J. of Plant Production, Mansoura Univ., Vol. 11 (7):579-586, 2020

Journal of Plant Production

Journal homepage: www.jpp.mans.edu.eg
Available online at: www. jpp.journals.ekb.eg

Gene Action and Combining Ability Analysis in some Soybean Quantitative Characters

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ABSTRACT

This present investigation was carried out at Food Legumes Department, Sakha Agricultural Research Station, Agriculture Research Center, Egypt, in summer 2016 and 2017 seasons. Six parental genotypes of soybean were used in this study. In 2016, the Six soybean genotypes were used as parents in half diallel cross mating design. In the second season, the experimental were conducted to evaluate the yield potential and agronomic performance of the obtained F1's hybrids of the fifteen crosses compared with their parents. The results could be summarized as follows: Mean squares for genotypes, General and specific combining ability were highly significant for all the studied traits. The parental line L75-6648 was the best of tested parent in flowering and maturity dates. Also, the crosses Giza111 X Giza21 and L75-6648 X Giza21 , exhibited the lowest mean values for these traits. The parental L75-6648 as well as the crosses L75-6648 X Giza111 and Toano X Giza111, were taller in plant height than their parental means. For number of pods and seeds per plant, the parents Giza111 and Giza21 as well as the crosses Pershing X Giza111 and Holladay X Giza21 gave the highest values for number of pods and seeds per plant. For seed yield per plant, the two parents, Giza21 and Giza111 gave the highest values of this trait. The crosses Pershing X Giza111, Toano X Giza111, Holladay X Giza21 and Giza111X Giza21 gave the highest values for seed yield/plant. The parental variety Giza111(P5) gave significant negative (gi) effects for flowering and maturity dates.

Keywords: Gene action - combining ability – heritability - hetrossts

INTRODUCTION

Soybeans *(Glycine max L. Merrill)* occupy a premier position among crops, making soybeans one of the first domesticated food crops. Soybeans became one of the main food crops in the world. In Egypt, soybean production commercial in 1970, and during the 2011's, the area cropped to soybean has averaged 8,903 ha with an average yield of 2.14 t/ha. In the world soybeans were planted on 103, 83 million hectares in 2011season, producing about 259, 22 million metric tons of soybeans.

Soybean is the major oil crop in the world, which share with about 30% of the total world production of edible oil. Also soybean share more than 60% of the world production of high pratem meal. Twenty five percent of the total worldwide soybean production is commonly used in the international trade market in the from of whole beans. The major soybean exporters are the USA, Brazil and Argentina. About 90% soybean oil is processed for human consumption as cooking oil and margarine. Recently it was realized that soybean is valuable to Egypt because of its high oil and protein content. The high protein meal of soybean is popular now in poultry industry and many human food production. Although the local soybean production has decreased through this period, the local demand for soybean has extremely increased, which was covered by the imported soybean. The production in local soybean. Production was attributed mainly to the low price of the imported soybean and the low competitive value of soybean against the other summer crops. Soybean seeds contain about 14-24% oil, 30-50% of protein and lysine as well as phosphorus, calcium and vitamin A,C,B1,B2,B6,B12 and B19 which are important for human and animal feeding. Genetic improvement of soybean cultivars has played as a major productive oil crop. Soybean production in Egypt started with the introduced cultivars fro USA. Which were evaluated for their agronomic characteristics and the most desirable parameters. Developing heterogenous population through hybridization among the desired genotypes was always the optimum tool for breeder to improve crop yield and seed quality, especially for the self – pollinated crops. This procedure was used in Egypt to develop high yielding soybean cultivars with desired agronomic characters such as resistance to leaf foding insects.The present study aimed to: 1) evaluate the performance of six parental lines and their F_1crosses. 2) study the effects of general and specific combining ability. 3) study the effects of heterosis over mid and better-parent. 4) estimate the genetic variance components and heritability in both broad and narrow sense for studied characters.

MATERIALS AND METHODS

Materials

The present investigation was carried out at the Experimental Farm,of Sakha Agricultural Research Station (SARS), Kafr El-Sheikh, Egypt, during the summer seasons of 2016 and 2017. Six parental genotypes of soybean [*Glycine max* (L) Merrill] 2n = 40 namely: P1- Pershing, P2- Toano, P3- Holladay, P4- L75-6648, P5- Giza111 and P6- Giza21 were used in this study. The name, pedigree, maturity group, origin, flower color and growth habit of the studied genotypes are shown in Table 1

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DOI: 10.21608/jpp.2020.110543

Table 1. Code number, name, pedigree, maturity group, origin, flower color and growth habit of the studied soybean genotypes

Code No	Name	Pedigree	Maturity group	Origin	Flower color	Growth habit
1	Pershing	D76-3297 X Essay	VI	USDA, ARS, Illinois	White	Susceptible
2	Toano	Ware x Essex	V	Virginia AES	Purple	determinate
3	Holladay	N77-179 x Johnston	VI	USRSL	Purple	determinate
4	L75-6648	Selected from Clark	III	USDA,ARS,Illinois	Purple	Indeterminate
5	Giza 111	Crawford X Celest	IV	FCRI*	Purple	Indeterminate
6	Giza 21	Crawford XJohnston Celest	IV	FCRI*	Purple	Indeterminate

USDA = U.S. Regional soybean laboratory at Urbana, Illinois, and Stoneville, Mississippi.
AES = Agricultural Experiment Station. USRSL = U.S. Department of Agriculture. FCRI = Field Crops Research Institute, Giza, Egypt.

Methods:

In the first season 2016, the Six soybean genotypes were used as parents in half diallel cross mating design. So, the six genotypes were sown in three planting dates to avoid differences in flowering time and to insure enough hybrid seeds. During this season, all the possible cross combinations (without reciprocals) among the six soybean varieties (five teen crosses) were made by hand.

In the second season, the experimental were conducted to evaluate the yield potential and agronomic performance of the obtained F_1's hybrids of the five teen crosses compared with their parents. The experimental design was Randomized Complete Block Design (RCBD) with three replications. The plot size was one ridges in the F_1 and parents experiments. Each ridge was three meters long and 70 cm apart. Seeds were planted on one side of the ridge at 20 cm hill spacing with one seed per hill. The wet planting method (Herati) was used and the other cultural practices were followed as recommended.

The following readings and measurements were recorded at individual plant basis at harvesting. Data were recorded as an average of 30 individual guarded plants chosen at random for etch genotypes . Nine agronomic characters related to seed yield were chosen for this study these characters were flowering date, maturity date, plant height, number of branches per plant, number of pods per plant, number of seeds per plant, number of seeds per pod, 100 seed weight and seed yield per plant.

Statistical and genetical analyses:-

All the data collected were subjected to statistical analysis of variance as described by Snedecor and Cochran (1980). Heterosis as proposed by Mather and Jinks (1971) was determined as the deviation of the F1 means from mid-parent (MP) and better parent (BP) means and expressed as percentage. Average heterosis value for each trait was computed as parents vs. F1 hybrids. In the procedure, genotypes were subdivided to their components (parents, crosses and parents vs. crosses). General and specific combining ability estimates were obtained by using Griffing's (1956) diallel cross analysis designated as method 2 model 1. The data obtained for each trait were further subjected to diallel cross analysis described by Hayman (1954), to obtain more information about the genetic behavior of the traits under study. Heritability estimates in both broad and narrow senses for all traits studied were obtained as described by Mather and Jinks, (1982)

RESULTS AND DISCUSSION

1- Analysis of variance and mean performance:-

The analysis of variance as shown in table (2) revealed highly significant differences were detected among genotypes for all studied characters. These results indicate that genotypic differences between entries were present. Mean square values of parents and F1 crosses were found to be highly significant for all traits. These results could be used as indication to average heterosis overall crosses and there for could be used through breeding program to improve such traits. The differences between mean square values for parents Vs. crosses were highly significant for all studied traits, indicating that, non-additive (dominance or epitasis) genetic variances were of great importance in the inheritance of these traits. Similar results were obtained by Durai and Subbalakshmi, (2009) and Shiv *et al.*(2011).

Table 2. Mean squares for ordinary and combining ability analysis for all the studied traits.

S.O.V	DF	Flowering date (days)	Maturity date (days)	Plant height(cm)	No.of branches/plant	No.of pods/ plant	No.of seeds /plant	No.of seeds /pod	100-seed weight (g)	Seed yield /plant(g)
Replications	2	9.375	14.262	51.864	1.066	185.849	45.423	0.095	0.427	0.87
Genotypes	20	68.609**	159.081**	1334.903**	1.180**	559.301**	2592.510**	0.380**	9.076**	74.940**
parents	5	117.873**	199.571**	1970.452**	1.800**	810.351**	5468.671**	1.060**	28.298**	148.197**
crosses	14	52.873**	143.532**	867.477**	0.953**	329.664**	1625.814**	0.108**	1.969**	36.021**
P V Cross	1	42.593**	174.323**	4701.116**	1.259**	2518.960**	1745.443**	0.785**	12.470**	253.516**
Error	40	0.224	1.406	5.566	0.043	2.146	29.769	0.004	0.006	0.86
g ca	5	72.95**	168.40**	1230.50**	1.31**	413.91**	2697.84**	0.31**	8.03**	55.81**
s ca	15	6.17**	14.56**	183.12**	0.08**	110.60**	252.94**	0.06**	1.35**	14.70**
gca/sca		1.493	1.489	0.847	2.266	0.47	1.383	0.606	0.741	0.482

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

Mean performance values for parents and their F1's.

Mean performance of the different traits of soybean genotypes are shown in Table (3).The parental line L75-6648(P4) was the best of tested parents in flowering and maturity dates. This result is logically excepted where the L75-6648(P4) belong to maturity group III and the other varieties belong to maturity group IV or more. As well as the F1 crosses, the best crosses were (Pershing X Giza21) and (Giza111X Giza21) for flowering date and (Giza111X Giza21) and (L75-6648X Giza21) for maturity dates. For plant height and number of branches per plant, the parent L75-6648(P4) gave the best values for plant height, however, the parents variety Pershing (P1) and Toano (P2) gave the highest values for number of branches per plant. Concerning F1 hybrids, the crosses (L75-6648X Giza111) and (Toano X Giza 111), were teller in plant height than their parental means. For number of pods and seeds per plant, the parents Giza111 (P5) and Giza21 (P6) as well as the crosses (Pershing X Giza111) and (Holladay X Giza21) gave the highest values for for number of pods and seeds per plant, as well as the crosses (Pershing X Holladay)and (Pershing X L75-6648), gave the highest values for this traits. For 100- seed weight, the parents Holladay(P3) and Toano (P2), as well as crosses (Toano X Holladay) and

(Holladay X L75-6648) were superior in 100- seed weight ,while the lowest weight were found in the parent Pershing (P1) and the crosses (Pershing X Holladay) and (Pershing X Giza21). For seed yield per plant, the two parents, Giza21 (P6) and Giza111 (P5) gave the highest values of this trait. However, the parental variety Pershing (P1) gave the lowest one.

Table 3. Mean performance of parents and F1 crosses for all the studied traits.

Genotype	Flowering date (days)	Maturity date (days)	Plant height(cm)	No.of branches /plant	No.of pods / plant	No.of seeds /plant	No.of seeds /pod	100-seed weight (g)	Seed yield /plant(g)
Pershing(P1)	45.78	145.25	56.29	5.53	62.36	216.16	3.47	10.53667	22.78
Toano(P2)	51.57	137.11	63.1	5.34	80.37	141.5	1.94	18.35	25.96
Holladay(P3)	50.95	134.51	68.33	4	76	139.16	1.83	19.29	26.83
L75-6648(P4)	37.17	123.97	103.21	3.85	90.71	193.17	2.13	16.52	31.9
Giza111(P5)	37.7	130.36	115.05	3.88	102.29	218.23	2.13	16.41	35.8
Giza21(P6)	46.65	124.29	106.64	4.05	105.3	241.99	2.3	17.21	41.63
Grand mean (parents)	44.97	132.58	85.44	4.44	86.17	191.7	2.3	16.38	30.82
Pershing x Toano	47.61	139.63	73.35	5.95	92.94	211.86	2.28	17.31	36.67
Pershing X Holladay	46.18	143.55	75.13	5.47	78.16	196.15	2.51	15.78	30.95
Pershing X L75-6648	38.76	125.27	102.83	5.03	92.23	193.65	2.1	17.63	34.13
Pershing X Giza111	39.53	131.61	112.18	4.51	113.4	229.05	2.02	16.74	38.84
Pershing X Giza21	37.57	127.71	99.49	5	106.4	230.27	2.17	16.12	37.07
Toano X Holladay	52.61	135.11	71.83	5.32	94.94	166.89	1.97	19.18	32
Toano X L75-6648	42.75	130.61	110.5	5.26	99.4	197.36	1.99	17.74	35
Toano X Giza111	44.4	132	121.15	4.48	109.4	217.09	1.99	17.51	38
Toano X Giza21	47.75	131	113.7	4.74	111.4	211.46	1.9	17.58	37.17
Holladay X L75-6648	40.3	126.99	114.83	4.56	83.52	152.13	1.82	18.11	27.5
Holladay XGiza111	41.45	123.51	113.49	4.35	104.94	202.06	1.93	17.52	35.4
Holladay X Giza21	45.65	122.08	112.77	4.08	110.38	213.9	1.94	17.68	38.17
L75-6648X Giza111	40.88	122.9	119.93	4.35	95.16	202.29	2.13	16.81	34
L75-6648X Giza21	38.75	118.01	112.27	4.05	103.27	186.25	1.8	17.72	33
Giza111X Giza21	43.03	123.53	114.93	4.16	107	239.87	2.24	17.12	41
Grand mean (crosses)	41.68	122.84	114.7	4.26	100.71	199.42	1.98	17.49	34.84
Lsd0.05	0.77	1.94	3.85	0.34	2.39	8.91	0.11	0.13	1.51
Lsd0.01	1.02	2.58	5.12	0.45	3.18	11.85	0.15	0.18	2.01

The crosses (Pershing X Giza111), (Toano X Giza111), (Holladay X Giza21) and (Giza111X Giza21) gave the highest values for seed yield/plant. While, the F1 of both crosses between Holladay and each of Pershing and L75-6648had the lowest mean values of seed yield per plant. similar results were obtained by Friedrichs, (2009), Durai, and Subbalakshmi, (2009), Shiv *et al.* (2011) and Shehzad *et al.* (2015).

2- Estimation of heterosis:

Heterosis relative to mid - parent and better- Parent average values for all the studied traits are presented in table (4).

With regard to flowering date, eleven and ten Crosses had highly significant negative heterosis, which ranged from (-18.70 to-2.18) and (-20.90 to -7.39) over the mid and better parent respectivily, the highest significant negative value was (-18.70) for the cross (Pershing X Giza21) over the mid-parent. The results indicate to could be used the cross (Pershing X Giza21) in breeding program to improve the earliness in soybean Crop. For maturity date, seven Crosses manifested highly significant negative heterotic effects over mid- parent, also, the Crosses (Pershing X L75-6648) and (Pershing X Giza21) gave highly significant negative heterotic effects relative to better – parent. Hence, it could be concluded that these Crosses are valuable in breeding for earliness. Significant negative heterotic effects for flowering and maturity dates were found by by Habeeb (1988b), El-Refaey and Radi (1991), Ibrahim *et al.* (1996), Bastawisy *et al.* (1997), El-Hosary *et al.* (1997), Ragaa *et al.* (1998), Refat (1998), El-Hosary *et al.* (2001), Mansour *et al.* (2002) and Ramana and Satyanarayana (2006b.)

For plant height, the all Crosses had highly significant positive heterosis effects relative to mid- parent, which ranged from (3.69 to 36.01). Also, the Crosses (Pershing x Toano) and (Holladay X L75-6648) gave highly significant positive heterosis effects relative to better- parent . For number of pods per plant, thirteen and nine Crosses exhibited highly significant positive heterotic effects. Ranged from (3.09 to 37.74) and (2.59 to 18.13) relative to mid and better- parent respectively. The Crosses (Pershing x Toano), (Pershing X Giza111), (Toano X H0lladay) and (Toano X Giza21) had the most desirable heterotic effects for this trait.

The results agreed with those reported by (Ibrahim *et al.* (1996), Refat (1998) and El-Hosary *et al.*.(2001). Pandini, *et al.* (2002), Ramana and Satyanarayana, (2006b.) Ramana and Satyanarayana, (2006b.) Ramana and Satyanarayana, (2006b.) Sudaric, *et al.* (2009), Durai and Subbalakshmi (2010) and Nassar MAA 2013).

For number of seeds per plant, ten hybrids showed significant and highly significant positive heterotic effects relative to mid-parent. While, the one Crosse expressed significant positive heterotic effects relative to better- parent. For 100-seed weight. eleven hybrid showed highly significant positive heterotic effects relative to mid- parent, ranged from (1.88 to 30.32).while, four Crosses expressed highly significant positive heterotic effects relative to better- parent. Ranged from (1.76 to 6.73), significant positive heterotic effects were reached before by Habeeb *et al.* (1988 a), Refat (1998), El-Hosary *et al.* (2001). Pandini *et al.* (2002), Gravina *et al.* (2003), Ramana and Satyanarayana, (2006 a), Durai and Subbalakshmi (2010), and assar MAA (2013).

For seed yield per plant, thirteen and seven Crosses manifested highly significant positive heterosis, ranged from (5.90 to 50.44) and (6.15 to 41.22) relative to mid and better- parent respectively. Also the Crosses (Pershing x Toano), (Pershing X Holladay), (Pershing X Giza111), (Toano X Holladay), (Toano X L75-6648) and (Toano X Giza111) had the highest seed yield per plant. These Crosses exhibited heterosis for one or more of traits contributing yield. It could be concluded that these Crosses would be efficient and prospective in breeding programs for improving seed yield per plant. Significant positive heterotic effects relative to higher yielding parent were also reached before by Pandini *et al.* (2002), Gravina *et al.* (2003), Ramana and Satyanarayana,(2006 b), Yang andGai (2009), Sudaric *et al.* (2009), Yin, and Yi, (2009) and Nassar (2013).

Table 4. Estimates of heterosis relative to mid and better parent for all the studied traits.

Genotypes	Flowering date (days)		Maturity date (days)		Plant height(cm)		No.of branches/plant		No.of pods/ plant	
	H M.P	H B.P	H M.P	H B.P	H M.P	H B.P	H M.P	H B.P	H M.P	H B.P
Pershing x Toano	-2.18**	-7.67**	-1.1	-3.87*	22.88**	16.25**	9.45**	7.60**	30.23**	15.64**
Pershing X Holladay	-4.52**	-9.36	2.62**	-1.17**	20.58**	9.96**	14.84**	-1.03	12.98**	2.84
Pershing X L75-6648	-6.55**	-15.34**	-6.94**	-13.76**	28.94**	-0.37**	7.18**	-9.05**	20.50**	1.67**
Pershing X Giza111	-5.30**	-13.66**	-4.50**	-9.40*	30.94**	-2.50*	-4.08*	-18.40**	37.74**	10.86**
Pershing X Giza21	-18.70**	-19.45**	-5.24**	-12.08**	22.12**	-6.71**	4.39	-9.59**	26.92**	1.04
Toano X Holladay	2.63**	2.02**	-0.51	-1.46	9.30**	5.12	13.99**	-0.31	21.43**	18.13**
Toano X L75-6648	-3.65**	-17.10**	0.05	-4.74**	32.88**	7.06**	14.36**	-1.56	16.20**	9.58**
Toano X Giza111	-0.52	-13.90**	-1.30*	-3.73	36.01**	5.30**	-2.71	-16.04**	19.79**	6.95**
Toano X Giza21	-2.76**	-7.39**	0.23	-4.46**	33.97**	6.62**	1.07	-11.17**	20.00**	5.79**
Holladay X L75-6648	-8.53**	-20.90**	-1.74*	-5.59**	33.89**	11.26**	16.04**	13.92**	0.2	-7.93**
Holladay XGiza111	-6.49**	-18.65**	-6.74**	-8.18**	23.77**	-1.36	10.45**	8.75*	17.72**	2.59*
Holladay X Giza21	-6.44**	-10.39*	-5.66**	-9.24*	28.91**	5.75**	1.49	0.91	21.77**	4.82**
L75-6648X Giza111	9.21**	8.44**	-3.36**	-5.72	9.90**	4.24*	12.43**	12.10**	-1.39	-6.97**
L75-6648X Giza21	-7.53**	-16.93**	-4.93**	-5.05**	6.99**	5.27**	2.53	0.08	5.37**	-1.93
Giza111X Giza21	2.03*	-7.75	-2.98	-5.24	3.69*	-0.1	5.01	2.8	3.09**	1.61

Genotypes	No.of seeds /plant		No.of seeds /pod		100-seed weight (g)		Seed yield /plant(g)	
	H M.P	H B.P	H M.P	H B.P	H M.P	H B.P	H M.P	H B.P
Pershing x Toano	18.47**	-1.99**	-15.58**	-34.17**	19.84**	-5.67	50.44**	41.22**
Pershing X Holladay	10.41**	-9.26**	-5.12**	-27.50**	5.80**	-18.2	24.75**	15.33**
Pershing X L75-6648	-5.38**	-10.41*	-24.88**	-39.35**	30.32**	6.73**	24.85**	7.00**
Pershing X Giza111	5.46**	4.96*	-27.83**	-41.69**	24.24**	2.01**	32.60**	8.49**
Pershing X Giza21	0.52	-4.84**	-24.87**	-37.52**	16.23**	-6.30**	15.09**	-10.97**
Toano X Holladay	18.93**	17.95	4.71	1.78	1.91**	-0.57	21.22**	19.25**
Toano X L75-6648	17.94**	2.17	-2.31	-6.70*	1.75**	-3.32**	20.97**	9.72**
Toano X Giza111	20.70**	-0.52**	-2.47	-6.92*	0.75*	-4.58**	23.05**	6.15**
Toano X Giza21	10.28**	-12.62**	-10.38**	-17.39**	-1.13**	-4.20**	9.96**	-10.73**
Holladay X L75-6648	-8.45**	-21.25**	-7.93**	-14.42**	1.17**	-6.10**	-6.36**	-13.79**
Holladay XGiza111	13.08**	-7.41**	-2.85	-9.77**	-1.85**	-9.18**	13.04**	-1.12
Holladay X Giza21	12.24**	-11.61**	-6.02*	-15.60**	-3.11**	-8.33**	11.49**	-8.33**
L75-6648X Giza111	-1.66	-7.30**	-0.25	-0.33	2.10**	1.76**	0.44	-5.03*
L75-6648X Giza21	-14.40**	-23.03	-18.53**	-21.51**	5.07**	2.96**	-10.24**	-20.74**
Giza111X Giza21	4.24*	-0.87**	1.11	-2.51	1.88**	-0.48	5.90**	-1.52**

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

3- Combining ability effects.

The general combining ability effects (GCA) of the parents and Specific combining ability effects (SCA) of the parental combinations for F1 are presented in table (5).

I-General combining ability effects.

The parental variety Giza111(P5) gave significant negative (gi) effects for flowering and maturity dates. The same parental variety, gave significant positive (gi) effects for plant height, number of pod and seeds per plant and seed yield per plant. The parental variety L75-6648(P4) ranked the first good combiner for earliness (flowering and maturity dates). Also, it gave significant positive (gi) effects for plant height and 100-seed weight .However, it gave undesirable (gi) effects for other traits. The parental variety Giza21(P6) exhibited significant positive (gi) effects for plant height, number of pods, number of seeds, 100-seed weight and seed yield per plant. These results were coincident with those reported by Cho (2006), Ramana and Satyanarayana (2006 a), Solgotra *et al.* (2009), Durai and Subbalakshmi (2010), Shiv *et al.* (2011), Nassar M. (2013) and Shehzad *et al.*(2015),

II-Specific combining ability effects

For flowering and maturity dates, nine and six crosses exhibited highly significantly negative effects at F1 crosses respectively. The crosses (Pershing X Giza21) and (Holladay XGiza111) exhibited the best (SCA) effects for flowering and maturity dates in F1 crosses. However, the best crosses were (Pershing X Giza21), (Holladay X L75-6648) and (Holladay XGiza111) for flowering date and the crosses (Pershing X L75-6648), (Holladay XGiza111), (Holladay X Giza21) and (Pershing X Giza21) for maturity date. On the other side, four and two parental combinations exhibited significantly positive SCA effects for flowering and maturity dates respectively. For plant height, nine cross exhibited significant positive SCA effects, the highest positive SCA effects obtained by cross (Toano X Giza111) followed by crosses (Holladay X L75-6648) and (Toano X Giza21). On the other side, four parental combinations exhibited significantly negative SCA effects for plant height. For number of branches, pods, seed per plant and number seed per pod six, ten, eight and five crosses had significant positive SCA effects in F1 respectively. Also, the results indicated that the crosses (Pershing x Toano), (Toano X Holladay) and (Toano X L75-6648) had the highest significant positive SCA effects For number of branches, pods, seed per plant. Regarding 100-seed weight, six parental combination exhibited significantly positive SCA effects in F1 crosses. The crosses (Pershing X L75-6648), (Pershing X Giza111) and (Pershing x Toano) were the best hybrid in F1 crosses. Concerning seed yield per plant ten parental combinations expressed significant positive SCA effects in F1 crosses. The rest crosses gave insignificant or significant negative SCA effects in the same order. These findings were also found by Gravina *et al.* (2003), Ramana and Satyanarayana (2006 a), Solgotra *et al.* (2009), Durai and Subbalakshmi (2010), Shiv *et al.* (2011), NassarM.A.A. (2013) and Shehzad *et al.*(2015).

4- Genetic components Analysis:-

I-Estimates of genetic variance components:

The computed parameters as described by Hayman (1954) for all traits are presented in table (6). The additive genetic variance (D) was highly significant for all traits. It is clear that the additive effect plays major role in the inheritance of these traits. The dominance genetic variations (H1) and (H2) were significant for all studied traits. Comparing between the magnitude of additive and dominance components revealed that, the additive component was more important than dominance component for these traits. With regard to (F) parameter, it is apparent form the table (6) that the values of studied traits were not significant for flowering dates, plant height and number of pods per plant. The significant values of (F) for these characters might indicate that there is a symmetric gene distribution or the equality in the relative frequencies of dominant and recessive genes in the parents. On the other hand, the (F) values were significant and positive for number of seeds per plant and pod, 100-seed weight and seed yield per plant. This might indicate that the dominance genes were more frequent in the parental lines and the majority is for the dominant genes. The (F) values were insignificant and negative for maturity date and number of branches per plant, this might indicate that the recessive gene were more frequent in the parental lines and the majority is for the recessive genes. The overall dominance effects of heterozygous loci (h2) were significant and positive for all traits. This indicates that dominance variance over all the heterozygous loci is important in the inheritance of these traits. Similar results were previously reported by Karad, *et al.* (2005), Singh, *et al.* (2010), Datt, *et al.* (2011 b), Shiv *et al.* (2011), Raulji *et al.* (2014) and Shehzad *et al.* (2015).

Table 5. Estimates of general and specific combining ability effects of parents and F1 crosses for all the studied traits .

Genotypes	Flowering date (days)	Maturity date (days)	Plant height(cm)	No.of branches/plant	No.of pods/ plant	No.of seeds /plant	No.of seeds /pod	100-seed weight (g)	Seed yield /plant(g)
Pershing(P1)	-0.557**	6.075**	-14.763**	0.544**	-8.168**	11.642**	0.394**	-1.870**	-1.840**
Toano(P2)	4.072**	4.114**	-9.617**	0.473**	-0.547	-14.065**	-0.107**	0.799**	-0.896**
Holladay(P3)	2.800**	1.324**	-8.621**	-0.108**	-6.156**	-23.840**	-0.128**	0.903**	-2.532**
L75-6648(P4)	-3.738**	-4.743**	9.140**	-0.213**	-2.273**	-10.267**	-0.095**	0.178**	-1.312**
Giza111(P5)	-2.624**	-1.925**	14.765**	-0.381**	7.662**	15.833**	-0.037**	-0.138**	2.613**
Giza21(P6)	0.047	-4.845**	9.097**	-0.315**	9.482**	20.697**	-0.027*	0.128**	3.967**
LSD gi 5%	0.178	0.447	0.889	0.078	0.552	2.055	0.025	0.03	0.349
LSD gi 1%	0.239	0.598	1.189	0.105	0.738	2.75	0.034	0.041	0.467
LSD gi-gj 5%	0.49	1.226	2.44	0.215	1.515	5.643	0.069	0.083	0.959
LSD gi-gj 1%	0.655	1.641	3.265	0.288	2.028	7.552	0.093	0.112	1.284
sij=s 1 x 2	Flowering date (days)	Maturity date (days)	Plant height(cm)	No.of branches/plant	No.of pods/ plant	No.of seeds /plant	No.of seeds /pod	100-seed weight (g)	Seed yield /plant(g)
Pershing x Toano	0.43*	-0.51	-1.36	0.27**	5.48**	14.26**	-0.13**	1.29**	5.41**
Pershing X Holladay	0.27	6.19**	-0.58	0.37**	-3.69**	8.32**	0.12**	-0.34**	1.33**
Pershing X L75-6648	-0.61**	-6.02**	9.36**	0.03	6.50**	-7.75**	-0.32**	2.23**	3.30**
Pershing X Giza111	-0.96**	-2.50**	13.08**	-0.32**	17.74**	1.55	-0.46**	1.66**	4.08**
Pershing X Giza21	-5.59**	-3.47**	6.06**	0.1	8.92**	-2.09	-0.32**	0.78**	0.95*
Toano X Holladay	2.07**	-0.28	-9.03**	0.29**	5.47**	4.77*	0.09**	0.39**	1.44**
Toano X L75-6648	-1.26**	1.29*	11.88**	0.33**	6.05**	21.67**	0.07*	-0.33**	3.22**
Toano X Giza111	-0.72**	-0.14	16.91**	-0.27**	6.12**	15.30**	0.01	-0.24**	2.29**
Toano X Giza21	-0.03	1.78**	15.12**	-0.08	6.29**	4.80*	-0.09**	-0.44**	0.11
Holladay X L75-6648	-2.43**	0.45	15.22**	0.21*	-4.22**	-13.79**	-0.08**	-0.06	-2.65**
Holladay XGiza111	-2.40**	-5.84**	8.25**	0.17	7.26**	10.05**	-0.03	-0.34**	1.33**
Holladay X Giza21	-0.86**	-4.35**	13.20**	-0.16	10.88**	17.02**	-0.03	-0.44**	2.74**
L75-6648X Giza111	3.57**	-0.38	-3.07**	0.28**	-6.40**	-3.3	0.14**	-0.32**	-1.29**
L75-6648X Giza21	-1.23**	-2.35**	-5.07**	-0.09	-0.11	-24.20**	-0.20**	0.32**	-3.64**
Giza111X Giza21	1.94**	0.35	-8.02**	0.19*	-6.31**	3.32	0.18**	0.05	0.43
LSD Sij 5%	0.4	1.01	2.01	0.18	1.25	4.66	0.06	0.07	0.79
LSD Sij 1%	0.54	1.36	2.7	0.24	1.67	6.24	0.08	0.09	1.06
LSD sij-sik 5%	0.73	1.83	3.64	0.32	2.26	8.42	0.1	0.12	1.43
LSD sij-sik 1%	0.98	2.45	4.87	0.43	3.03	11.27	0.14	0.17	1.92
LSD sij-skl 5%	0.68	1.69	3.37	0.3	2.09	7.8	0.1	0.12	1.33
LSD sij-skl 1%	0.91	2.27	4.51	0.4	2.8	10.43	0.13	0.15	1.77

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

II- Estimates of genetic ratios

The estimates of the relationship of these genetic parameters were calculated and presented in table (6). The mean degree of dominance $(H1/D)^{1/2}$ exceeded the unity and showed over dominance for number of pods and seed yield per plant. The mean degree of dominance $(H1/D)^{1/2}$ did not exceed the unity and showed partial dominance for flowering and maturity dates, plant height, number of branches and pod per plant and number of seeds per pod and plant. The proportion of genes with positive to negative gene effects ($H^2/4H^1$) in the parents were around one quarter for positive values of flowering, maturity dates and plant height, implying the equality between the number of positive and negative alleles distributed among the parents for these characters. However, the rest estimates of ($H^2/4H^1$) at the remain of characters were not close enough to one quarter proportion, showing unequal distribution between the positive and negative alleles among the parents. The ratio of dominant to recessive alleles (KD/KR) in the parents was found to be more than unity for all traits except maturity date and number of branches per plant, confirming the existence of more numbers of dominant genes controlled these traits in parents. On the other hand, the (KD/KR) ratios were less than unity for no of maturity date and number of branches per plant, confirming the existence of more recessive genes controlled these traits in the parents. These results were in agreement with those obtained by Alam *et al.* (1984), Habeeb *et al*. (1988 b), El-Hosary *et al.* (1997), Habeeb (1998 b) and El-Hosary *et al*. (2001). Karad *et al.*(2005), Singh *et al.*(2010), Datt *et al.*(2011 b), Shiv *et al.* (2011) , Baraskar *et al.*(2014) and Raulji *et al.*(2014).

III-Heritability

Heritability estimates in both broad and narrow senses for all traits are presented in table (6). High heritability estimates in broad sense (Hb) were detected for all traits under studied. High heritability estimates in narrow sense (Hn) were recorded for flowering and maturity dates and number of branches and seeds per plant. High to moderate estimates of heritability in narrow sense (Hn) were found for plant height and, number of pods per plant, number of seeds per pod, 100-seed weight and seed yield per plant. Similar results were previously reported by Alam *et al.* (1984) and Aditya *et al.*(2011) for most traits, by Kang (1990) and Baraskar, *et al.*(2014) for number of branches per plant and number of seeds per pod. By El-Refaey , Radi (1991b) and Ghodrati (2013)for flowering date, plant height, 100-seed weight, seed yield, number of seeds and pods per plant and number of seeds per pod by Yong *et al.* (1992) Karasu *et al.*(2009) for seed yield; 100-seed weight; and number of (seeds and pods) per plant, plant height, number of pods per plant and seed yield per plant by Choukan (1996) and Raulji *et al.*(2014)for maturity date, first pod height, number of seed per pod and 100-seed weight by Refat (1998) and Ghodrati (2013)for number of seeds per plant and 100-seed weight by El-Hosary *et al.* (2001) for number of pods, number of seeds and seed weight per plant and Mansoure (2002) Osekita and Olorunfemi (2014) for plant height.

Table 6. Estimates of the genetic components and genetic ratios for all studied traits.

genetic Component	**Flowering date (days)**	**Maturity date (days)**	**Plant height(cm)**	**No.of branches/plant**	**No.of pods/ plant**	**No.of seeds /plant**	**No.of seeds /pod**	**100-seed weight (g)**	**Seed yield /plant(g)**
E	0.22	0.67	2.59	0.03*	3.63	10.17	0.01	0.01	0.29
D	39.07**	65.85**	654.23**	0.57**	266.49**	1812.72**	0.35**	9.42**	49.11**
F	6.91	-19.18	57.07	-0.07	123.61	912.25**	0.32**	8.87**	42.04**
H1	24.84**	53.54**	554.86**	0.25**	368.94**	1115.91**	0.26**	6.05**	57.83**
H^2	20.38**	46.94**	549.79**	0.21**	312.37**	730.88**	0.19**	3.84**	39.67**
$h^{\wedge 2}$	9.08*	37.29**	1014.23**	0.25**	542.20**	371.45**	0.17**	2.69**	54.61**
$S^{\wedge 2}$	6.81	37.2	492.66	0.01	842.01	4295.5	0.01	0.35	6.57
genetic ratio	Flowering date (days)	Maturity date (days)	Plant height(cm)	No.of branches/plant	No.of pods/ plant	No.of seeds /plant	No.of seeds /pod	100-seed weight (g)	Seed yield /plant(g)
$(H1/D)^{\wedge 0.5}$	0.8	0.9	0.92	0.66	1.18	0.78	0.87	0.8	1.09
$H^2/4H^1$	0.21	0.22	0.25	0.21	0.21	0.16	0.18	0.16	0.17
KD/KR	1.25	0.72	1.1	0.83	1.49	1.94	3.22	3.85	2.3
r	0.9215	0.714	-0.9618	0.0368	-0.9847	-0.873	0.8484	-0.7671	-0.7552
$r^{\wedge 2}$	0.8492	0.5098	0.925	0.0014	0.9696	0.7621	0.7198	0.5884	0.5704
$h^{\wedge 2}/H^2$	0.45	0.79	1.84	1.24	1.74	0.51	0.9	0.7	1.38
$h^{\wedge 2}$ (n.s)	0.77	0.79	0.68	0.81	0.55	0.77	0.52	0.59	0.55
$H^{\wedge 2}$ (b.s)	0.94	0.99	0.92	0.93	0.96	0.95	0.87	0.97	0.91

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

CONCLUSION

Comparing between the magnitude of additive and dominance components revealed that, the additive component was more important than dominance component for all agronomic traits, implying that selection could be effective. The parental variety Giza111(P5) gave significant negative (gi) effects for flowering and maturity dates. The same parental variety, gave significant positive (gi) effects for plant height, number of pod and seeds per plant and seed yield per plant. The parental variety L75-6648(P4) ranked the first good combiner for earliness (flowering and maturity dates). Also, it gave significant positive (gi) effects for plant height and 100-seed weight .Therefore, these parents are recommended as source of pod shattering resistance and high yielding for soybean breeding program, while, the good crosses for SCA effects for yield and yield components are (Pershing X Giza21) and (Holladay XGiza111) exhibited the best (SCA) effects for flowering and maturity dates in F1 crosses. Also, the crosses (Pershing x Toano), (Toano X Holladay) and (Toano X L75-6648) had the highest significant positive SCA effects For number of branches, pods, seed per plant. These crosses should be advanced for selection in later generations.

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الفعل الجيني وتحليل القدرة على التالف لبعض الصفات الكمية في فول الصويا

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أجريت الدراسة بالمزرعة البحثية بمحطة البحوث الزراعية بسخا مركز البحوث الزراعية- مصر خلال الفترة 2016 وحتى 2017 بهدف تقدير قوة الهجن و القدرة على التآلف في الجيل الأول لمحصول بذور النبات والصفات المحصوليه .تم استخدام ستة تراكيب وراثية من فول الصويا متباعدة وراثيا و أجرى التهجين النصف تبادلي بينها وتم إنتاج بذور الجيل الأول خلال الموسم الاول2016 وفى الموسم الثانى2017 تم زراعة الآباء والخمسة عشر هجين الناتجة منها في تصميم القطاعات الكاملة العشوائية في ثلاث مكررات.ويمكن تلخيص النتائج المتحصل عليها من هذه الدراسة فيما يلى : وجود اختلافات عالية المعنوية بين الآباء الداخلة في الهجن , وكذلك بين الهجن الناتجة منها في كل الصفات المدروسة. - تشير نتائج متوسط المربعات و تحليل التباين للقدرة العامة والخاصة على التالف الي وجود معنوية عالية لجميع الصفات المدروسة. كان الاب L75-6648 من أبكر الآباء لصفتي التزهير والنضج فى حين اعطا الهجينان L75-6648 X Giza21 ,Giza111 X Giza21 اقل قيم لهاتين الصفتين .أعطا الأب L75-6648 وكذلك الهجينان L75-6648 X Giza111 - واToano X Giza111 اعلى قيم فى صفة الطول بين التراكيب الوراثية . بالنسبة لصفة عدد القرون والبذور للنبات في حين أعطا الآبوان Giza111 و Giza21 وكذلك الهجينان Pershing X Giza111 وا - Holladay X Giza21 أعلى القيم لهاتين الصفتين. بالنسبة لصفة محصول البذور للنبات اظهرت النتائج ان الابوان Giza21 وGiza111 وكذلك الهجن (Toano X - Pershing X Giza111 Giza111 - Holladay X Giza21 و Giza111X Giza21) أعلى القيم لصفة محصول البذور للنبات. - أظهر الصنفGiza111 قدرة عامة على التآلف سالبة ومرغوبة لصفات التزهير والنضج وكذلك اظهر نفس الأب قدرة عامة موجبة ومعنوية لصفات ارتفاع النبات وعدد القرون ,عدد بذور للنبات