Annals of Agricultural Science, Moshtohor (ASSJM)

https://assjm.journals.ekb.eg/

www.fagr.bu.edu.eg

ISSN:1110-0419

Original Article: Vol. 61(1) (2023), 19 – 28 **DOI:** 10.21608/ASSJM.2022.277385

Determination of Gene Action and Heterosis in Diallel Crosses For the F_1 and F_2 Cotton Generations

H.S. Abd El Samad[1], A.A. El Hosary[2], M.E. El-Badawy[2], A.E.M. Eissa[1],

[1]Cotton Research Institute, A.R.C., Giza, Egypt.

[2]Agronomy Department, Fac. of Agric. Benha Univ., Egypt.

Corresponding author: a.elhousary@fagr.bu.edu.eg

Abstract

Heterosis and gene action on oil%, and yield traits were determined in a 6x6 diallel cross of cotton without reciprocals and their F_2 generation to define and select an efficient and prospective material for immediate use in hybridization programs to improve seed yield of cotton in Egypt. Parents, F_1 and F_2 were evaluated in a randomized complete block design (RCBD) with three replicates for yield traits in 2021 season. High significant mean squares for genotype, parents and crosses were showed for the studied traits in both generations. Significant heterosis in F_1 generation was obtained for all studied traits. The desirable heterosis of relative to better parent varied from 5.36 to 25.29, 5.92 to 33, 2.3 to 5.89 and 1.14 to 7.38 in F1 generation for seed cotton yield, lint yield, seed index and oil%, respectively. The cross P2xP3 was the best cross for all studied traits heterosis. Mean squares for general (GCA) and specific (SCA) combining ability were significant for all studied traits. MS (GCA)/ MS (SCA) ratios displays the relative importance of additive and additive by additive gene action effects in their inheritance for seed cotton yield, lint yield , seed index and lint percentage in F1 generation and seed cotton yield and lint yield in F2 generation. P1 exhibited significant desirable $\hat{g}_i$ effect among all the tested parents for lint percentage, lint index and oil% in F_1 and seed cotton yield , lint yield and oil % in F_2. The cross P2xP3 showed significantly desirable SCA effects for most studied traits.

Keyword: **Cotton, Diallel analysis, Gene action, Combining ability.**

Introduction

Cotton “White gold” is the world's first fiber crop also; it used as food crops. It contributed in economy and national income in Egypt. Moreover, the agricultural practices that take place from the preparation of land for agriculture to cotton picking. Then the operations of the textile industry and its products can be used to improve livestock and some additional industries such as oils, soap and other industries contributes to reducing unemployment (Bellaloui *et al.*, 2015 and Abd El Samad et al., 2017).

In, Egypt the cultivated area in 1990 reached about one million feddans, this area were decreased to nearly 240 Thousands feddan in the 2019 season, according to the C.A.T.G.O. (2019).

Cotton Research Institute working hard to obtain promising genotypes that are superior to the cultivated varieties in terms of yield, early and fiber quality. Also, the Cotton Research Institute is trying hard to maintain the status of Egyptian cotton among other cottons globally. It is known that all Egyptian varieties originated from the original variety (Ashmoni), which was produced in 1860. Improving the early qualities of the crop, its ingredients and the quality of the fibers are the main objectives of the breeder.

Heterosis is a complex phenomenon, which depends on the balance of different combinations of gene effects as well as on the distribution of plus and minus alleles in the parents of a mating system. In self-pollinated crops, like cotton, the scope for utilization of heterosis depends mainly upon the direction and magnitude of heterosis. Heterosis over better parent may be useful in identifying the best crosses but these hybrids can be of immense practical value if they involve the best cultivars of the area (Abd El Samad et al., 2017 and Hussain *et al.*, 2019). Production of cotton hybrid seed is expensive and the economics of the commercial production of hybrid cotton have not yet been worked out. The economic feasibility would be considerably improved if sufficient heterosis were retained in the F_2 generation to render its production value. The segregation that occurs in an F_2 generation could, however, cause problems. Further advancement in yield of this important species requires adequate information regarding the nature of the combining ability of the parents available in a wide array of genetic material to be used in the hybridization programme and also the nature of gene action involved in the expression of traits of economic importance. The choice of selection and breeding procedures for genetic improvement of cotton or any crop, is largely conditioned by the type and relative amounts of genetic variance components in the population. The exploitation of genetically diverse stock in cross combinations helps to identify promising hybrid and / or to develop superior lines (Vasconcelos *et al*., 2018).

The first step for a successful breeding program is to select appropriate parents. The efficiency of a breeding program could be increased by a careful choice of parents. One of the most commonly used method for choosing parents is diallel cross, which informs us about the parents potential, and also about gene action involved in determining quantitative traits (Cruz and Vencovsky, 1989; Ramalho et al., 1993; Basal and Turgut, 2005; Verhalen and Murray, 1967 , Abd El Samad et al., 2017 and Sedhom *et al.* 2021). Diallel analysis is one of the efficient biometric methods that has been used frequently by researchers for creating and studying the pattern of heritable variation in the metric plant characters (Griffing, 1956)

The diallel analysis also provides a unique opportunity to test a number of lines in all possible combinations. The present study is aimed at estimating heterosis in F_1 and comparing combining ability obtained from F_2 crosses with those of F_1 resulting from a set of diallel crosses for certain quantitative traits of cotton.

Materials And Methods

The present investigation used six divergent cotton genotypes as parents. These genotypes are Giza 85, BBB, Giza 90, Giza 95, CB58 and [(G.83 × G.80) × G.89] × Australy. The name, pedigree, origin and the main characteristics of these parent genotypes are presented in Table (1). All genotypes belong to (*Gossypium barbadense*, L.) and the pure seeds of these genotypes were obtained from Cotton Breeding Section, Cotton Research Institute, Agricultural Research Center at Giza, Egypt.

Table 1. The name, pedigree, origin and the main characteristics of six cotton genotypes (*G. barbadense,* L.) used as parents in the present study.

Genotypes	Pedigree	Origin	Characteristics
(P_1) Giza 85	G.67 × C.B.58	Egypt	A long staple variety, characterized by high lint strength and earliness.
(P_2) BBB	---	Australian	The long stable characterized by big boll and black with boll weight (2.7g)
(P_3) Giza 90	(G.83 × Dendara)	Egypt	Long staple variety for upper characterized by earliness, high No. of bolls/plant, high yielding ability and high lint percentage
(P_4) Giza 95	[(G.83 × (G.75 × 5844)) × G.80]	Egypt	A new long staple cotton variety. Characterized by high yielding ability, high lint percentage, early maturity and heat tolerance.
(P_5) C.B. 58	-----	USA	A medium long staple. Characterized by high lint percentage and earliness.
(P_6) [(G.83 × G.80) × G.89] × Australy	---	Egypt	A new Promising hybrid. Characterized by high yielding ability, high lint percentage, early maturity and heat tolerance.

The mentioned parents were crossed in all possible combinations excluding reciprocals during ٢٠١٩ growing season, giving seeds of F_1 15 crosses. In 2020 season, hybrid seeds were sown to obtain F_2 seeds and parents were re-crossed for obtaining adequate hybrid seeds. In 2021 season, the experiment involved parents, F_1 hybrids and F_2 crosses grown at Sids Experimental Station. The experiment was set as a Randomized Complete Blocks Design (R.C.B.D.) with three replications. The plot size was two rows for parents and F_1 hybrids. Rows were 4.0 m long with row wide of 0.65 m and hills were spaced of 0.40 m apart to give 10 hills /row, and thinned at one plant per hil. The experiment was planted on the 2nd of April. All cultural practices were followed throughout the growing season as usually done with ordinary cotton culture.

Data were recorded on individual plant basis: ten for F_1 and parents and 30 guarded plants for F_2

were randomly chosen from each plot. The following traits were measured: Boll weight (B.W.) (g), seed cotton yield (S.C.Y.) (g/p.), lint yield (L.Y.) (gp.), seed index (S.I.) (g), lint percentage (L. %) and lint index (L.I.) (g).

Heterosis relative to better parent was computed as a deviation of F_1 mean performance from the better parent mean value. The general and specific combining ability estimates were determined according to Griffing (1956) for method 2 model 1.

Results And Discussion

Analysis of variance of both F_1 and F_2 cotton generations for all studied characters is shown in Table 2. Genotypes, parents and crosses mean squares were significant for all traits in both F_1 and F_2 generations, indicating the presence of diversity in the material and sufficient amount of genetic variability adequate for further biometrical assessment.

Table 2. Mean squares from ordinary and combining ability analysis for all characters studied in F_1 and F_2 generations.

S.O.V	DF	Boll weight (B.W.) (g)	Seed cotton yield (S.C.Y.) (g/p.)	Lint yield (L.Y.) (gp.)	Seed index (S.I.) (g)	Lint percentage (L. %)	Lint index (L.I.) (g)	oil %
				F1				
Replications	2	0.02	10.22*	1.56*	0.03	0.25	0.01	0
Genotypes	20	0.12**	434.35**	105.11**	0.39**	23.8**	1.51**	1.79**
parents	5	0.08**	262.43**	54.55**	0.36**	18.67**	1.31**	1.66**
crosses	14	0.15**	526.47**	130.49**	0.43**	26.28**	1.63**	1.7**
P V Cross	1	0.05*	9.21*	2.65*	0.03*	14.75**	0.77**	3.76**
Error	40	0.01	3.06	0.46	0.01	0.37	0.02	0.01
GCA	5	0.03**	257.16**	59.22**	0.14**	10.65**	0.41**	0.42**
SCA	15	0.05**	107.32**	26.97**	0.13**	7.03**	0.53**	0.66**
Error	40	0.0041	1.0188	0.1521	0.0045	0.1234	0.0068	0.01
GCA/SCA		0.60	2.40	2.20	1.08	1.51	0.77	0.64
				F2				
Replications	2	0	16.23*	7.5	0.02	33.7	1.02	0
Genotypes	20	0.05**	411.92**	111.49**	0.57**	80.52**	3.89**	2.22**
parents	5	0.08**	262.43**	54.55**	0.36**	18.67	1.31*	1.66**
crosses	14	0.01**	459.65**	112.95**	0.62**	61.64**	2.62**	2.32**
P V Cross	1	0.42**	491.08**	375.75**	0.9**	654.12**	34.52**	3.5**
Error	40	0.01	3.47	2.54	0.01	12.4	0.44	0.02
GCA	5	0.01**	211.03**	44.44**	0.11**	11.58*	0.41*	0.27**
SCA	15	0.02**	112.73**	34.73**	0.22**	31.93**	1.59**	0.9**
Error	40	0.0019	1.1556	0.8467	0.0038	4.1345	0.1472	0.0082
GCA/SCA		0.50	1.87	1.28	0.50	0.36	0.26	0.30

*** and ** refer to significant if p> 0.05 and p> 0.01, respectively.**

The parents *vs* crosses mean squares were significant and large in magnitude in F_2 analysis than F_1 ones for all studied traits. These findings are reasonable and might be due to inbreeding depression existing the F_2 which would reduce the heterosis effects. Significant differences among genotypes for grain yield and related traits in different sets of material of cotton were reported by Taha *et al.* (2018); Chaudhary *et al.* (2019) and El-Aref *et al.* (2019).

Mean performance values of the parents, F_1 and F_2 generations for all traits are presented in Table 3. For Boll weight (B.W.) (g), the F_1 hybrids: P2xP3 and P2xP4 had the highest values. Furthermore, P3 and F_2 hybrid: P4xP6 had the highest values for this trait.

The parent no 3, the two F_1 hybrids P1xP2 and P1xP4 and the F_2 cross P1xP6 had the highest values of seed cotton yield (S.C.Y.) (g/p.)

For, lint yield; the P_1 and the two F_1 hybrids P1xP2 and P1xP4 as well as the F_2 hybrid P2xP3 expressed the highest values for this trait. The parent no 6, F_1 hybrid P2xP5 and P2xP5 was the highest genotypes for seed index. As for lint percentage, P6, the F_1 hybrid P2xP3 and F_2 hybrid P2xP3 exhibited the lint percentage.

For, lint index; P6, the F_1 hybrid P1xP2 and F_2 hybrid P2xP3 showed the highest values. The highest values for oil% were detected by P1, F_1 hybrid P5xP6 and F_2 hybrid P2xP3. Therefore, these crosses could be efficient for prospective cotton breeding programs aiming at improving cotton yield.

Similar genetic differences for cotton yield and related traits and fiber quality parameters were demonstrated by Orabi *et al.* (2017); Taha *et al.* (2018); El-Aref *et al.* (2019) and Mokadem *et al.* (2020).

Heterosis

Mean squares for parents *vs* crosses in F_1 generation, as an indication of average heterosis in F_1 across all crosses were significant for all the studied traits (Table 2). The heterotic effects relative to better parent are presented in Table 4. The most significant and desirable heterosis relative to better parent was exhibited by P1xP6, P2xP3, P2xP4 and P2xP5 for boll weight, four crosses (P1xP2, P1xP4, P1xP6 and P2xP3) for cotton yield, crosses P1xP2, P1xP4, P1xP6 and P2xP3 for lint yield, P1xP3, P2xP3, P2xP4, P2xP5 and P3xP4 for seed index, three crosses (P1xP2, P1xP4 and P2xP3) for lint%, crosses P1xP2, P1xP4, P2xP3 and P3xP4 for lint index and the crosses P1xP3, P1xP5, P2xP3, P2xP5, P3xP4, P4xP5 and P5xP6 for oil%

Table 3. Mean performance of all studied genotypes (parents, F_1 and F_2 generations) for yield traits and its quality in cotton.

Genotype	Boll weight (B.W.) (g)	Seed cotton yield (S.C.Y.) (g/p.)	Lint yield (L.Y.) (gp.)	Seed index (S.I.) (g)	Lint percentage (L. %)	Lint index (L.I.) (g)	oil %
			Parents				
P1	3.03	71.53	28.73	8.97	40.17	6.02	21.08
P2	3.00	46.00	16.50	8.98	35.87	5.02	20.52
P3	3.25	59.43	23.43	8.66	39.43	5.64	20.46
P4	3.30	58.07	24.53	8.55	42.25	6.25	19.04
P5	2.89	50.43	19.53	9.32	38.73	5.89	19.72
P6	3.15	48.97	20.90	9.42	42.68	7.01	20.72
			F_1 crosses				
P1xP2	3.07	75.37	32.27	8.91	42.82	6.67	20.31
P1xP3	3.06	46.17	17.44	9.25	37.78	5.62	22.04
P1xP4	3.03	75.63	32.33	8.91	42.75	6.65	19.95
P1xP5	2.89	49.00	17.67	9.23	36.05	5.20	21.32
P1xP6	3.24	73.93	30.43	9.02	41.16	6.31	20.66
P2xP3	3.43	74.47	31.17	9.19	41.85	6.61	21.48
P2xP4	3.43	55.30	21.23	9.30	38.40	5.80	20.18
P2xP5	3.39	42.17	15.47	9.80	36.68	5.68	20.85
P2xP6	3.07	44.73	16.40	9.01	32.84	4.42	19.94
P3xP4	2.83	53.63	22.40	9.17	41.77	6.58	21.13
P3xP5	2.80	43.13	15.90	8.80	36.86	5.14	20.13
P3xP6	3.05	51.43	20.30	8.81	39.47	5.74	19.88
P4xP5	3.07	37.50	13.30	8.20	35.47	4.51	21.05
P4xP6	2.71	55.77	22.40	8.43	40.17	5.66	20.78
P5xP6	3.10	49.27	18.57	8.84	37.69	5.35	22.25
LSD5 %	0.18	2.89	1.11	0.19	1.00	0.24	0.02
LSD1 %	0.25	3.86	1.49	0.26	1.34	0.32	0.02
P1xP2	3.09	65.73	24.80	8.61	37.70	5.24	19.14
P1xP3	3.02	40.72	10.88	8.94	26.94	3.36	20.94
P1xP4	3.20	63.46	24.44	8.86	38.52	5.55	19.86
P1xP5	2.92	44.55	13.62	8.08	30.65	3.61	18.72
P1xP6	3.04	70.90	27.10	8.97	38.22	5.58	19.37
P2xP3	3.26	70.54	27.41	9.06	38.86	5.76	21.34
P2xP4	3.25	49.10	15.34	9.18	31.24	4.20	19.76
P2xP5	3.16	38.44	11.78	9.54	30.78	4.33	19.49
PxP6	2.95	37.66	12.36	8.93	24.50	2.90	18.35
P3xP4	3.18	47.88	17.41	9.06	36.29	5.17	20.41
P3xP5	3.13	40.18	12.30	8.76	30.75	3.95	19.63
P3xP6	2.92	46.36	15.99	8.18	34.62	4.37	18.34
P4xP5	3.18	32.61	8.94	7.95	27.51	3.05	19.88
P4xP6	3.40	51.52	17.08	8.32	33.10	4.13	20.42
P5xP6	3.07	43.71	13.55	8.35	31.15	3.82	20.39
LSD5 %	0.10	3.07	2.63	0.18	5.81	1.10	0.26
LSD1 %	0.14	4.11	3.52	0.23	7.78	1.47	0.35

Table 4. Heterosis percentage relative to better parent for studied traits in the studied F_1 cotton crosses.

Cross	Boll weight (B.W.) (g)	Seed cotton yield (S.C.Y.) (g/p.)	Lint yield (L.Y.) (gp.)	Seed index (S.I.) (g)	Lint percentage (L. %)	Lint index (L.I.) (g)	oil %
1x2	1.32	5.36**	12.3**	-0.82*	6.6**	10.79**	-3.64**
1x3	-5.75**	-35.46**	-39.3**	3.12**	-5.94**	-6.72**	4.54**
1x4	-8.28**	5.73**	12.53**	-0.67*	1.18*	6.41**	-5.36**
1x5	-4.6**	-31.5**	-38.52**	-0.97*	-10.25**	-13.6**	1.14**
1x6	2.75*	3.36*	5.92**	-4.28**	-3.55**	-10.05**	-1.99**
2x3	5.75**	25.29**	33**	2.3**	6.15**	17.34**	4.69**
2x4	3.84*	-4.76**	-13.45**	3.56**	-9.11**	-7.25**	-1.66**
2x5	12.89**	-16.39**	-20.82**	5.15**	-5.3**	-3.65**	1.61**
2x6	-2.75*	-8.65**	-21.53**	-4.39**	-23.05**	-37.02**	-3.75**
3x4	-14.34**	-9.76**	-8.7**	5.89**	-1.14*	5.2**	3.27**
3x5	-13.86**	-27.43**	-32.15**	-5.58**	-6.51**	-12.81**	-1.61**
3x6	-5.95**	-13.46**	-13.37**	-6.51**	-7.52**	-18.12**	-4.05**
4x5	-7.07**	-35.42**	-45.79**	-12.02**	-16.06**	-27.93**	6.74**
4x6	-17.88**	-3.96*	-8.7**	-10.47**	-5.88**	-19.27**	0.29**
5x6	-1.69	-2.31*	-11.16**	-6.16**	-11.69**	-23.77**	7.38**

* $p< 0.05$; ** $p< 0.01$

These hybrids exhibited heterosis for one or more of the contributing traits. In this context, significant heterosis relative to mid-parents and better-parent for earliness characters, yield traits and fiber quality parameters was recorded by other researchers as Zhang *et al.* (2017); Monicashree *et al.* (2017); Bilwal *et al.* (2018) Taha *et al.* (2018); Malathi *et al.* (2019) and Mokadem *et al.* (2020).

Combining ability

The analysis of variance for both general (GCA) and specific (SCA) combining abilities show that the mean squares were highly significant for all studied traits in both generations (Table 2) which indicates the importance of both additive and non-additive gene effects in the inheritance of such traits.

The relative importance of additive and non-additive gene action is essential for the development of an efficient hybridization program. The concept of combining ability as a measure of gene action refers to the capacity or ability of genotype to transmit superior performance to its crosses. The value of line depends on its ability to produce superior hybrids in combination with other line. If both GCA and SCA mean squares are significant, it is vital to determine the type of gene action which is important in determining the performance of progeny. To overcome such situation the magnitude of mean squares can be used to assume the relative importance of general and specific combining ability mean squares which were highly significant. Hence, GCA/ SCA ratio was used to reveal the nature of genetic variance involved. The ratio of MS GCA/ MS SCA (Table 2) displays the relative importance of additive and additive by additive gene action effects in their inheritance for seed cotton yield, lint yield , seed index and lint percentage in F1 generation and seed cotton yield and lint yield in F2 generation. Therefore, selection for these traits in early generations would be effective in developing the high yielding varieties in cotton breeding programs. The preponderance of additive genetic variation for yield and its related characters in F_1 and F_2 generations indicate that the parents involved in these crosses could be selected based on their GCA values. Meanwhile, the non-additive play the important role in inheritance the other cases. The significance of additive and non-additive gene action with more pronounced non-additive effect in heredity of cotton characters was disclosed previously by numerous authors as Ekinci and Basbag (2018); Taha *et al.* (2018) and Chaudhary *et al.* (2019).

General combining ability effects

General combining ability effects $\hat{g}_i$ of individual parent for each trait from both F_1 and F_2 generations are presented in Table 5. The estimates of $\hat{g}_i$ effects obtained from F_2 generation were similar to those of F_1 generation in most cases. The

P1 exhibited significant desirable $\hat{g}_i$ effect among all the tested parents for lint percentage, lint index and oil% in F_1 and Seed cotton yield , lint yield and oil % in F_2. The P_2 gave significant positive $\hat{g}_i$ effects for boll weight and seed index in F1 and seed index in F2. But, it gave significant undesirable or insignificant $\hat{g}_i$ effects for other traits. The P_3 expressed significant positive $\hat{g}_i$ effects and seemed to be the best combiner for lint% and oil% in both F_1 and F_2. The P_4 expressed significant positive $\hat{g}_i$ effects for Seed cotton yield lint percentage and lint index in F1 while, it give desirable $\hat{g}_i$ effects for boll weight in F2. The parental line P_5 expressed significant desirable $\hat{g}_i$ effects for seed index in F_1 generation. The parental line P_6 expressed significant positive $\hat{g}_i$ effects for lint percentage, lint index and oil% in F_1 generation.

The correlation between parental mean performance and $\hat{g}_i$ effects were significantly positive for most studied traits in F_1 and F_2.This indicates highly valuable agreement between the parental performance and its $\hat{g}_i$ effects. Therefore, the mean performance of the genotypes could be a reliable and effective indication for their general combining ability effects for most traits. Therefore, selection among the tested parental population for initiating any proposed breeding program could be practiced either on mean performance or $\hat{g}_i$ effects basis with similar efficiency. These results are in harmony with those obtained by Al-Ashmoony *et al.* (2016); Khalifa *et al.* (2016); Orabi *et al.* (2017); Baker and El-Areed (2018); Ekinci and Basbag (2018) and Chaudhary *et al.* (2019).

Table 5. Estimates of parental general combining ability effects for yield traits and its quality in cotton in F_1 and F_2 generations.

Parent	Boll weight (B.W.) (g)	Seed cotton yield (S.C.Y.) (g/p.)	Lint yield (L.Y.) (gp.)	Seed index (S.I.) (g)	Lint percentage (L. %)	Lint index (L.I.) (g)	oil %
F_1							
P1	-0.03	9.48**	4.25**	0.04	0.91**	0.24**	0.24**
P2	0.1**	-0.41	-0.51**	0.16**	-1.16**	-0.17**	-0.09**
P3	0.01	0.05	0.05	-0.05*	0.37**	0.05	0.14**
P4	0.01	0.83*	0.89**	-0.23**	1.18**	0.14**	-0.42**
P5	-0.07**	-8.17**	-4.21**	0.07**	-1.68**	-0.37**	0.07**
P6	-0.01	-1.78**	-0.47**	0.01	0.38**	0.11**	0.06**
LSD gi 5%	0.04	0.66	0.25	0.04	0.23	0.05	0.008
LSD gi 1%	0.06	0.88	0.34	0.06	0.31	0.07	0.01
LSD gi-gj 5%	0.06	1.02	0.39	0.07	0.36	0.08	0.01
LSD gi-gj 1%	0.09	1.36	0.53	0.09	0.48	0.11	0.01
R	0.97**	0.91**	0.98**	0.96**	0.80**	0.89**	0.99**
F_2							
P1	0.0	8.64**	3.68**	-0.02	1.13	0.22	0.12**
P2	0 .0	-0.72*	-0.52	0.21**	-1.06	-0.14	-0.01
P3	0.03	0.66	0.25	-0.03	0.38	0.03	0.3**
P4	0.03*	0.18	0.42	-0.14**	0.98	0.12	-0.1**
P5	-0.07**	-7.36**	-3.7**	-0.03	-1.88**	-0.38**	-0.21**
P6	0.01	-1.4**	-0.13	0	0.45	0.15	-0.11**
LSD gi 5%	0.03	0.7	0.6	0.04	1.33	0.25	0.06
LSD gi 1%	0.04	0.94	0.8	0.05	1.77	0.33	0.08
LSD gi-gj 5%	0.04	1.09	0.93	0.06	2.05	0.39	0.09
LSD gi-gj 1%	0.06	1.45	1.24	0.08	2.75	0.52	0.12
r	0.86**	0.64**	0.68**	0.25*	0.21**	0.25*	0.12*

* p< 0.05; ** p< 0.01 and refer to the correlation coefficient between GCA effects for parents and its mean performance.

Specific combining ability effects

Specific combining ability effects $\hat{S}_{ij}$ of both F_1 and F_2 for all traits are presented in Table 6, and show highly significant desirable $\hat{S}_{ij}$ values for some crosses in the F_1 than F_2 generation. This result is expected indicating inbreeding depression in the F_2 reducing the non-additive or increased the additive portion.

Table 6. Estimates of specific combining ability effects of the parental combination for yield traits and its quality in cotton in F_1 and F_2 generations.

Cross	Boll weight (B.W.) (g)	Seed cotton yield (S.C.Y.) (g/p.)	Lint yield (L.Y.) (gp.)	Seed index (S.I.) (g)	Lint percentage (L. %)	Lint index (L.I.) (g)	oil %
F_1							
1x2	-0.08	10.96**	6.59**	-0.28**	3.98**	0.8**	-0.49**
1x3	0	-18.69**	-8.81**	0.27**	-2.59**	-0.47**	1.02**
1x4	-0.03	9.99**	5.25**	0.11*	1.57**	0.48**	-0.52**
1x5	-0.09	-7.64**	-4.32**	0.13*	-2.27**	-0.47**	0.37**
1x6	0.2**	10.9**	4.71**	-0.02	0.78**	0.16*	-0.28**
2x3	0.24**	19.5**	9.68**	0.09	3.56**	0.94**	0.79**
2x4	0.23**	-0.45	-1.09**	0.38**	-0.71**	0.03	0.04**
2x5	0.28**	-4.58**	-1.76**	0.58**	0.43	0.42**	0.23**
2x6	-0.1*	-8.41**	-4.57**	-0.14**	-5.47**	-1.33**	-0.67**
3x4	-0.28**	-2.58**	-0.49	0.46**	1.13**	0.59**	0.77**
3x5	-0.22**	-4.07**	-1.89**	-0.21**	-0.92**	-0.34**	-0.72**
3x6	-0.03	-2.16**	-1.24**	-0.14**	-0.37	-0.22**	-0.95**
4x5	0.05	-10.49**	-5.33**	-0.64**	-3.12**	-1.06**	0.76**
4x6	-0.37**	1.39	0.03	-0.33**	-0.48	-0.39**	0.5**
5x6	0.1*	3.89**	1.29**	-0.23**	-0.11	-0.2**	1.48**
LSD Sij 5%	0.09	1.49	0.58	0.1	0.52	0.12	0.01
LSD Sij 1%	0.13	2	0.77	0.13	0.7	0.16	0.01
LSD sij-sik 5%	0.17	2.7	1.04	0.18	0.94	0.22	0.02
LSD sij-sik 1%	0.23	3.61	1.4	0.24	1.26	0.3	0.02
LSD sij-skl 5%	0.16	2.5	0.97	0.17	0.87	0.2	0.01
LSD sij-skl 1%	0.21	3.34	1.29	0.22	1.16	0.27	0.02
r							
F_2							
1x2	0.03	6.49**	3.24**	-0.38**	2.87	0.36	-0.86**
1x3	-0.03	-19.91**	-11.46**	0.19**	-9.33**	-1.7**	0.63**
1x4	-0.04	3.31**	1.93**	0.22**	1.65	0.41	-0.05
1x5	-0.08*	-8.05**	-4.76**	-0.66**	-3.37*	-1.03**	-1.08**
1x6	0	12.33**	5.13**	0.19**	1.88	0.41	-0.53**
2x3	0	19.28**	9.28**	0.08	4.78**	1.06**	1.16**
2x4	-0.06	-1.68*	-2.98**	0.31**	-3.44*	-0.58*	-0.01
2x5	0	-4.8**	-2.4**	0.56**	-1.04	0.06	-0.18*
2x6	-0.03	-11.54**	-5.4**	-0.09	-9.65**	-1.91**	-1.41**
3x4	-0.24**	-4.28**	-1.68*	0.43**	0.18	0.21	0.33**
3x5	-0.08*	-4.44**	-2.66**	0.02	-2.51	-0.5	-0.35**
3x6	-0.09**	-4.22**	-2.55**	-0.58**	-0.96	-0.62*	-1.73**
4x5	0.02	-11.53**	-6.2**	-0.68**	-6.36**	-1.49**	0.3**
4x6	-0.22**	1.41	-1.63*	-0.34**	-3.1*	-0.95**	0.74**
5x6	0.04	1.15	-1.04	-0.42**	-2.19	-0.75*	0.82**
LSD Sij 5%	0.06	1.59	1.36	0.09	3.01	0.57	0.13
LSD Sij 1%	0.09	2.13	1.82	0.12	4.02	0.76	0.18
LSD sij-sik 5%	0.12	2.87	2.46	0.16	5.44	1.03	0.24
LSD sij-sik 1%	0.16	3.85	3.29	0.22	7.27	1.37	0.32
LSD sij-skl 5%	0.11	2.66	2.28	0.15	5.03	0.95	0.22
LSD sij-skl 1%	0.15	3.56	3.05	0.2	6.73	1.27	0.3
r	0.68**	0.84**	0.88**	0.73**	0.83**	0.77**	0.72**

* $p< 0.05$; ** $p< 0.01$ and r refer to the correlation coefficient between SCA effects for hybrid and its mean performance.

As for boll weight the cross P_1xP_5 in F_1 generation and the crosses of: P1xP6, P_2xP_3, P_2xP_4, P_2xP_5 and P_5xP_6 gave significant and positive $\hat{S}_{ij}$ effects. With regard to both traits Seed cotton yield lint yield, five crosses (P1xP2, P_1xP_4, P_1xP_6, P_2xP_3 and P_5xP_6) and four crosses (P1xP2, P_1xP_4, P_1xP_6 and P_2xP_3) expressed significant and positive $\hat{S}_{ij}$ effects at F_1 and F_2 generation, respectively.

Such results indicate that the behavior of the four crosses P1xP2, P_1xP_4, P_1xP_6 and P_2xP_3 was the same in $\hat{S}_{ij}$ effects of F_1 and F_2 which the mention crosses recorded the highest desirable $\hat{S}_{ij}$ effects for the two traits. The other crosses had either significant negative or insignificant $\hat{S}_{ij}$ effects for these traits.

As for seed index; the crosses P_1xP_3, P_1xP_4, P_1xP_5, P_2xP_4, P_2xP_5 and P_3xP_4 in F_1 and six crosses in F_2 i.e. P_1xP_3, P_1xP_4, P_1xP_6, P_2xP_4, P_2xP_5 and P_3xP_4 gave desirable $\hat{S}_{ij}$ effects for this trait.

For, lint percentage, the crosses P_1xP_2, P_1xP_4, P_1xP_6, P_2xP_3 and P_3xP_4 in F_1 and the cross P_2xP_3 in F_2 showed desirable $\hat{S}_{ij}$ effects for this trait. Regarding, Lint index, five crosses i.e. P_1xP_2, P_1xP_6, P_2xP_3, P_2xP_5 and P_3xP_4 in F_1 and the cross P_2xP_3 in F_2 showed exhibited significant and positive $\hat{S}_{ij}$ effects. Inter-and intera-allelic interactions were detected in the cross P2xP3 in both generations.

For, oil%, ten and six crosses had significant and positive $\hat{S}_{ij}$ effects in F_1 and F_2 generations, respectively. The crosses P_1xP_3, P_2xP_3, P_3xP_4, P_4xP_5, P_4xP_6 and P_5xP_6 gave the highest desirable $\hat{S}_{ij}$ effects in both generations.

If crosses of high SCA involve both parental lines which also are good combiners, they could be exploited for breeding varieties. Nevertheless, if crosses of high SCA involve only one good combiner, such combinations would throw out desirable transgressive segregates provided that the additive genetic system in the good combiner (as well as complementary and epistatic effects in the crosses) act in the same direction to reduce undesirable characteristics and maximize the character under consideration. The correlation coefficient between mean performance of crosses and their $\hat{S}_{ij}$ effects was positive and significant. Therefore, the mean performance of crosses could be a reliable and effective indication for their specific combining ability effects for all studied traits.

The obtained results are in harmony with previous studies used GCA and SCA to identify good combiners and good cross combinations as El-Hosary (2014), Al-Ashmoony *et al.* (2016); Khalifa *et al.* (2016); Orabi *et al.* (2017); Baker and El-Areed (2018); Ekinci and Basbag (2018) and Chaudhary *et al.* (2019).

References

Abd El Samad H.S., A.A. El Hosary, El.S. M.H. Shokr, M.E. El-Badawy, A.E.M. Eissa, A.A.A. El Hosary (2017). Selecting high yield and quality cotton genotypes using phenotypic and genotypic stability statistics. Egypt. J. Plant Breed. 21(5):642-653.

Al-Ashmoony, M. S. F., Tantawy, A. A., El-Fesheikawy, A. B. A., and Ibrahim, F. M. (2016). Diallel analysis for earliness, yield components and fiber quality traits in Egyptian cotton. El-Minia Journal of Agricultural Research and Development. 36(3), 529-549.

Baker, K. M., and El-Areed, S. R. (2018). Potential of foreign genotypes *G. barbadense* for the improvement of yield in Egyptian cotton. Egyptian Journal of Plant Breeding. 22(2), 343-355.

Basal, H. and Turgut, I., (2005). Genetic Analysis of Yield Components and Fiber Strength in Upland Cotton (*Gossypium hirsutum* L.). Asian Journal of Plant Sciences, 4: 293– 298.

Bellaloui, N., Stetina, S. R., and Turley, R. B. (2015). Cotton seed protein, oil, and mineral status in near-isogenic *Gossypium hirsutum* cotton lines expressing fuzzy/linted and fuzzless/linted seed phenotypes under field conditions. Frontiers in plant science, 6, Article 137, 1-14.

Bilwal, B. B., Vadodariya, K. V., Rajkumar, B. K., Lahane, G. R., and Shihare, N. D. (2018). Combining ability analysis for seed cotton yield and its component traits in cotton (*Gossypium hirsutum* L.). International Journal of Current Microbiology and Applied Sciences, 7(7), 3005-3010.

C.A.T.G.O. (2019). Cotton arbitration and testing general organizatio. (on-line) available at http://www.egyptcotton-catgo.org.

Chaudhary, M. T., Majeed, S., Shakeel, A., Du Yinhua, J., and Xiongming, M. T. A. (2019). Estimation of heterosis and combining ability for some quantitative parameters in *Gossypium hirsutum*. International Journal of Biosciences, 15(2), 166-173.

Cruz C.D. and Vencovsky, R., (1989). Comparação de alguns métodos de análise dialélica. Revista Brasileira de Genética, 12: 425–438.

Ekinci, R., and Basbag, S. (2018). Combining ability analysis and heterotic effects for cotton fiber quality traits. Ekin Journal of Crop Breeding and Genetics, 4(2), 20-25.

El-Aref, K. A., Zaher, A. E., Haridy, M. H., and Shrmokh, H. M. (2019). Genetic analysis for diallel crosses on Egyptian cotton (*Gossypium barbadense* L.). Assiut Journal of Agricultural Sciences, 50(3), 1-15.

El-Hosary, A.A.A. (2014) Comparison between some methods of diallel cross analysis in maize. Egypt. J. Plant Breed. 18 (4):715 –736.

Griffing, B., (1956). Concept of general and specific combining ability in relation to diallel crossing systems. Australian Journal of Biological Sciences, 9: 463–493.

Hussain, A., Zafar, Z. U., Athar, H. U. R., Farooq, J., Ahmad, S., and Nazeer, W. (2019). Assessing gene action for hypoxia tolerance in cotton (*Gossypium hirsutum* L.). Agronomía Mesoamericana, 30(1), 51-62.

Khalifa, H. S., Said, S. R. N., and Eissa, A. E. M. (2016). Diallel analysis on some Egyptian cotton genotypes for earliness, yield components and some fiber traits. Egyptian Journal of Plant Breeding, 20(1), 11-25.

Malathi, S., Patil, R. S., and Saritha, H. S. (2019). Heterosis studies in interspecific cotton hybrids (*Gossypium hirsutum* L.× *Gossypium barbadense* L.) under irrigated condition. Electronic Journal of Plant Breeding, 10(2), 852-861.

Mokadem, S. 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. Journal of Plant Production, Mansoura University, 11(2), 189-193.

Monicashree, C., Amala Balu, P., and Gunasekaran, M. (2017). Heterosis studies for yield and fiber quality traits in upland cotton (*Gossypium hirsutum* L.). Indian Journal of Pure and Applied Biosciences, 5(3), 169-186.

Orabi, M. H. M., Ali, S. E., El-Hoseiny, H. A., and Saleh, E. M. (2017). Estimates of heterosis and gene action for yield components and fiber traits in *Gossypium barbadense*, L. Journal of Plant Production, 8(12), 1439-1444.

Ramalho M.A.P., Santos J.B. dos, and Diallel analysis on cotton 215 Genetics & Plant Physiology 2014 vol. 4 (3–4) Special Issue (Part 2) Zimmermann M.J.O., 1993. Genética quantitativa em plantas autógamas: aplicações no melhoramento do feijoeiro, Goiânia: UFV, pp 271.

Sedhom AS, M.E.M. EL-Badawy, A.A.A.El Hosary, M.S. Abd El-Latif, A.M.S. Rady, M.M.A. Moustafa, S.A. Mohamed, O.A.M. Badr, S.A. Abo-Marzoka, K.A. Baiumy and M.M. El-Nahas(2021) Molecular markers and GGE biplot analysis for selecting higher-yield and drought-tolerant maize hybrids. Agronomy Journal, 2021;1–15.

Taha, E. M., El-Karamity, A. E., Eissa, A. E. M., and Asaad, M. R. (2018). Heterosis and combining ability of some Egyptian cotton genotypes. El-Minia Journal of Agricultural Research and Development. 38(1), 1-61.

Vasconcelos, U. A. A., Cavalcanti, J. J. V., Farias, F. J. C., Vasconcelos, W. S., and Santos, R. C. D. (2018). Diallel analysis in cotton (*Gossypium hirsutum* L.) for water stress tolerance. Crop Breeding and Applied Biotechnology, 18(1), 24-30.

Verhalen, L. M. and Murray, J.C., (1967). A Diallel Analysis of Several Fiber Property Traits in Upland Cotton (*Gossypium hirsutum* L.). Crop Science, 7: 501–505.

Zhang, J. F., Abdelraheem, A., and Wu, J. X. (2017). Heterosis, combining ability and genetic effect, and relationship with genetic distance based on a diallel of hybrids from five diverse *Gossypium barbadense* cotton genotypes. Euphytica, 213(9), 1-15.

تقدير الفعل الجينى و قوة الهجين فى الهجن التبادلية للجيل الاول و الثانى فى القطن

حسين سلامه عبد الصمد[1] , على عبد المقصود الحصرى٢ ,محمود الزعبلاوى البدوى٢ , أنور عيسى مسعود عيسى١

١– قسم بحوث القطن – معهد بحوث القطن – مركز البحوث الزراعية الجيزة – مصر

٢– قسم المحاصيل – كلية الزراعة – جامعة بنها

تم تقدير قوة الهجين والتأثير الجيني على نسبة الزيت ، المحصول و مكوناته في الهجن التبادلية بين ٦ تراكيب وراثية من القطن و الجيل الثانى لهم وذلك لتحديد واختيار برنامج مناسب للتهجين و الانتخاب فى برامج القطن لتحسين محصوله في مصر. تم تقييم الاباء ، الجيل الاول و الثانى في تصميم القطاعات العشوائية الكاملة (RCBD) بثلاثة مكررات و اخذت الصفات المحصولية ونسبة الزيت و صفات التيلة و في موسم ٢٠٢١. كان متوسط التباين للاباء و الهجن عالية المعنوية للصفات المدروسة في كلا الجيلين. واظهرت قوة الهجين معنوية عالية فى الجيل F1 لجميع الصفات المدروسة. وبلغت قوة الهجين المرغوب مقارنتها بالأب الأفضل من ٥.٣٦ إلى ٢٥.٢٩ ، ٥.٩٢ إلى ٣٣ ، ٢.٣ إلى ٥.٨٩ و ١.١٤ إلى ٧.٣٨ في هجن الجيل الأول لمحصول القطن الزهر، محصول القطن الشعر ، وزن ١٠٠ بذره ونسبة الزيت على التوالي. كان الهجين P2xP3هو أفضل هجين لجميع الصفات المدروسة. كانت تباينات القدرة العامة والخاصة معنوية لجميع الصفات المدروسة. وأظهرت النسبة بين القدرة العامة و الخاصة على التالف (اقل من الوحدة) الأهمية النسبية للجزء المضيف لصفات محصول القطن الزهر ، محصول القطن الشعر ، وزن ١٠٠ بذره وتصافى الحليج في الجيل الاول لمحصول القطن الزهر ومحصول القطن الشعر في الجيل الثانى وكان الاب الاول ذات تأثيراً مرغوباً معنوياً فى القدرة العامة على التالف بالنسبة لتصافى الحليج ومحصول القطن الشعر ونسبة الزيت في الجيل الاول ومحصول القطن الزهر وتصافى الحليج ونسبة الزيت في الجيل الثانى و اظهر الهجين P2xP3تأثيرات قدرة خاصة على التالف مرغوبة بشكل كبير لمعظم الصفات المدروسة.