). Positive and negative heterosis benefit yield contributing traits (Nadeem *et al.*, 2022). in the yield and yield components heterosis occurs when F_1 is superior, whereas negative heterosis occurs when F_1 is inferior. Similar results were agreed with (Hafeez *et*

*Corresponding author: mf0250711@gmail.com

al., 2021, Chaudhry *et al.,* 2022, Hassan *et al.,* 2022, Fatima *et al.,* 2023 and Iqbal *et al.,* 2023).

Highly significant values and desirable heterosis of mid- and better-parents for most studied characters were achieved by AL-Hibbiny *et al.* (2020) and Mokadem *et al.* (2020). Also, they found high estimates of heritability in broad-sense (>50%) relative to most studied traits. Chapara *et al.* (2020) recorded that the ratio of σ^2 GCA/σ^2 SCA was smaller than zero for traits index. It indicated that predominance of non-additive gene action (dominant or epistasis) in the inheritance of these. Said *et al.* (2021) and Mabrouk *et al.* (2018) found high values of broad-sense heritability for all the studied traits, meanwhile narrow-sense heritability values were low for most studied characters.

The aim of this study is for yield, yield components and fiber properties.

MATERIALS AND METHODS

Six of the varieties belong to (*Gossypium barbadense* L.) were used in the present investigation as showed in Table (1). The selfed seeds of the six cotton varieties were kindly provided by the Cotton Breeding and Cotton Maintenance Departments; Cotton Research Institute, Agricultural Research Center, Giza, Egypt.

In the 2022 growing season, the six parents were planted and mated in half diallel to obtain 15 F_1 single crosses. The parental varieties were also self-pollinated to obtain enough seeds for further investigations.

In 2023 season, a randomized complete block design with three replications was carried out at Sakha Agricultural Research Station at Kafr El-Shiekh Governorate to evaluate 21 genotypes (six parents and their 15 half diallel crosses). Each plot was one row 4.0 m long, the distance between the rows were 0.6 m and plant to plant spacing of 0.4 m to insure 10 plants per row. The plants thinned to keep a constant stand of one plant per hill at seedlings stage. All practices were applied as usually recommended for ordinary cotton fields.

Table 1. Origin, pedigree and category of the six cotton varieties used in the study.

No.	varieties	Origin	Pedigree	Category
P1	Giza 88	Egypt	(Giza 77 x Giza 45) B	Extra long staple
P2	Giza 86	Egypt	Giza 75 x Giza 81	Long staple
P3	Giza 92	Egypt	Giza 84 x (Giza 74 x Giza 68)	Extra long staple
P4	Australy 13	Australia	Unknown	Long staple
P5	Karshenky	Russian	Unknown	Long staple
P6	Pima S_7	U.S.A.	(6614-91-9-3 x 6907-513-509-501)	Long staple

The traits studied were: seed cotton yield per plant (SCY/P), lint cotton yield per plant (LCY/P) in grams, lint percentage (L %), boll weight (BW) in grams and seed index (SI). Also, fiber quality characters such as upper half mean (UHM) (mm), fiber strength (FS), Micronaire reading (Mic) and uniformity index (UI) measured using individual samplers at the Cotton Technology Laboratory, Cotton Research Institute, Agricultural Research Center, Giza, Egypt.

STATISTICAL ANALYSIS

To test the null hypothesis of no differences between various F1 hybrids and their parental means, data of plot means were subjected to a regular statistical analysis of RCBD as outlined by Steel and Torrie (1980). For means separation and comparison after significance, the least significant difference at 5% level of probability (LSD at 5%) was also used.

The GCA effects of parents and SCA effects of F_1 crosses were calculated according to the method described by Griffing (1956) based on method 2, model 1 (fixed model) as also outlined by Singh and Chaudhary (1985).

Average heterosis was calculated as the deviation of the F_1 mean from the mid-parents and expressed in percentages for each F_1 cross, and heterobeltosis was calculated as the deviation of the F_1 mean from the better parent and expressed in percentages. The significance of heterosis was determined using the least significant difference (LSD), as suggested by Steel and Torrie (1980).

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).

RESULTS AND DISCUSSION

Analysis of variance:

Analysis of variance and the mean squares of all traits studied of the six parents and their 15 F_1 crosses calculated and the results presented in Table 2. The cleared mean squares of the genotypes, parents and crosses were significant or highly significant for all traits studied except for boll weight in parents. Meanwhile, mean squares due to parents versus crosses, also, were significant for all traits studied except for seed cotton yield per plant and micronaire reading. Such as these results were obtained by Gohil *et al.* (2017), Sultan (2018), Yehia and El-Hashash (2019), Mokadem *et al.* (2020), Ramdan (2021), Hafez *et al.* (2022) and Rasheed *et al.* (2023).

Combining ability analysis:

The mean squares of combining calculated and the results presented in Tables 2 and 3. The result showed that the general and specific combining ability were highly significant for all studied traits revealed the importance of both additive and non-additive gene action for these traits. These results are in common agreement with the results obtained by many authors among them Sultan (2018), Hafez *et al.* (2022), Subhashini *et al.* (2022), Bhimireddy *et al.* (2023).

Table 2. Mean squares of analysis of variances for genotypes and combining abilities for yield components and fiber quality traits in cotton.

SOV	df	Seed cotton yield/plant	Lint cotton yield/plan	Lint percentage	Boll weight (gm)	Seed index (%)
Replications	2	105.16	31.46	3.12	0.05	0.69
Genotypes	20	3718.32**	652.60**	6.09**	0.08**	0.89**
Parents (P)	5	6433.94**	1109.47**	8.50**	0.04	0.94**
Crosses (C)	14	2993.58**	527.70**	4.98**	0.08**	0.77**
P *VS.* C	1	286.57	116.90**	9.67**	0.22**	2.34*
GCA	5	2428.49**	429.54**	3.43**	0.04**	0.55**
SCA	15	843.09**	146.87**	1.56**	0.02**	0.21**
Error	40	78.72	14.05	0.92	0.02	0.19

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

Table 2. Cont.

SOV	df	Lint index (%)	Micronaire reading	Fiber length (mm)	Fiber strength (gm/tex)	Uniformity index (%)
Replications	2	0.13	0.17	0.77	0.08	0.79
Genotypes	20	0.86**	0.21**	4.25**	0.61**	3.83**
Parents (P)	5	1.17**	0.38**	5.62**	0.49**	6.33**
Crosses (C)	14	0.60**	0.16**	3.72**	0.65**	2.01**
P *VS.* C	1	2.84**	0.03	4.84**	0.63*	16.74**
GCA	5	0.42**	0.13**	2.28**	0.44**	2.09**
SCA	15	0.24**	0.05**	1.13**	0.12**	1.00**
Error	40	0.09	0.03	0.50	0.09	0.78

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

Table 3. Mean squares of analysis of variances of combining abilities for yield components and fiber quality traits in cotton.

SOV	df	Seed cotton yield/plant	Lint cotton yield/plan	Lint percentage	Boll weight (gm)	Seed index (%)
GCA	5	2428.49**	429.54**	3.43**	0.04**	0.55**
SCA	15	843.09**	146.87**	1.56**	0.02**	0.21**
GCA/ SCA	---	2.88	2.92	2.20	2.00	2.62
Error	40					

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

Table 3. Cont.

SOV	df	Lint index	Micronaire reading	Fiber length	Fiber strength	Uniformity index
GCA	5	0.42**	0.13**	2.28**	0.44**	2.09**
SCA	15	0.24**	0.05**	1.13**	0.12**	1.00**
GCA/ SCA	---	1.75	2.60	2.02	3.67	2.09
Error	40					

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

The mean performance of genotypes

The mean performances of the six parents and their 15 F_1 crosses of all traits studied are presented in Table 4. The best mean performances values were recorded by Giza 86 parent for boll weight, seed index and lint index. Australy 13 parent was the best for seed cotton yield per plant, lint cotton yield per plant and lint percentage. While, Giza 88 surpassed for fiber length and uniformity index Giza 92 was the best for micronaire reading and fiber strength treats.

Respecting for the mean performances of 15 F_1 crosses, results revealed that Giza 88 x Giza 86 was the best mean performances for boll weight, seed index, lint index and uniformity index treats. Meanwhile, Giza 88 x Giza 92 was the best for fiber length treat. On other hand, Giza 86 x Pima S_7 surpassed for fiber strength. The cross Giza 86 x Australy 13 was the best for micronaire reading. Lately, the Crosse Australy 13 x Karshenky was the best crosses for seed cotton yield, lint cotton yield/plant and lint percentage treats.

Combining ability effects

Estimates of general combining ability (GCA) effects are shown in Table 5. Giza 88 parent gave positive significant (desirable) GCA effects for fiber length and uniformity index. Meanwhile, it was negative significant (desirable) GCA effect for micronaire reading. The Giza 86 parent exhibited positive significant (desirable) GCA effects for boll weight, seed index and lint index. The Giza 92 parent showed positive significant (desirable) and negative significant (desirable) GCA effects for fiber strength and micronaire reading, respectively. Both Australy 13 and Karshenky parents were recorded significant and positive (desirable) GCA effects for seed cotton yield/plant, lint cotton yield/plant and lint percentage. Results of the Pima S7 parent revealed significant and positive (desirable) GCA effects for lint index character. These results were in harmony with those obtained by Mahrous (2018), Munir *et al.* (2018), Sultan (2018), Mokadem *et al*. (2020), Gnanasekaran and Thiyagu (2021), Ramdan (2021), Yehia and El-Hashash (2022), Bhimireddy *et al*. (2023) and Rasheed *et al.* (2023).

Table 4. Mean performances of six parents and 15 F_1's crosses for yield components and fiber quality traits in cotton.

Genotypes	Seed cotton yield/plant	Lint cotton yield/plan	Lint percentage	Boll weight (gm)	Seed index (%)
Giza 88	112.03	39.45	35.21	3.03	10.05
Giza 86	150.17	57.43	38.27	3.27	11.39
Giza 92	166.53	57.70	34.66	3.15	10.02
Australy 13	241.13	92.95	38.56	3.07	9.99
Karshenky	207.83	78.69	37.87	2.95	10.02
Pima S_7	148.27	53.36	36.00	3.02	10.59
Giza 88 x Giza 86	186.93	71.63	38.33	3.56	11.53
Giza 88 x Giza 92	124.60	46.91	37.64	3.23	10.73
Giza 88 x Australy 13	153.00	57.11	37.31	3.26	10.23
Giza 88 x Karshenky	234.37	88.81	37.90	3.17	10.00
Giza 88 x Pima S_7	167.40	62.50	37.35	3.30	10.50
Giza 86 x Giza 92	176.50	64.08	36.29	3.40	11.67
Giza 86 x Australy 13	171.80	63.04	36.71	3.19	10.43
Giza 86 x Karshenky	150.23	55.71	37.03	2.85	10.90
Giza 86 x Pima S_7	164.43	64.80	39.39	3.22	10.77
Giza 92 x Australy 13	191.63	70.38	36.67	3.28	10.03
Giza 92 x Karshenky	172.67	60.76	35.25	2.95	10.97
Giza 92 x Pima S_7	167.77	62.33	37.13	3.15	11.30
Australy 13 x Karshenky	248.73	100.22	40.29	3.23	10.57
Australy 13 x pima S_7	148.27	56.37	38.01	3.26	11.23
Karshenky x pima S_7	177.40	69.50	39.15	3.11	10.67
LSD $_{0.05}$	**14.64**	**6.19**	**1.58**	**0.23**	**0.72**
LSD $_{0.01}$	**19.59**	**8.28**	**2.11**	**0.31**	**0.96**

Table 4. Cont.

Genotypes	Lint index (%)	Micronaire reading	Fiber length (mm)	Fiber strength (gm/tex)	Uniformity index (%)
Giza 88	5.47	3.78	35.90	9.94	86.61
Giza 86	7.06	3.98	33.53	9.64	84.94
Giza 92	5.32	3.48	32.27	10.51	83.38
Australy 13	6.27	4.55	32.60	9.37	82.74
Karshenky	6.11	4.08	33.27	9.51	84.11
Pima S_7	5.96	3.88	32.30	9.77	83.01
Giza 88 x Giza 86	7.17	3.88	35.37	9.78	87.03
Giza 88 x Giza 92	6.48	3.98	36.13	10.62	86.20
Giza 88 x Australy 13	6.09	3.92	32.40	9.85	84.57
Giza 88 x Karshenky	6.08	3.95	33.37	9.48	84.40
Giza 88 x Pima S_7	6.26	3.82	34.47	10.45	85.23
Giza 86 x Giza 92	6.65	4.22	33.73	10.42	85.07
Giza 86 x Australy 13	6.06	3.75	34.03	9.85	84.80
Giza 86 x Karshenky	6.39	4.02	32.90	9.38	85.47
Giza 86 x Pima S_7	6.99	3.95	34.20	10.72	84.43
Giza 92 x Australy 13	5.80	3.78	32.30	10.68	84.93
Giza 92 x Karshenky	5.98	3.95	35.27	9.68	86.50
Giza 92 x Pima S_7	6.67	3.88	34.77	10.25	85.77
Australy 13 x Karshenky	7.13	4.62	33.43	9.85	85.47
Australy 13 x pima S_7	6.89	4.35	33.27	9.48	84.17
Karshenky x pima S_7	6.87	4.12	33.23	9.68	85.07
LSD $_{0.05}$	**0.49**	**0.29**	**1.17**	**0.50**	**1.46**
LSD $_{0.01}$	**0.66**	**0.39**	**1.56**	**0.67**	**1.95**

Table 5. General combining ability effects of parental genotypes for yield components and fiber quality traits in cotton.

Genotypes	Seed cotton yield/plant	Lint cotton yield/plan	Lint percentage	Boll weight (gm)	Seed index (%)
Giza 88	-16.28**	-6.50**	-0.34	0.04	-0.18*
Giza 86	-8.79**	-2.97**	0.33	0.07**	0.44**
Giza 92	-6.79**	-4.76**	-1.17**	0.01	0.03
Australy 13	21.89**	9.39**	0.55**	0.02	-0.26**
Karshenky	22.31**	9.31**	0.46**	-0.13**	-0.17*
Pima S_7	-12.35**	-4.46**	0.17	-0.02	0.14
LSD $_{0.05}$	**3.34**	**1.41**	**0.36**	**0.05**	**0.16**
LSD $_{0.01}$	**4.47**	**1.89**	**0.48**	**0.07**	**0.22**

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

Table 5. Cont.

Genotypes	Lint index (%)	Micronaire reading	Fiber length (mm)	Fiber strength (gm/tex)	Uniformity index (%)
Giza 88	-0.19**	-0.11**	0.91**	0.05	0.75**
Giza 86	0.35**	-0.02	0.13	-0.03	0.26
Giza 92	-0.29**	-0.15**	0.06	0.38**	0.07
Australy 13	-0.01	0.19**	-0.70**	-0.15**	-0.65**
Karshenky	0.01	0.10**	-0.19	-0.32**	0.06
Pima S_7	0.13*	-0.01	-0.21	0.06	-0.49**
LSD $_{0.05}$	**0.11**	**0.07**	**0.27**	**0.11**	**0.33**
LSD $_{0.01}$	**0.15**	**0.09**	**0.36**	**0.15**	**0.45**

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

Significant favorable specific combining ability (SCA) effects were observed by some crosses for yield and fiber quality characters in Table 6. The results of seven crosses (Giza 88 x Giza 86, Giza 88 x Karshenky, Giza 88 x Pima S_7, Giza 86 x Giza 92, Giza 86 x Pima S_7, Giza 92 x Pima S_7 and Australy 13 x Karshenky) were positive significant (desirable) for seed cotton yield/plant and lint cotton yield/plant. Meanwhile, SCA effects of six crosses(Giza 88 x Giza 86, Giza 88 x Giza 92, Giza 86 x Pima S_7, Giza 92 x Pima S_7 ,Australy 13 x Karshenky and Karshenky x pima S_7) were positive significant (desirable) for lint percentage character. SCA effects of crosses Giza 88 x Giza 86, Giza 88 x Karshenky, Giza 88 x Pima S_7, Giza 86 x Giza 92, Australy 13 x Karshenky, Australy 13 x pima S_7 and Karshenky x pima S_7 were significant and positive (desirable) for boll weight. SCA effects for crosses i.e. Giza 88 x Giza 86, Giza 88 x Giza 92, Giza 86 x Giza 92, Giza 92 x Karshenky, Giza 92 x Pima S_7 ,Australy 13 x Karshenky and Australy 13 x pima S_7 were significant and positive (desirable) for seed index. SCA effects of crosses Giza 88 x Giza 86, Giza 88 x Giza 92, Giza 86 x Giza 92, Giza 92 x Pima S_7 ,Australy 13 x Karshenky, Australy 13 x pima S_7 and Karshenky x pima S_7 were significant and positive (desirable) for lint index. SCA effects of crosses Giza 86 x Australy 13 and Giza 92 x Australy 13 were significant and negative (desirable) for micronaire reading. SCA effects of Giza 88 x Giza 86, Giza 88 x Giza 92, Giza 86 x Australy 13, Giza 86 x Pima S_7, Giza 92 x Australy 13, Giza 92 x Karshenky, Giza 92 x Pima S_7, Australy 13 x Karshenky and Australy 13 x pima S_7 were significant and positive (desirable) for fiber length. SCA effects of crosses Giza 88 x Giza 92, Giza 88 x Pima S_7, Giza 86 x Pima S_7 and Australy 13 x Karshenky were significant and positive (desirable) for fiber strength, SCA effects of crosses Giza 88 x Giza 86, Giza 92 x Karshenky, Giza 92 x Pima S_7, Australy 13 x Karshenky and Karshenky x pima S_7 were significant and positive (desirable) for uniformity ratio character. The same findings were reported by Samreen *et al.* (2008), Mahrous (2018), Munir *et al.* (2018), Sultan (2018), Solongi *et al*. (2019), Gnanasekaran and Thiyagu (2021), Ramdan (2021), Subhashini *et al*. (2022) and Rasheed *et al.* (2023).

Table 6. Specific combining ability effects of each cross for yield components and fiber quality traits in cotton.

Genotypes	Seed cotton yield/plant	Lint cotton yield/plan	Lint percentage	Boll weight (gm)	Seed index (%)
Giza 88 x Giza 86	37.63**	15.70**	0.96**	0.27**	0.62**
Giza 88 x Giza 92	-26.70**	-7.24**	1.77**	0.00	0.24**
Giza 88 x Australy 13	-26.98**	-11.19**	-0.29	0.02	0.02
Giza 88 x Karshenky	53.96**	20.59**	0.40	0.08*	-0.30*
Giza 88 x Pima S_7	21.65**	8.05**	0.14	0.10*	-0.11
Giza 86 x Giza 92	17.72**	6.39**	-0.25	0.15**	0.55**
Giza 86 x Australy 13	-15.67**	-8.80**	-1.55**	-0.07	-0.40**
Giza 86 x Karshenky	-37.65**	-16.04**	-1.14**	-0.27**	-0.02
Giza 86 x Pima S_7	11.20**	6.82**	1.52**	0.00	-0.46**
Giza 92 x Australy 13	-15.67**	-8.80**	-1.55**	-0.07	-0.40**
Giza 92 x Karshenky	-17.22**	-9.21**	-1.42**	-0.11**	0.47**
Giza 92 x Pima S_7	12.54**	6.13**	0.75**	-0.02	0.49**
Australy 13 x Karshenky	30.16**	16.11**	1.89**	0.17**	0.35**
Australy 13 x pima S_7	-35.65**	-13.97**	-0.10	0.08*	0.70**
Karshenky x pima S_7	-6.93**	-0.77	1.14**	0.08*	0.05
LSD $_{0.05}$	**5.18**	**2.19**	**0.56**	**0.08**	**0.25**
LSD $_{0.01}$	**6.93**	**2.93**	**0.75**	**0.11**	**0.34**

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

Table 6. Cont.

Genotypes	Lint index (%)	Micronaire reading	Fiber length (mm)	Fiber strength (gm/tex)	Uniformity index (%)
Giza 88 x Giza 86	0.65**	0.02	0.57**	-0.19*	1.08**
Giza 88 x Giza 92	0.60**	0.24**	1.41**	0.24**	0.43
Giza 88 x Australy 13	-0.08	-0.16**	-1.56**	0.00	-0.48
Giza 88 x Karshenky	-0.10	-0.04	-1.10**	-0.20*	-1.36**
Giza 88 x Pima S_7	-0.04	-0.06	0.02	0.39**	0.03
Giza 86 x Giza 92	0.22*	0.39**	-0.21*	0.12	-0.21
Giza 86 x Australy 13	-0.65**	-0.41**	0.85**	0.07	0.25
Giza 86 x Karshenky	-0.34**	-0.06	-0.79**	-0.22**	0.20
Giza 86 x Pima S_7	0.14	-0.01	0.53**	0.73**	-0.28
Giza 92 x Australy 13	-0.65**	-0.41**	0.85**	0.07	0.25
Giza 92 x Karshenky	-0.11	0.00	1.65**	-0.33**	1.42**
Giza 92 x Pima S_7	0.47**	0.05	1.17**	-0.14	1.24**
Australy 13 x Karshenky	0.76**	0.32**	0.57**	0.37**	1.11**
Australy 13 x pima S_7	0.40**	0.17**	0.43*	-0.38**	0.36
Karshenky x pima S_7	0.36**	0.03	-0.11	-0.01	0.55*
LSD $_{0.05}$	**0.17**	**0.10**	**0.41**	**0.18**	**0.52**
LSD $_{0.01}$	**0.23**	**0.14**	**0.55**	**0.24**	**0.69**

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

Heterosis

The amounts of heterosis for all traits studied the mid-parents (M.P) and better-parent (B.P) are presented in Tables 7 and 8. Regarding for both the seed cotton yield per plant and lint cotton yield/plant treats, four crosses were positive significant and heterosis relative to mid-parent which ranged from (10.80% for 13 x Karshenky to 42.59% of Giza 88 x Giza 86) and from (11.32% of Giza 86 x Giza 92 to 47.88% of Giza 88 x Giza 86), respectively. Also, four crosses (Giza 88 x Giza 86, Giza 88 x Karshenky, Giza 88 x Pima S_7 and Giza 86 x Pima S_7) showed positive significant and heterosis relative to better-parent with value of 24.48%, 12.77%, 12.90% and 9.50%, respectively. six crosses out of 15 showed significant and positive and heterosis relative to better-parent which ranged from 11.06% of Giza 86 x Giza 92 to 24.73% of Giza 88 x Giza 86. For lint percentage the results showed that five crosses out of 15 crosses were significant and positive desirable heterosis relative to mid-parents which ranged from 4.31% of Giza 88 x Giza 86 to 6.26% of Giza 86 x Pima S_7. two crosses (Giza 88 x Giza 92 and Australy 13 x Karshenky) showed positive significant desirable heterosis relative to better-parent with heterosis of 6.90% and 4.49%, respectively. Regarding for boll weight found crosses (values ranged from 4.19% of Karshenky x Pima S_7 to 13.14% of Giza 88 x Giza 86) and two crosses (heterosis ranged from 8.98% to 9.93%, respectively) were found to be significant and positive desirable heterosis relative to mid-parents and better-parent, respectively. For seed traits the results revealed that five crosses out of 15 crosses were significant and positive desirable heterosis relative to mid-parent which ranged from 7.59% of Giza 88 x Giza 86 to 11.29% of Giza 92 x Pima S_7. with respect to lint index eight crosses were significant and positive desirable heterosis relative to mid-parents which ranged from 7.41% for Giza 86 x Giza 92 to 15.25% of Australy 13 x Karshenky. Meanwhile, five crosses showed significant and positive and heterosis relative to better-parent which ranged from 9.88% of Australy 13 x Pima S_7 to 18.46% of Giza 88 x Giza 92 for the same treat. Regarding for micronaire reading, one cross and two crosses (Giza 86 x Australy 13 and Giza 92 x Australy 13) showed significant and negative desirable heterosis relative to mid-parents (value -6.38%) and better-parent (value of -17.58% and -16.85%) respectively. With respect to fiber length treat, results of six and two crosses were significant and positive and heterosis relative to mid-parent and better-parent respectively, which ranged from (3.47% of Giza 88 x Pima S_7 to 7.81% of Giza 92 x Karshenky) and from (6.01% of Giza 92 x Karshenky and 7.64%, of Giza 92 x Pima S_7) respectively. For fiber traits the results showed that five crosses out of 15 crosses were significant and positive desirable heterosis relative to mid- parents which ranged from 4.70% of Giza 92 x Pima S_7 to 9.80% of Giza 86 x Pima S_7, two crosses showed significant and positive and heterosis relative to better-parent were Giza 88 x Pima S_7 and Giza 86 x Pima S_7 with values of 5.13% and 9.65%, For uniformity traits character, 6 out of 15 studied crosses were found to be detect significant and positive and heterosis relative to mid-parent which ranged from 1.80% of Karshenky x Pima S_7 to 3.70% of Giza 92 x Karshenky, three crosses showed significant and positive desirable heterosis relative to better-parent i.e. Giza 92 x Australy 13, Giza 92 x Karshenky and Giza 92 x Pima S_7 with value of 1.87%, 2.84% and 2.87%, respectively. On the other hand, results of seed index trait were not significant desirable for all crosses relative to better-parent. Similar results are obtained by Karademir *et al.* (2009), Khan *et al.* (2009), Karademir and Gençer (2010), Al-Hibbiny (2015), Gohil *et al.* (2017), Mahrous (2018), Sultan (2018), Solongi *et al.* (2019), Mokadem *et al.* (2020), Rani *et al.* (2020), Imtiaz (2022), Khuwaja (2022), Hafez *et al.* (2022), Subhashini *et al.* (2022) and Rasheed *et al.* (2023).

Table 7. Heterosis relative to the mid- parents for yield components and fiber quality traits in the studied cotton hybrids.

Genotypes	Seed cotton yield/plant	Lint cotton yield/plan	Lint percentage	Boll weight (gm)	Seed index (%)
Giza 88 x Giza 86	42.59**	47.88**	4.31*	13.14**	7.59*
Giza 88 x Giza 92	-12.81**	-8.95	4.42*	2.68	2.35
Giza 88 x Australy 13	-8.64*	-7.71	1.72	4.15	-1.24
Giza 88 x Karshenky	33.51**	36.12**	2.67	2.37	-2.85
Giza 88 x Pima S_7	-2.10	-1.20	1.60	7.12*	1.53
Giza 86 x Giza 92	11.46**	11.32*	-0.49	6.02	9.00**
Giza 86 x Australy 13	-7.61*	-9.12*	-1.23	0.91	-0.30
Giza 86 x Karshenky	-21.52**	-22.29**	-0.84	-8.47*	5.28
Giza 86 x Pima S_7	-10.04**	-4.74	6.26**	4.16	3.53
Giza 92 x Australy 13	-5.99	-6.56	0.16	5.46	0.30
Giza 92 x Karshenky	-15.84**	-20.52**	-4.80*	-3.52	9.57**
Giza 92 x Pima S_7	-12.14**	-11.80**	0.96	3.25	11.29**
Australy 13 x Karshenky	10.80**	16.79**	5.43**	7.42	5.63
Australy 13 x pima S_7	-25.52**	-24.84**	1.41	8.23*	10.15**
Karshenky x pima S_7	-0.37	5.26	6.01**	4.19*	3.53
LSD $_{0.05}$	**12.68**	**5.36**	**1.37**	**0.20**	**0.62**
LSD $_{0.01}$	**16.96**	**7.17**	**1.83**	**0.27**	**0.83**

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

Table 7. Cont.

Genotypes	Lint index (%)	Micronaire reading	Fiber length (mm)	Fiber strength (gm/tex)	Uniformity index (%)
Giza 88 x Giza 86	14.45**	0.00	1.87	-0.07	1.47
Giza 88 x Giza 92	8.90*	6.22	6.59**	5.86**	1.44
Giza 88 x Australy 13	0.98	-0.84	-3.50*	-0.15	0.18
Giza 88 x Karshenky	0.63	-0.67	-0.44	-3.17	0.05
Giza 88 x Pima S_7	3.78	-3.65	3.47*	6.74**	1.31
Giza 86 x Giza 92	7.41*	12.95	2.53	3.41	1.08
Giza 86 x Australy 13	-2.55	-6.38*	3.76*	0.10	1.33
Giza 86 x Karshenky	3.28	-0.21	-0.05	-3.83	2.00*
Giza 86 x Pima S_7	13.75**	-1.17	4.29**	9.80**	0.95
Giza 92 x Australy 13	0.18	-5.81	-0.41	7.48**	2.26**
Giza 92 x Karshenky	1.32	-2.20	7.81**	-1.15	3.70**
Giza 92 x Pima S_7	12.84**	-2.92	6.62**	4.70*	2.95**
Australy 13 x Karshenky	15.25**	6.95	1.52	4.34	2.45**
Australy 13 x pima S_7	12.68**	4.26	1.66	-0.71	1.06
Karshenky x pima S_7	13.88**	3.35	1.37	0.45	1.80*
LSD $_{0.05}$	**0.42**	**0.25**	**1.01**	**0.43**	**1.27**
LSD $_{0.01}$	**0.57**	**0.34**	**1.35**	**0.58**	**1.69**

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

Table 8. Heterosis relative to the better-parent for yield components and fiber quality traits in the studied cotton hybrids.

Genotypes	Seed cotton yield/plant	Lint cotton yield/plan	Lint percentage	Boll weight (gm)	Seed index (%)
Giza 88 x Giza 86	24.48**	24.73**	0.14	8.98*	1.29
Giza 88 x Giza 92	-25.18**	-18.69**	6.90**	2.54	6.76
Giza 88 x Australy 13	-36.55**	-38.56**	-3.25	6.07	1.79
Giza 88 x Karshenky	12.77**	12.87**	0.07	4.63	-0.53
Giza 88 x Pima S_7	12.90**	17.13**	3.77	9.03*	-0.82
Giza 86 x Giza 92	5.98	11.06*	-5.19*	4.18	2.46
Giza 86 x Australy 13	-28.75**	-32.18**	-4.80*	-2.24	-8.37*
Giza 86 x Karshenky	-27.71**	-29.20**	-3.26	-12.86**	-4.27
Giza 86 x Pima S_7	9.50*	12.83*	2.93	-1.43	-5.44
Giza 92 x Australy 13	-20.53**	-24.28**	-4.91*	4.12	0.13
Giza 92 x Karshenky	-16.92**	-22.78**	-6.92**	-6.45	9.45
Giza 92 x Pima S_7	0.74	8.03	3.14	-0.21	6.74
Australy 13 x Karshenky	3.15	7.83*	4.49*	5.21	5.46
Australy 13 x pima S_7	-38.51**	-39.35**	-1.44	6.07	6.11
Karshenky x pima S_7	-14.64**	-11.68**	3.38	2.98	0.76
LSD $_{0.05}$	**14.64**	**6.19**	**1.58**	**0.23**	**0.72**
LSD $_{0.01}$	**19.59**	**8.28**	**2.11**	**0.31**	**0.96**

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

Table 8. Cont.

Genotypes	Lint index (%)	Micronaire reading	Fiber length (mm)	Fiber strength (gm/tex)	Uniformity index (%)
Giza 88 x Giza 86	1.55	-2.51	-1.49	-1.58	0.49
Giza 88 x Giza 92	18.46**	5.29	0.65	1.05	-0.47
Giza 88 x Australy 13	-2.87	-13.92	-9.75**	-0.91	-2.36**
Giza 88 x Karshenky	-0.46	-3.27	-7.06**	-4.59	-2.55**
Giza 88 x Pima S_7	5.07	-1.72	-3.99*	5.13*	-1.59
Giza 86 x Giza 92	-5.85	5.86	0.60	-0.86	0.15
Giza 86 x Australy 13	-14.22**	-17.58**	1.49	2.18	-0.17
Giza 86 x Karshenky	-9.47**	-1.63	-1.89	-2.66	0.62
Giza 86 x Pima S_7	-1.04	-0.84	1.99	9.65**	-0.60
Giza 92 x Australy 13	-7.42	-16.85**	-0.92	1.68	1.87**
Giza 92 x Karshenky	-2.22	-3.27	6.01**	-7.84**	2.84**
Giza 92 x Pima S_7	12.03**	0.00	7.64**	-2.44	2.87**
Australy 13 x Karshenky	13.82**	1.47	0.50	3.61	1.61
Australy 13 x pima S_7	9.88**	-4.40	2.04	-2.97	1.39
Karshenky x pima S_7	12.42**	0.82	-0.10	-0.92	1.14
LSD $_{0.05}$	**0.49**	**0.29**	**1.17**	**0.50**	**1.46**
LSD $_{0.01}$	**0.66**	**0.39**	**1.56**	**0.67**	**1.95**

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

Genetic parameters

Using the suitable selection method this is on how we are the gene action. It leads to select of desirable parents for hybridization as well as the selection of appropriate breeding programs for genetic improvement of various quantitative traits. As a result, a plant breeder must understand the nature of gene action involved in the expression of the various quantitative characters before beginning a breeding program. Table 8 displays the genetic variance components and dominance degree ratios for all traits studied. The results indicated that non-additive genetic variances were greater than additive genetic variances of all traits under study. These results that non-additive effects play the role are in the expression of these traits, while additive effects play a minor role. These results are in harmony with those obtained by Basal *et al.* (2009), Al-Hibbiny (2015), Mahrous (2018) and Munir *et al.* (2018).

Heritability

Data of heritability in broad- and narrow-sense which illustrated in Table 9 demonstrated that the highest broad-sense heritability value was observed in case of seed cotton yield/plant with value of 93.91% and the lowest value was 50.51%, for boll weight. However, the values of narrow-sense heritability were ranged from 9.44% for boll weight to 31.14% for lint cotton yield/plant, respectively. Such as these results were obtained by Al-Hibbiny (2004), Said (2005), Mahrous (2018), Mokadem *et al.* (2020) and Hafez *et al.* (2022).

Table 9. Estimates of variance components of combining ability and heritability for yield and fiber quality traits in cotton.

variance components and heritability	Seed cotton yield/plant	Lint cotton yield/plan	Lint percentage	Boll weight (gm)	Seed index (%)
σ^2_{GCA}	198.175	35.33	0.23	0.002	0.04
σ^2_{SCA}	816.850	142.18	1.26	0.016	0.15
$\sigma^2_{GCA}/\sigma^2_{SCA}$	0.24	0.25	0.18	0.13	0.27
σ^2_A	396.351	70.67	0.47	0.004	0.08
σ^2_D	816.850	142.18	1.26	0.016	0.15
h^2b	93.91	93.81	65.31	50.51	55.26
h^2n	30.68	31.14	17.68	9.44	19.90

Table 9. Cont.

variance components and heritability	Lint index (%)	Micronaire reading	Fiber length (mm)	Fiber strength (gm/tex)	Uniformity index (%)
σ^2_{GCA}	0.02	0.01	0.14	0.04	0.14
σ^2_{SCA}	0.21	0.04	0.96	0.09	0.74
$\sigma^2_{GCA}/\sigma^2_{SCA}$	0.10	0.25	0.15	0.44	0.19
σ^2_A	0.05	0.02	0.29	0.08	0.27
σ^2_D	0.21	0.04	0.96	0.09	0.74
h^2b	74.34	64.95	71.46	65.03	56.43
h^2n	13.34	23.18	16.42	29.52	15.15

CONCLUSION

The non- additive genetic variance effects play the major role in controlling the genetic variance for all traits studied. The parental genotypes Giza 88 and Giza 92 gave significant (desirable) GCA effects for most fiber properties. Karshenky and Australy 13 exhibit significant and positive (desirable) GCA effects of most yield traits. Heterosis over mid and better parent was significant desirable for most traits studied. Narrow-sense heritability (h^2_n) was low to moderate for most of the traits studied , which may be ascribed to the opposite direction of additive and dominance variances.

REFERENCES

Abbas, H. G.; Mahmood, A. and Ali, Q. (2015). Genetic variability and correlation analysis for various yield traits of cotton (*Gossypium hirsutum* L.). Journal of Agricultural Research, 53 (4): 481-491.

Abbas, H. G.; Mahmood, A. and Ali, Q. (2016). Zero tillage: a potential technology to improve cotton yield. Genetika, 48 (2): 761-776.

AL-Hibbiny, Y. I.; Mabrouk, A. H. and Ramadan, B. M. (2020). Generation means analysis for some quantitative characters in cotton. Menoufia J. Plant Prod., 5: 111-123.

Al-Hibbiny, Y.I.M. (2015). Estimation of heterosis, combining ability and gene action by using line X tester analysis in cotton (*Gossypium barbadense* L.). Egypt. J. Plant Breed. 19 (2): 385 – 405.

Al-Hibbiny, Y.I.M. (2004). Relation between the factors affecting boll opening and cotton yield and quality in Egyptian cotton. M.Sc. Thesis, Agron. Dept. Fac. Agric., Al-Azhar Univ. Egypt.

Ali, Q.; Ahsan, M.; Ali, F.; Aslam, M.; Khan, N. H.; Munzoor, M. and Muhammad, S. (2013). Heritability, heterosis and heterobeltiosis studies for morphological traits of maize (*Zea mays* L.) seedlings. Advancements in Life sciences, 1 (1): 53-62.

Ali, Q.; Ali, A.; Ahsan, M.; Nasir, I. A.; Abbas, H. G. and Ashraf, M. A. (2014). Line× Tester analysis for morpho-physiological traits of *Zea mays* L. seedlings. *Advancements in Life sciences*, 1 (4): 242-253.

Allard, R.W. (1960). Principles of Plant Breeding. John Wiley, New York.

Babar, M.; Nawaz, M.; Shahani, A.; Khalid, M.; Latif, A.; Kanwal, K.; Ijaz, M.; Maqsood, Z.; Amjad, I. and Khan, A. (2022). Genomic Assisted Crop Breeding Approaches For Designing Future Crops To Combat Food Production Challenges. Biol. Clin. Sci. Res. J., 143: 1-8.

Bano, M.; Shakeel, A.; Khalid, M. N.; Ahmad, N. H.; Sharif, M. S.; Kanwal, S.; Bhutta, M. A.; Bibi, A. and Amjad, I. (2023). Estimation of Combining Ability for Within-Boll Yield Components in Upland Cotton (*Gossypium hirsutum*). Sarhad Journal of Agriculture, 39(1): 174-181.

Basal, H.; Unay, A.; Canavar, O. and Yavas, I. (2009). Combining ability for fiber quality parameters and within-boll yield components in intraspecific and interspecific cotton populations. Spanish Agric. Res. 7(2): 364-374.

Bhimireddy, S.; Sivakami, R.; Premalatha, N.; Manikanda, B. N.; Thirukumaran, K. and Manivannan, A. (2023). Combining ability and gene action studies for yield and fibre traits in *Gossypium arboretum* using Griffings numerical and Haymans graphical approach. Journal of Cotton Research, 6:12.

Bhutta, M. A.; Bibi, A.; Ahmad, N. H.; Kanwal, S.; Amjad, Z.; Farooq, U.; Khalid, M. N. and Nayab, S. F. (2023). Molecular Mechanisms of Photoinhibition in Plants: A Review. Sarhad Journal of Agriculture, 39: 340-345.

Chapara, R.; Rani, S. M. and Satish, Y. (2020). Combining ability studies in cotton (*Gossypium hirsutum* L.) for yield and fibre quality parameters. International Journal of Chemical Studies, 8(2): 523-527.

Chaudhry, U. F.; Khalid, M. N.; Aziz, S.; Amjad, I.; Khalid, A.; Noor, H. and Sajid, H. B. (2022). Genetic studies in different F2 segregating population for yield and fiber quality traits in cotton (*Gossypium hirsutum* L.). Journal of Current Opinion in Crop Science, 3 (3): 135-151.

Fatima, A.; Saeed, A.; Ullah, M.; Shah, S.; Ijaz, M.; Anwar, M.; Khaliq, A.; Chohan, S.; Khalid, M. and Khan, A. (2022). Estimation of gene action for the selection of superior parents and their cross combinations for yield and fiber associated attributes in american cotton (*Gossypium hirsutum* L.). Biol. Clin. Sci. Res. J., 15(1): 1-5.

Gnanasekaran, M. and Thiyagu, K. (2021). Gene action, combining ability and standard heterosis for seed cotton yield and fibre quality components in upland cotton. Electronic Journal of Plant Breeding, 12(2): 325 – 334.

Gohil, S.B.; Parmar, M.B. and D.J. Chaudhari (2017). Study of Heterosis in Interspecific Hybrids of Cotton (*Gossypium hirsutum* L. x *Gossypium barbadense* L.). Journal of Pharmacognosy and Phytochemistry; 6(4): 804-810.

Griffing, L.B. (1956). Concept of general and specific combining ability in relation to diallel crossing systems. Austr. Jour. Biol. Sci. 9: 463-493.

Hafeez, M. N.; Khan, M. A.; Sarwar, B.; Hassan, S.; Ali, Q.; Husnain, T. and Rashid, B. (2021). Mutant Gossypium universal stress protein-2 (GUSP-2) gene confers resistance to various abiotic stresses in E. coli BL-21 and CIM-496-*Gossypium hirsutum*. Scientific reports, 11(1): 20466.

Hafez, S.H.; Heba H. E. Hamed and Darwesh, A. E. I. (2022). Evaluation of Combining Ability and Heterosis for some Yield and Fiber Quality Properties in Cotton (*G. barbadense* L.) Obtained by Half Diallel Mating Design. J. of Plant Production, Mansoura Univ., 13 (8): 581 - 588.

Hassan, A.; Naseer, A.; Shahani, A.; Aziz, S.; Khalid, M.; Mushtaq, N. and Munir, M. (2022). Assessment of fiber and yield related traits in mutant population of cotton. Int J Agri Biosci, 11(1): 95-102.

Hassan, A.; Khalid, M. N.; Rehman, Z. U.; Amjad, I.; Mudasir, M.; Rasheed, Z. and Chaudhry, U. F. (2021). Hormones Performs a Crucial Role in the Regulation of Cotton Fiber Synthesis. Curr. Rese. Agri. Far. 2 (4): 9-25.

Imtiaz, M.; Shakeel, A.; Nasir, B.; Khalid, M.N. and Amjad, I. (2022). Heterotic potential of upland cotton hybrids for earliness and yield related attributes. Biol. Clin. Sci. Res. J., 196: 1-8.

Iqbal, A.; Aslam, S.; Ahmed, M.; Khan, F.; Ali, Q. and Han, S. (2023). Role of Actin Dynamics and GhACTIN1 Gene in Cotton Fiber Development: A Prototypical Cell for Study. Genes, 14 (8), 1642: 1-15.

Karademir, C.; Emine, K.; Remzi, E. and Oktay, G. (2009). Combining ability estimates and heterosis for yield and fiber quality of cotton in line x tester design. J. of Not. Bot. Hort. Agrobot. Cluj. Turkey 37(2): 228-233.

Karademir, E. and GenÇer, O. (2010). Combining ability and heterosis for yield and fiber quality properties in cotton (*G. hirsutum* L.) obtained by half diallel mating design. J. of Not. Bot. Hort. Agrobot. Cluj. Turkey, 38 (1): 222-227.

Khalid, M. and Amjad, I. (2018). Study of the genetic diversity of crops in the Era of modern plant breeding. Bull. Biol. All. Sci. Res., 3 (14): 1-5.

Khalid, M.; Hassan, U.; Hanzala, M.; Amjad, I. and Hassan, A. (2022). Current situation and prospects of cotton production in Pakistan. Bull. Biol. All. Sci. Res., 7(27): 1-6.

Khan, N.; Gul, H.; Moula, B.K.; Khan, B.M.; Muhammad, A.K.; Aisha, P.; Umm-E-Aiman and Muhammad, S. (2009). Combining ability analysis to identify suitable parents for heterosis in seed cotton yield, its components and lint% in upland cotton. Science Direct. 2(9): 108-115.

Khuwaja, S.; Bux, H.; Abro, S.; Rizwan, M. and Kaleri, G. M. (2022). Estimate of heterosis and heterobeltiosis for the improvement of yield in upland cotton (*Gossypium hirsutum* l.). Pak. J. Agri., Agril. Engg., Vet. Sci., 38 (1): 1-6.

Mabrouk, A. H.; EL-Dahan, M. A. A. and Eman M. R. Saleh (2018). Diallel analysis for yield and fiber traits in cotton. Egypt. J. Plant Breed., 22(1): 109-124.

Mahrous, H. (2018). Line × Tester Analysis for Yield and Fiber Quality Traits in Egyptian cotton under Heat Conditions. J. Plant Production, Mansoura Univ., 9 (6): 573 - 578.

Mather, K. (1949). Biometrical Genetics. Dover Publication. Inc. New York.

Mokadem, Sh. A.; Salem, M. A.; Khalifa, H. S. and Salem, T. M. E. (2020). Estimation of Combining Ability, Heterosis and Heritability in some Egyptian cotton Crosses. J. of Plant Production, Mansoura Univ., 11 (2): 189 – 193.

Mudasir, M.; Noman, M.; Zafar, A.; Khalid, M. N.; Amjad, I. and Hassan, A. (2021). Genetic Evaluation of *Gossypium hirsutum* L. for Yield and Fiber Contributing Attributes in Segregating Population. Int. J. Rec. Biotech, 9 (3): 1-9.

Munir, S.; Quresh, M.K.; Shahzad, A.N.; Manzoor, H.; Shahzad, M.A.; Aslam, K. and Athar, H.R. (2018). Assessment of Gene Action and Combining Ability for Fiber and Yield Contributing Traits in Interspecific and Intraspecific Hybrids of Cotton. Genet. Plant Breed., 54(2): 71–77.

Nadeem, A.; Shakeel, A.; Imtiaz, M.; Nasir, B.; Khalid, M. and Amjad, I. (2022). Genetic Variability Studies For Yield And Within Boll Yield Components In Cotton (*Gossypium Hirsutum* L.). Biol. Clin. Sci. Res. J., 19(7): 1-7.

Ramdan, B. M. (2021). Combining ability and genetic divergence in cotton (*G. barbadense* L.). Menoufia J. Plant Prod., 6 (3): 151 – 164.

Rani, S.; Chapara, M. R. and Satish, Y. (2020). Heterosis for seed cotton yield and yield contributing traits cotton (*Gossypium hirsutum* L.). International Journal of Chemical Studies; 8(3): 2496-2500.

Rasheed, Z.; Anwar, M.R.; Hanif, K.; Adrees, A.; Karim, W.A.; Amjad, K.; Hassan, A.; Mazhar hsud, A.l.K. Tipu and Khan, T.M. (2023). Evaluating combining abilities and heterotic effects for enhanced cotton yield. Biol. Clin. Sci. Res. J., 384: 1-6.

Riaz, A.; Ullah, F.; Chohan, S.; Saeed, A.; Aqeel, M.; Sher, A.; Nadeem, A.; Akram, M.; Shahid, M. and Hussnain, H. (2023). Estimation of heterosis and combining ability effects for yield and fiber quality traits in cotton (*Gossypium hirsutum* L.). Biological and Clinical Sciences Research J., (1): 261-261.

Said, S. R. N.; Mariz; Max, S.; Darwesh, A. E. I. and Amer, E. A. (2021). Estimation of heterosis and combining ability in F_1 and F_2 generations for yield and fiber traits in cotton. Plant Cell Biotechnology and Molecular Biology, 22: 241-254.

Said, S.E.R.N. (2005). Studies on breeding for boll worm resistance in cotton. M.Sc. Thesis, Agron. Dept. Fac. Agric., Al-Azhar Univ. Egypt.

Samreen, K.; Baloch, M.J.; Soomro, Z.A.; Kumbhar, M.B.; Khan, N.U.; Kumboh, N.; Jatoi, W.A. and Veesar, N.F. (2008). Estimating combining ability through line × tester analysis in upland cotton. Sarhad J. Agric. 24(4): 581- 586.

Shafique, M.; Bano, M.; Khalid, M.; Raza, A.; Shahid, M.; Hussnain, H.; Iqbal, M.; Hussain, M.; Abbas, Q. and Iqbal, M. (2023). Germplasm Potential for Different Advance Lines of *Gossypium hirsutum* for Within Boll Yield Components. Biol. Clin. Sci. Res. J., 297: 1-9.

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

Solongi, N.; Jatoi, W. A.; Baloch, M. J.; Siyal1, M.; Solangi, A. H. and Memon, S. (2019). Heterosis and combining ability estimates for assessing potential parents to develop F_1 hybrids in upland cotton. The Journal of Animal & Plant Sciences, 29(5): 1362-1373.

Steel, R.G.D. and Torrie, J.H. (1980). Principles and Procedures of Statistics. Second Edition, Mc.Graw Hill Book Company Inc., New York.

Subhashini, S.; Rajeswari, S.; Premalatha, N.; Kalaimagal, T.; Muthuswami, M. and Jeyakumar, P. (2022). Combining ability and heterosis for yield contributing and fibre quality traits in the hybrids of *Gossypium hirsutum* L. Electronic Journal of Plant Breeding, 13(2): 645 – 654.

Sultan, M. S.; Abdel-Moneam, M. A.; EL-Mansy, Y. M. and El-Morshidy, Huda S.

(2018). Estimating of Heterosis and Combining Ability for some Egyptian Cotton Genotypes Using Line X Tester Mating Design. J. Plant Production, Mansoura Univ., 9 (12): 1121 - 1127.

Yehia, W.M.B. and El-Hashash, E.F. (2019). Combining ability effects and heterosis estimates through line x tester analysis for yield, yield components and fiber traits in Egyptian cotton. Journal of Agronomy, Technology and Engineering Management. 2(2): 248-262.

Yehia, W.M.B. and El-Hashash, E.F. (2022). Estimates of genetic parameters for cotton yield, its components, and fiber quality traits based on line x tester mating design and principal component analysis. Egypt. J. Agric. Res., 100 (3): 302-315.

Zafar, M. M.; Mustafa, G.; Shoukat, F.; Idrees, A.; Ali, A.; Sharif, F. and Li, F. (2022). Heterologous expression of cry3Bb1 and cry3 genes for enhanced resistance against insect pests in cotton. Scientific Reports, 12 (1): 10878.

Zaghum, M.; Khalid, M.; Zia, M.; Gul, M.; Amjad, I. and Irfan, M. (2021). Molecular Regulation in Seed Development Influencing the Fiber Growth in *Gossypium hirsutum* L. Acta scientific agriculture, 5: 15-23.

تقدير القدرة علي التآلف وقوة الهجين وكفاءة التوريث لبعض صفات المحصول ومكوناته وجودة التيلة في أقطان الباربادنس

محمد فتحى حامد، أشرف ابراهيم اسماعيل درويش، فتحي السيد الفقي، بديعة أنور محمود، رانيا محمد عبدالتواب

معهد بحوث القطن – مركز البحوث الزراعية – الجيزة - مصر

الملخص العربى

أجريت هذه الدراسة في محطة البحوث الزراعية بسخا – معهد بحوث القطن – مركز البحوث الزراعية – مصر خلال موسمي الزراعة ٢٠٢٢ و ٢٠٢٣. تم استخدام ستة أصناف من القطن تنتمي جميعها إلي أقطان الباربادنس منها ثلاثة أصناف مصرية وهي جيزة ٨٨ و جيزة ٨٦ و جيزة ٩٢ وثلاثة أصناف أخري وهي استرالي ١٣ و كارشنكي و بيما س٧. تم التهجين بينهم بطريقة التزاوج التبادلي النصف دائري لانتاج ١٥ هجين للجيل الاول في موسم ٢٠٢٢ وفي موسم ٢٠٢٣ تم تقييم الستة أصناف والخمسة عشر هجين في تجربة قطاعات كاملة عشوائية في ثلاث مكررات.

وفيما يلى أهم النتائج المتحصل عليها: أشارت نتائج تحليل التباين لكل من التراكيب الوراثية والآباء والهجن وجود فروق معنوية لكل الصفات المدروسة عدا صفة وزن اللوزة بالنسبة للآباء. أظهر الصنفين جيزة ٨٨ و جيزة ٩٢ أفضل قدرة عامة علي التآلف لمعظم صفات التيلة بينما أظهر الصنفين كارشنكي واسترالي ١٣ أفضل قدرة عامة علي التآلف لمعظم الصفات المحصولية. كما أظهرت الهجن جيزة ٨٨ × جيزة ٨٦ و استرالي ١٣ × كارشنكي أفضل قدرة خاصة علي التآلف لمعظم صفات المحصول وصفات التيلة. أشارت دراسة قوة الهجين الي وجود قوة هجين مفيدة محسوبة بالنسبة لمتوسطات الابوين وأفضل الأباء وذلك لبعض الصفات المدروسة، وقد أظهرت الهجن جيزة ٨٨ × جيزة ٨٦ ، استرالي ١٣ × كارشنكي أعلي قيم لقوة الهجين بالنسبة لمتوسط الابوين وأفضل الأباء لبعض الصفات المحصولية المدروسة. بينما أظهرت الهجن جيزة ٩٢ × بيما س٧ و جيزة ٩٢ x كارشنكي أعلي قيم لقوة الهجين بالنسبة لمتوسط الابوين لبعض صفات التيلة. كانت قيم المكونات الوراثية تدل علي أن التباين الراجع للسيادة كان أعلي من التباين الإضافي في كل الصفات المدروسة. كانت أعلي قيمة لدرجة التوريث بالمعني الواسع لصفة محصول الزهر للنبات (٩٣,٩١%) بينما كانت أقل قيمة لصفة وزن اللوزة (٥٠,٥١%). هذا وكانت درجة التوريث بالمعني الضيق تتراوح بين ٩,٤٤% لصفة وزن اللوزة و ٣١,١٤% لصفة محصول الشعر للنبات.

وعموما فإنه يمكن استخدام الصنفين كارشنكي واسترالي ١٣ في برامج تربية القطن لتحسين وزيادة القدرة الانتاجية للاصناف الجديدة. هذا ويمكن اعتبار الصنفين جيزة ٨٨ وجيزة ٩٢ كآباء متفوقة في برامج التربية للحصول علي أصناف جديدة عالية الجودة.