Heterosis and Combining Ability for Yield and its Components in some Crosses of Soybean

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ABSTRACT

A diallel cross excluding reciprocals among six parents of soybean namely L86-K-73, Giza111, Giza22, H88L1, H155 and DR101 was utilized to estimate heterotic expression and combining ability for earliness traits, growth characters, yield and its components viz., number of pods/plant, number of seeds/pod, number of seed/plant, seed yield/plant(gm), 100-seed weight(gm), oil percentage and protein percentage. The parent L86-K-73 behaved as the earliest one and best in protein content , while parent (Giza111) was the best for plant height, number of pods/plant, number of seeds/plant and seed yield/plant. The parent DR101 the best for number of branches/plant and gave the highest mean value in oil percentage.

The hybrid produced from the (L86-K-73 X H155) was the earliest one among fifteen crosses and gave highest mean value for protein percentage.While the hybrid (Giza111 X H88L1) performed the highest mean value for number of pods/plant, number of seeds/plant and seed yield / plant. Highly significant negative heterotic effects relative to mid-parent for flowering date was detected for two crosses and four crosses exhibited highly significant positive heterotic effects to better parent for plant height. All crosses expressed highly significant positive heterotic effects for number of pods / plant and number of seeds / plant Highly significant mean squares due to both general and specific combining ability were detected for all traits except number of seed/pod. Moreover high G. C. A / S. C. A ratio which largely exceeded the unity were obtained for earliness traits, number of branches / plant, number of pods / plant and number of seeds / plant indicating that the additive and additive x additive interaction types of gene action were predominant in controlling these traits.

High heritability values in narrow and broad sense were detected for flowering date, maturity date, yield components, oil and protein content.

Key words: Soybean, Heterosis, Combining ability and heritability.

INTRODUCTION

The soybean (*Glycine max* (L.) Merrill), a native of eastern Asia, is one of oldest crops of that area and it considered as a vital leguminous crop.

The soybean is a crop with many uses .It provides human food, animal feed and materials for many industrial uses .As a source of protein, oil, and fat, it compliments the contribution of most other major crop

In Egypt, soybean is an important food legume crop that was introduced in the 1970`s and gained local interest since then soybean product commercially since 1972, when about 2800 feddans* were grown this area has increased about 112,000 feddans in 1986

The primary goal of the researcher effort is to increase yield. The average seed yield increased from 400 Kg/feddan year 1972 to more than 1500 Kg/feddan year 2008*. Early maturity is another important character since it frees land quickly, often allowing an additional planting of the same crop or other crop in the same year. The plant breeders are interested in the determination of gene effects to establish the most advantageous breeding programs for the improvement of the desired characters (Tawar *et al.*, 1989) especially for soybean because it is an important source of protein and oil, its seeds contain about 14 to 24 %or more oil and about 40 to 48 % protein (Brim and Burton, 1979).In Egypt, the quantity of oil seeds production including main oil crops; i.e., cotton, sesame, flax and peanut, is far from being sufficient for excessive demand. Therefore, Egyptian plant breeders intensified their efforts to increase soybean yield and yield components to meet the increasing demanded for oil and protein production. Such improvement is strongly dependent up on the genetic improvement of soybean germplasm (Bastawisy *et al.*, 1997 and El-Hosary *et al.*, 2001). To achieve such goals, it is important to study the type and mode of gene actions that influence agronomic traits. Combining ability analysis helps the breeder to identify and select superior genotypes for seed yield and major yield attributes.

Diallel crossing analysis is an excellent tool providing the breeder with:

(I) The nature and amount of genetic parameter.

(Π) General and specific combining ability of parents and their hybrids, respectively. There are two main approaches to achieve there objectives, namely Griffing's approach and Hayman's approach.

Heterosis effects for hybrids over their mid and better parents were reported by many authors (Konieczny, 1986; Raut *et al* 1988 and Loiselle *et al*, 1990).

The main objectives of the present investigation are:

a) To study the heterosis of early maturity traits such as number of days to inflorescence, days to maturity, maturity period, yield and yield components characters such as number of seeds / pod, 100-seed weight, seed yield / plant and the number of branches / plant.

b) To estimate the relative importance of general combining ability (g. c. a) and specific combining ability (s. c. a).

c) Investigate of genetic components i.e. additive variance, non-additive variance, environmental variance and heritability.

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MATERIALS AND METHODS

Two varieties and four lines of soybean (***Glycine max L.Merrill***) were used as parents in 2008 and 2009 seasons. Table (1) shows the code number, genotype names, pedigree, maturity group, origin, growth habit, pubescence color and flower color of the parents.

Table (1) code number, genotype names, pedigree, maturity group, country of origin, growth habit, pubescence color and flower color.

Code number	Genotype	Pedigree	Maturity group	Country of origin	Growth habit	Pubescen-ce color	Flower color
1	L86-k-73	Selected from L73-4673	I 100-105 dayes	U S A	I.D	Gray	White
2	Giza 111	Crawford X Celest	IV 120-130 dayes	Egypt	I.D	Tawny	Purple
3	Giza 22	Forrest X Crawford	IV 120-130 dayes	USA	I.D	Tawny	Purple
4	H88L1	G21 X L86-K-73	III 115-120 dayes	Egypt	I.D	Tawny	White
5	H 155	G 111 X L86-K-73	III 115-120 dayes	Egypt	I.D	Gray	Purple
6	DR 101	Selected from Elgin	V 130-140 dayes	U S A	D	Tawny	Purple

I.D- Indeterminate D- Determinate I- Group (1)
III- Group (3) IV- Group (4) V-Group (5)

A half diallel cross set involving the six parents were made during summer season 2008 at Itay El-Barud (Zarzora) Agricultural Research Station. In summer season 2009the six parents along with their offspring's were growth in a randomized complete block design with three replicates. Each plot consisted of four ridges of four meter long and 60 cm width, area of plot = (9.6 m^2). Seeds were sown in hills and spaced at 20 cm with one seed /hill on one side of the ridge. Phosphorus fertilizer was applied in the form of calcium superphosphate (15.5 % P_2O_5) at the rate of 150 kg/feddan. Potassium fertilizer was added in the form of potassium sulphate (48 % K_2O) at the rate of 50 kg/feddan. Both of phosphorus and potassium fertilizer were added during the soil preparation and incorporated into the soil before irrigation. Nitrogen fertilizer was added in form of ammonium nitrate (33.5 % N) at the rate of 25 kg/feddan applied before the first irrigation, in addition to Rhizobia inoculation (*Rhizobium japonicum domiati*). The Herati method of planting was used in whish the soil was irrigated before sowing. All cultural practices were carried out as recommended for growing at the proper time.

Data of the following traits were recorded on ten garded individual plants chosen at random from each plot.

1 - Number of days to inflorescence (days): It was estimated as the number of days from sowing to the appearance of the first inflorescence on the main stem.
2- Number of days to maturity (days): It was estimated as the number of days from sowing to the maturity of about 95% of the pods.
3-Maturty period (days): It was estimated as the number of days between flowering and maturity dates.
4- Plant height (cm):
5- Number of branches / plant:
6- Number of pods / plant.
7- Number of seeds / pod.
8- Number of seeds / plant.
9- Seed yield (g/plant).
10- Weight of 100 seeds in grams.
11- Oil content (%):

Oil percentage in soybean seeds was determined according to the extraction method described by A.O.A.C. (1975) by using Petroleum ether b-p= (62 68) as a solvent.

12- Protein content (%):

Protein percentage in the seeds of soybean was calculated by multiplying total nitrogen percentage by 6.25 N%. The nitrogen percentage was determined using the Micro-Kjeldahl method as described by A.O.A.C (1975).

Statistical Analysis:

The ordinary analysis of variance for randomized complete blocks design was firstly performed for F_1 diallel set according to Snedecor and Cochran (1967). A one tail F ratio was used to test the significance of different sources of variation.

Heterosis was expressed as the deviation of F1 from mid-parent mean ($\overline{MP}$) and better-parent mean ($\overline{BP}$), (Mother and Jinks, 1971)

General and specific combining ability estimates were obtained by employing Griffing's diallel cross analysis (1956) designated as method 2 model 1.

Estimation of genetic variance i.e additive, non additive and heritability according to Singh and Choudhary (1976).

RESULTS AND DISCUSSION

Analysis of variance for all characters are presented in Table (2).The obtained results showed that genotypes mean squares were highly significant for all traits except number of seeds/pod indicating wide diversity between the parental genotypes of this studies

The mean performance of the six parental genotypes and fifteen crosses for the studied traits are shown in Table(3). It is clear that variety L86-K-73 behaved as the earliest one for flowering date , maturity date and maturity period (29.13 , 98.57 and 69.43 days) respectively. The parent Giza111 recorded the highest values with respect to plant height, number of pods/plant, number of seeds/plant and seed yield/plant (gm) while parent L86-K-73 produced the lowest value for these traits The highest number of branches was observed in the parent DR101 followed by $H88L_1$, while the lowest number was in parent L86-K-73.

For 100- seed weight, parent DR 101heavyer one (18.2g) and parent L86-K-73 lightest parent (10.3g). Concerning oil and protein percentage, parent Giza22 gave highest value for oil content (21.90%) and parent $H88L_1$ gave high value for protein content (50.30%)..

It is also clear from data in Table(3) that the F1 cross (L86-K-73xH155) expressed the lowest value for flowering and maturity dates (31.67 and 109.27 days) respectively.

The cross (L86-K-73xH88L1) produced the tallest plants (153.80), where as cross (H88l1xH155) the shortest plants.

The cross (Giza111xDR101) gave the highest value for number of branches/plant (10.23), whereas cross (L86-K-73xGiza111) gave the lowest value for this trait (5.27) The cross (Giza 111×H88L1) had the highest mean values for number of pods/ plant, number of seed/ plant and seed yield /plant.

For oil content, the cross (H155×DR101) gave highest mean value (22.17%) followed by cross (Giza111×H155), (20.73%), while the cross (Giza 22×DR101) gave the lowest mean value (15.87%). For protein content, the crosses (L86-K-73×H155) and (H88L1×H155) were superior (49.47% and 48.83%), while the cross (H155×DR101) gave the lowest mean for this traits.

Heterosis expressed as the percentage of F1 mean performance from its mid and better parent average values for all studied traits are presented in Table(4 and 5) respectively.

For flowering date, two crosses expressed significant negative heterosis relative to mid-parent value (L86-K-73xGiza111) and cross (L86-K-73xH88L_1).Highly significant positive heterosis relative to better parent expressed for all crosses

For maturity date, six crosses significant positive heterosis relative to mid-parent, while all crosses significant positive heterosis relative to better parent.

Concerning maturity period, one cross (Giza22xH155) expressed significant negative heterosis relative to mid-parent value and also to better parent value (-4.96 and -4.59) respectively.

For plant height, six crosses exhibited highly significant positive heterotic effects to mid-parent. However the highest heterotic effects were detected for the cross (L86-K-73xH155). To better parent showed that highly significant negative and positive heterotic effect for eight and four crosses respectively.

With regard to number of branches/plant, eleven and eight crosses showed highly significant positive heterotic effects relative to mid-parent and better parent, respectively.

The results were agreement with those previously obtained by Habeeb *et al* (1988), El-Hosary *et al* (2001), Mansour *et al* (2002) and Fayiz (2009).

For number of pods/plant all crosses showed a highly significant positive heterosis percentage relative to mid and better parent. Moreover, the desirable heterotic effect this traits was detected for the crosses (L86-K-73 XH88L1) and (Giza111 X H88L1) relative to mid and better parent respectively.

For number of seed/plant, five and two crosses showed significant positive heterotic effect to mid and better parent values, respectively.

Concerning number of seed/plant, all crosses expressed highly significant positive except two crosses not significant relative to mid-parent, while four crosses not significant relative to better parent

With regard to seed yield/plant, seven and four crosses exhibited highly significant favorable positive to mid and better parent value. However, the cross(L86-K-73 XH155) exhibited the best heterosis for mid and better parent (98.79% and 42.52%) respectively.

As for 100-seed weight, significant positive heterotic effects were detected for seven and three crosses relative to mid and better parent.

Among those are Shang *et al* (1992), Ibrahime *et al.*(1996), Bastawisy et al.(1997), Mansour *et al.*(2002), and El-Garhy et al (2008). They reported that, heterosis was significant positive or negative for yield and its components traits.

Regarding oil percentage, four and three crosses expressed highly significant positive heterotic effects relative to mid and better parent values respectively. Moreover the crosse(H155 X DR101) was the best since it had the highest heterosis value to mid-parent (8.3%), while cross (Giza22 X DR101) gave highest heterosis value to better parent (10.29%)

For protein percentage , four and three crosses exhibited significant positive heterosis relative to mid and better parent respectively. The cross (Giza22 X DR101)gave highest value (10.45%) to mid-parent, however, the cross (L86-K-73 X H88L1) gave highest value (5.59%) to better parent.

Similar results were obtained by Brim and Brurton (1979), Wehrmann *et al* (1987), Fahmi *et al* (1999) and Chen *et al* (2008).

Regarding oil percentage, four and three crosses expressed highly significant positive heterotic effects relative to mid and better parent respectively. Moreover, the cross(H155 X DR101) was the best since it had the highest Heterosis value (8.3%) to mid parent and cross (H88L1 X DR101) (10.29%) to better parent.

Data presented in Table (6) indicated that highly significant mean squares due to both general (gca)and specific(sca) combining ability for all traits studied except number of seed/pod. High gca/sca ratio which largely exceeded the unity for seven characters, such results indicated that additive and additive by additive types of gene action were important role in the inheritance for these traits.

Estimates of general combining ability effects (ĝi) of each parent for all studied traits are presented in Table (7). From Table (7) it was observed that the high negative (ĝi) values were required to develop earlier varieties. The parent L86-k-73 expressed high significant negative (ĝi) effects for flowering date, maturity date and maturity period. Therefore this parent could be considered a good combiner for earliness among the studied six parents. Parent genotype H88L1 was the best combiner for plant height, number of branches/plant, number of pods/plant, 100-seed weight and protein percentage. Whereas parent Giza22 was the best combiner for oil percentage.

Specific combining ability effects (ŝij) for all studied traits are presented in Table (8). Results indicated that three crosses expressed significant negative (S.C.A) effects for maturity date. Moreover the cross (Giza 111 × H88L1) had the highest desirable S.C.A effects for this trait followed by the cross (Giza 22× H155).

Moreover, the cross(H88L1 X DR101) had the height significant positive values for s.c.a effects for plant height, number of branches/plant, number of seed / plant, seed yield/plant and protein percentage. Cross (L86-K73 X Giza22) had height positive significant value S.C.A effects for oil percentage. Other crosses had negative or positive significant S.C.A effects.

Through appropriate selection programs (pedigree selection, modified single seed or single pod descent) desirable segregates may be obtained from such crosses.

Estimates variances of the genetic and environmental components. heritability for all studied characters are given in Table (9). From these data it's clear that confirmed the additive genetic variance. For all traits, where non additive variance was more important than additive gene action in controlling the inheritance.

Narrow sense heritability estimates were low for plant height and number of branches/plant, intermediate for maturity period 0.54 and high for flowering date and maturity date (.91,and .90) respectively. The results from table (9) also heritability estimates ranged from 0.03 for seed yield/plant to 0.21 for protein content. These results revealed that dominant genetic variance more important for these traits. Such results indicated that bulk method may be useful in this respect.

These results are in full agreement with those obtained by Kunta *et al* (1985), Ibrahim *et al* (1996), Bastawisy *et al* (1997), El-Garhy *et al* (2008) and Fayiz (2009).

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Table (2): Mean square of all traits studies for half diallel crosses soybean.

S.O.V	D.F	Flowering date (days)	Maturity date (days)	Maturity period (days)	Plant height (cm)	No. of branches / plant	No.of pods/ plant	No.of seeds/ pod	No.of seeds/ plant	Seed yield/ plant(g)	100-seed Weight (g)	Oil content %	Protein content %
Block	2	0.56	1.45	2.57	6.53	0.69	31.24	0.004	88.14	78.26	0.18	2.24	1.47
Genotype	20	112.11**	289.59**	65.46**	1599.78**	7.89**	4153.03**	0.04	7988.49**	757.29**	17.32**	8.61**	29.12**
Error	40	2.81	1.51	4.26	9.24	0.09	33.30	0.01	153.4	10.34	0.66	0.85	0.96

NS: Not significant
* : Significant at 0.05% level of probability
**: Significant at 0.01% level of probability

Table (3): Mean performance of all traits studied for half diallel crosses of soybean.

Genotypes	Flowering date (days)	Maturity date (days)	Maturity period (days)	Plant height (cm)	No. of branches / plant	No.of pods /plant	No.of seeds /pod	No.of seeds /plant	Seed yield /plant (g)	100-seed Weight (g)	Oil Content %	Protein content %
L 86-K-73$_1$(P1)	29.13	98.57	69.43	54.37	4.13	103.80	2.17	226.87	23.37	10.30	18.67	48.79
Giza 111(P2)	41.17	120.70	79.53	139.87	7.60	140.26	2.40	334.13	57.80	17.30	18.40	41.13
Giza 22(P3)	43.27	122.87	79.60	120.47	7.17	127.07	2.37	301.05	50.28	16.70	21.90	43.30
H88L1(P4)	36.57	116.97	80.40	121.37	8.13	134.63	2.01	263.57	44.36	16.83	18.40	50.30
H 155(P5)	35.20	114.20	79.00	112.97	6.13	103.77	2.27	235.17	41.08	17.47	21.20	42.93
DR 101(P6)	51.57	138.87	87.30	128.07	8.33	111.53	2.47	275.05	50.06	18.20	19.73	43.43
P_1xP_2	33.60	110.57	76.97	103.93	5.27	179.10	2.37	422.69	62.43	14.77	19.67	44.13
P_1xP_3	36.33	113.07	76.73	139.40	8.17	162.53	2.36	352.20	56.46	16.03	17.87	40.10
P_1xP_4	31.73	115.30	83.57	153.80	10.03	210.93	2.27	475.70	82.30	17.30	19.50	44.13
P_1xP_5	31.67	109.27	77.60	130.80	6.17	137.53	2.33	319.90	50.64	15.83	16.73	49.47
P_1xP_6	40.37	121.23	80.87	126.47	7.17	128.97	2.27	289.23	50.62	17.50	18.47	46.43
P_2xP_3	41.57	120.00	78.43	94.23	9.17	197.97	2.20	435.43	62.70	14.40	20.60	45.47
P_2xP_4	37.97	117.30	79.33	134.13	9.57	231.10	2.30	527.57	98.29	18.63	18.27	46.43
P_2xP_5	38.33	118.77	80.43	112.63	10.17	169.80	2.23	375.90	70.67	18.80	20.73	40.70
P_2xP_6	48.57	130.83	82.27	115.53	10.23	155.90	2.10	335.63	55.82	16.63	17.90	42.83
P_3xP_4	40.17	119.90	79.73	101.09	8.07	219.50	2.03	439.33	61.95	14.10	19.13	42.83
P_3xP_5	41.83	117.20	75.37	121.67	7.17	157.63	2.27	365.50	62.98	17.23	17.00	41.90
P_3xP_6	47.97	133.07	85.10	147.80	8.43	173.17	2.17	376.07	65.81	17.50	15.87	47.90
P_4xP_5	35.33	117.20	81.87	83.50	7.03	177.63	2.13	382.77	39.31	10.27	18.17	48.83
P_4xP_6	48.27	135.33	87.07	117.17	8.07	197.67	2.17	429.03	72.08	16.80	17.03	43.43
P_5xP_6	44.23	135.57	91.33	93.23	6.07	181.43	2.07	360.80	46.90	13.00	22.17	39.63
L.S.D 0.05	2.77	2.03	3.41	5.02	0.49	9.52	0.17	20.44	5.31	1.34	1.52	1.62
L.S.D 0.01	3.71	2.71	4.56	6.71	0.66	12.74	0.22	27.34	7.11	1.78	2.03	2.16

Table (4): Heterosis of mid-parent (MP) of all traits studied for half diallel crosses of soybean.

Crosses	Flowering date (days)	Maturity date (days)	Maturity period (days)	Plant height (cm)	No. of branches / plant	No.of pods /plant	No.of seed /pod	No.of seed /plant	Seed yield /plant (g)	100-seed Weight (g)	Oil content %	Protein content %
P_1xP_2	-4.41**	0.85	3.34*	7.01**	-10.14**	46.77**	3.49**	50.69**	28.14**	7.03**	6.09**	-1.85*
P_1xP_3	0.36	2.12*	2.97*	59.46**	44.60**	40.80**	1.32**	33.43**	49.98**	18.74**	-11.93**	-12.92**
P_1xP_4	-3.41**	6.99**	11.55**	75.03**	63.62**	76.93**	8.61**	93.99**	88.47**	27.49**	5.18**	-10.94**
P_1xP_5	-1.54	2.71**	4.56**	56.33**	20.27**	32.51**	4.95**	38.47**	98.79**	13.97**	-16.10**	7.87**
P_1xP_6	0.05	2.11*	3.20*	38.64**	15.09**	19.79**	-2.16**	15.25	50.62**	22.80**	-3.80**	0.69
P_2xP_3	-1.54	-1.47	-1.43	-27.61**	24.17**	48.11**	-7.95**	37.10**	-14.68**	-15.29**	-2.23**	7.70**
P_2xP_4	-2.32	-1.29	-0.79	2.69	21.68**	68.14**	4.31**	76.53**	-14.30**	9.14**	-0.71	0.77
P_2xP_5	0.38	1.12	1.47	-10.91**	48.14**	39.16**	-4.7**	32.06**	7.30**	8.11**	5.77**	-3.16**
P_2xP_6	2.43*	-0.03	-1.41	-7.03**	32.00**	30.68**	-13.93**	16.52	18.77**	-6.31**	-6.14**	1.30
P_3xP_4	0.63	-0.02	-0.34	-16.40**	5.49**	67.75**	-16.00**	55.62**	-40.72**	-15.92**	-5.06**	-8.48**
P_3xP_5	6.61**	-1.13	-4.96**	4.24	7.82**	36.57**	-2.16**	36.32**	-24.00**	0.82	-2.11**	-3.39**
P_3xP_6	1.16	1.68	1.98	18.93**	8.77**	45.16**	-15.33**	30.56**	31.14**	0.29	-23.78**	10.45**
P_4xP_5	-1.55	1.40	2.72	-28.74**	-1.40**	49.02**	-0.46**	53.49**	-38.83**	-40.12**	-8.23**	3.67**
P_4xP_6	9.53**	5.79**	3.84*	-6.05**	-1.94**	60.60**	-2.91**	59.31**	-28.45**	-4.11**	-10.70**	-7.34**
P_5xP_6	1.95	7.14**	9.84**	-22.64**	-16.04**	68.54**	-12.66**	41.43**	-2.79	-27.13**	8.30**	-8.22**
L.S.D 0.05	2.40	1.76	2.95	4.35	0.43	8.25	0.14	17.68	4.6	1.16	1.32	1.40
L.S.D 0.01	3.22	2.35	3.95	5.81	0.57	11.03	0.18	23.69	6.14	1.54	1.76	1.87

P1- L 86-K-73 **P2- Giza 11** **P3- Giza 22** **P4- H88L1** **P5- H 155**
P6- DR 101
NS:Not significant *and** significant at0.05 and 0.01 levels of probability, respectively.

Table (5): Heterosis of better- parent (BP): of all traits studied for half diallel crosses of soybean.

Crosses	Flowering date (days)	Maturity date (days)	Maturity period (days)	Plant height (cm)	No.of branches / plant	No.of pods /plant	No.of seeds /pod	No.of seeds /plant	Seed yield /plant (g)	100-seed Weight (g)	Oil Content %	Protein Content %
P_1xP_2	15.35**	12.17**	10.86**	-25.7**	-30.66**	27.69**	-1.25**	26.5*	-11.7**	-14.62**	-9.55**	5.36**
P_1xP_3	24.72**	14.71**	10.5**	15.71**	13.95**	27.9**	-2.95**	17	4.47	-4.01**	-17.81**	-18.4**
P_1xP_4	8.93**	16.97**	20.37**	26.72**	23.37**	55.98**	4.61**	80.48**	21.92**	2.97**	-12.27**	5.59**
P_1xP_5	8.72**	10.85**	11.77**	15.78**	0.65**	32.5**	2.64**	35.8**	42.52**	-9.39**	1.39	-21.08**
P_1xP_6	38.59**	22.99**	16.48**	-1.25	-13.93**	15.64**	-5.24**	5.16	10.67**	-3.85**	-4.84**	-6.39**
P_2xP_3	0.97	0.58	-1.38	-32.63**	20.66**	41.15**	-8.33**	30.32**	-16.31**	-16.76**	5.01**	-5.94**
P_2xP_4	3.83**	0.28	-0.25	-4.1	17.71**	64.76**	-4.17**	57.9**	-23.85**	7.69**	-8.41**	-0.71**
P_2xP_5	8.89**	4.00**	1.8	-19.48**	33.82**	21.06**	-7.08**	12.5	0.40	7.61**	-5.19**	-2.22**
P_2xP_6	17.97**	8.39**	3.44*	-17.4**	22.81**	11.15*	-14.98**	0.45	4.92	-8.63**	-1.38	-9.28**
P_3xP_4	9.84**	2.5*	0.16	-16.71**	-0.74**	63.04**	-14.35**	45.93**	-48.21**	-16.22**	-14.85**	-12.65**
P_3xP_5	18.83**	2.63*	-4.59**	1.00	0	24.05**	-4.22**	21.38*	-27.57**	-1.37*	-3.23**	-22.37**
P_3xP_6	10.86**	8.3**	1.34	15.41**	1.2**	36.28**	-12.15**	24.9*	20.46**	-3.85**	10.29**	-27.53**
P_4xP_5	0.37	2.63*	3.6*	-31.2**	-13.5**	31.94**	-6.17**	45.23**	-48.7**	-41.21**	3.92**	-14.29**
P_4xP_6	31.99**	15.7**	10.22**	-9.3**	-3.12**	46.82**	-12.15**	62.78**	-40.84**	-7.69**	-13.66**	-13.69**
P_5xP_6	25.65**	18.71**	15**	-27.2**	-27.13**	15.63**	-16.19**	31.18**	-6.49**	-28.57**	-8.75**	4.58**
L.S.D 0.05	2.77	2.03	3.42	5.02	0.5	9.52	0.17	20.44	5.31	1.34	1.52	1.62
L.S.D 0.01	3.71	2.71	4.56	6.71	0.65	12.74	0.22	27.34	7.11	1.78	2.03	2.16

P1- L 86-K-73 **P2- Giza 11** **P3- Giza 22** **P4- H88L1** **P5- H 155**
P6- DR 101
NS:Not significant *and** significant at0.05 and 0.01 levels of probability, respectively.

Table (6): Mean square of General and specific combining ability (G.C.A, S.C.A) and G.C.A/ S.C.A ratio of all traits studied for half diallel crosses soybean.

S.O.V	D.F	Flowering date (days)	Maturity date (days)	Maturity period (days)	Plant height (cm)	No.of branches / plant	No.of pods /plant	No.of seeds /pod	No.of seeds /plant	Seed yield /plant (g)	100-seed weight (g)	Oil content %	Protein content %
G.C.A	5	432.96**	1081.64**	184.97**	1579.27**	16.24**	4723.18**	0.06	9633.19**	682.77**	6.12**	6.38**	13.29**
S.C.A	15	5.16**	25.57**	25.63**	1606.62**	5.10**	3962.98**	0.03	7440.26**	782.12**	21.05**	9.36**	33.73**
G.C.A/S.C.A		83.9	42.30	7.22	0.98	3.18	1.19	2	1.29	0.87	0.29	0.68	0.45
Error	40	2.82	1.51	4.26	9.25	0.09	33.30	0.01	153.4	10.34	0.66	0.85	0.96

Table (7): General combining ability (G.C.A) effects of all traits studied for half diallel crosses of soybean.

S.O.V	Flowering date (days)	Maturity date (days)	Maturity period (days)	Plant height (cm)	No.of branches / plant	No.of pods /plant	No.of seeds /pod	No.of seeds /plant	Seed yield /plant (g)	100-seed weight (g)	Oil content %	Protein content %
L 86-K-73$_1$	-5.79**	-5.46**	-3.67**	-1.22*	-0.2*	-13.91**	0.08**	-7.65	-2.63**	-0.60**	0.55**	0.93**
Giza 111	0.51	-0.42*	-0.94*	3.40**	-0.59**	9.55**	0.07**	40.56**	6.88**	0.20	-0.28	-0.15
Giza 22	2.02**	0.84**	-1.18**	-0.29	0.29**	4.87*	-0.03*	5.57	-0.13	0.47**	0.61**	-0.87**
H88L1	-1.46**	-0.41*	-1.05**	3.00**	0.49**	21.01**	-0.05**	2.45	1.62**	0.48**	-0.66**	0.59**
H 155	-2.06**	-1.98**	2.1**	-3.63**	-0.60**	-11.80**	-0.02	-42.67**	-6.50**	-0.65**	-0.35**	0.48**
DR 101	6.78**	7.43**	4.66**	-1.25*	0.61**	-9.72**	-0.05**	1.74	0.77	0.10	0.13	-0.98**
S.E(gi)	0.54	0.39	0.67	0.88	0.1	1.86	0.03	10.87	1.03	0.26	0.3	0.32
S.E(gi-gj)	0.84	0.61	1.03	1.52	0.21	2.89	0.05	16.22	1.61	0.41	0.46	0.44

NS:Not significant *and** significant at0.05 and 0.01 levels of probability, respectively.

Table (8): Specific combining ability (S.C.A) effects of earliness and growth traits for half diallel crosses of soybean.

Crosses	Flowering date (days)	Maturity date (days)	Maturity period (days)	Plant height (cm)	No.of branches / plant	No.of pods/plant	No.of seed /pod	No.of seed /plant	Seed yield /plant (g)	100-seed weight (g)	Oil content%	Protein content %
P_1xP_2	-0.88	0.13	1.01	23.75**	1.48**	20.89**	0.04	9.28	3.25	1.71**	-0.86	-4.12**
P_1xP_3	0.35	1.37*	1.01	15.29**	-0.69**	9.01*	0.08	15.63	7.09**	0.85	1.86**	-1.20
P_1xP_4	-0.77	4.85**	5.62**	7.40**	0.79**	41.26**	-0.01	113.15**	24.64**	0.97	-0.43	4.31**
P_1xP_5	-0.24	0.39	0.63	13.84**	-0.24	0.68	-0.02	20.64	7.62**	2.73**	2.05**	-2.95**
P_1xP_6	-0.38	-1.07*	-0.69	21.53**	1.62**	-9.97*	0.23**	-18.60	0.66	2.72**	0.14	-0.99
P_2xP_3	-0.71	-0.74	-0.02	13.38**	-0.20	20.98**	-0.04	42.36	-4.15	-0.62	-1.45*	-3.01**
P_2xP_4	-0.84	-2.19**	-1.35	18.99**	2.18**	37.96**	0.02	108.51**	28.31**	0.64	1.56*	-0.77
P_2xP_5	0.13	0.85	0.72	10.83**	-0.71**	9.48*	0.04	20.14	16.81**	0.30	-1.43*	4.67**
P_2xP_6	1.52*	-0.5	-2.02*	-0.9	-0.04	-6.50	0.02	-28.71	-8.24**	1.22	-0.30	3.10**
P_3xP_4	-0.14	-0.85	-0.71	10.27**	-0.02	31.05**	0.11	37.13	-2.20	1.71**	-0.63	1.88*
P_3xP_5	2.12*	-1.98**	-4.10**	3.61*	1.53**	14.00**	0.01	26.59	8.21**	3.00**	1.49*	-3.38**
P_3xP_6	-0.59	0.47	-1.05	-0.89	1.27**	15.45**	-0.09	28.58	7.86**	0.09	-1.79*	-0.22
P_4xP_5	-0.9	-0.73	0.17	3.85*	-0.94**	5.85	0.93**	14.88	-13.71**	1.42*	-0.97	-3.63**
P_4xP_6	3.19**	3.98**	0.79	22.58**	0.00	23.81**	0.02	55.56**	11.95**	0.94	-2.55**	3.83**
P_5xP_6	-0.23	5.79**	6.03**	6.78**	0.59**	40.39**	-0.01	50.62**	-4.74*	1.37*	-1.70*	-3.50**
S.E(sij)	1.23	0.9	1.51	2.22	0.22	4.22	0.07	23.75	2.35	0.59	0.67	0.72
S.E (sij-sik)	2.22	1.63	2.73	4.02	0.16	7.63	0.13	42.93	4.25	1.07	1.22	1.3

P1- L 86-K-73 P2- Giza 111 P3- Giza 22 P4- H88L1 P5- H 155 P6-DR101

NS:Not significant *and** significant at0.05 and 0.01 levels of probability, respectively.

Table (9): Estimates of additive and nonadditive genetic variance, environmental variance and heritability for all characters among half diallel crosses of soybean.

Estimates	Flowering date (days)	Maturity date (days)	Maturity period (days)	Plant height (cm)	No.of branches / plant	No. of pods /plant	No of seeds /pod	No of seeds /plant	Seed yield /plant (g)	100-seed weight (g)	Oil content%	Protein contents%
Additive variance	86.95	224.02	29.84	26.84	2.79	190.05	0.008	548.23	24.84	3.73	0.75	4.61
Non-additive variance	2.34	24.06	21.37	497.37	3.01	929.68	0.02	1286.86	371.7	15.39	8.51	18.77
Environmental variance	28.46	35.53	22.78	147.75	3.27	199.90	0.03	860.2	231.02	6.98	2.55	7.88
Heritability in broad sense	0.75	0.87	0.69	0.78	0.64	0.85	0.48	0.68	0.63	0.73	0.75	0.75
Heritability in narrow sense	0.73	0.79	0.4	0.04	0.31	0.14	0.14	0.2	0.04	0.14	0.07	0.15

الملخص العربى

قوة الهجين والقدرة على التآلف للمحصول ومكوناتة فى بعض هجن فول الصويا

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أجرى هذا البحث بهدف دراسة قوة الهجين والقدرة على التآلف للمحصول ومكوناته في مجموعه من الهجن التبادلية فبإتجاه واحد لعدد ستة تراكيب وراثية من فول الصويا وذلك خلال الموسمين 2009/2008 وكانت الأباء هى:

L86-K-73-1	Giza111 -2	Giza22 -3
H88L1 -4	H155 -5	DR101-6

وتم تحليل التباين لكل الصفات المدروسة وتقدير القدرة على التآلف طبقا لما اقترحة Griffing(1956) حسب النموذج الأول للطريقة الثانية ويمكن تلخيص النتائج المتحصل عليها فيما يلى:

1- اظهر الأب L86-K-73 تفوقا لصفات التبكير(التزهير -النضج -فترة النضج) وكذلك فى المحتوى من البروتين بينما الأب جيزة 111 كان الأفضل فى صفات طول النبات وعدد القرون للنبات وعدد البذور للنبات وكذلك الأفضل فى وزن محصول النبات . وكان الأب DR101 الأفضل فى عدد الفروع للنبات وكذلك فى المحتوى من الزيت.

2- أظهر الهجين (L86-K-73 X H155) تبكيرا عن كل الهجن الأخرى وكان أيضا أعلى قيمة فى المحتوى من البروتين . وقد أعطى الهجين (Giza111 X H88L1) أعلى قيمة لكل من صفة عدد القرون للنبات ،عدد البذور للنبات ووزن بذور النبات.

3- أعطى اثنين من الهجن هما (L86-K-73 X H88L1) والهجين (L86-K-73 X Giza111)قيم عالية المعنوية وسالبة فى قوة الهجين منسوبه لمتوسط الأبوين لصفة عدد الأيام حتى التزهير.

كما أعطى أربعة هجن قيم عالية المعنوية وموجبة فى قوة الهجين منسوبة للأب الأعلى قيمة لصفة طول النبات.

كما أظهرت كل الهجن قيمة عالية المعنوية وموجبة فى قوة الهجين منسوبة لكل من الأب الأعلى قيمة وذلك بالنسبة لصفات عدد القرون للنبات- عدد البذور للنبات.

4- كان التباين الراجع لكل من القدرة الخاصة والقدرة العامة على التآلف عالى المعنوية لكل الصفات المدروسة عدا صفة عدد البذور فى القرن. كما كانت النسبة بين تباين القدرة العامة للتآلف على القدرة الخاصة للتآلف اكبر من الوحدة لكل من صفات التبكير وعدد الأفرع للنبات وعدد القرون للنبات وعدد البذور للنبات وهذا مؤشر لأن هذة الصفات يتحكم فيها وراثيا الفعل الجينى المضيف وكذلك تفاعل الجينات المضيفة.

5- درجة التوريث كانت قيمته عالية بمعناة الضيق والواسع وذلك لصفات ميعاد التزهير وميعاد النضج وكذلك لصفات المحصول ومكوناتة وكذلك صفات كميات الزيت والبروتين.