Minufiya J. Agric. Res. Vol. 28 No. 1: 59 - 70 (2003)

HETEROSIS AND COMBINING ABILITY IN SOYBEAN

A. A. El-Hosary [1], I. H. I. Darwish[2] and M.H. Bastawisy[3]

[1] Agron. Dept., Fac. of Agric. Moshtohor, Zagazig Univ.
[2] Agron. Dept., Fac. of Agric. Shebin El-Kom, Minufiya Univ.
[3] Food Legumes Research Section, Field Crops Res. Inst., ARC., Giza

(Received: Nov., 17, 2002)

ABSTRACT: *A half diallel crosses involving six parental varieties were evaluated in a randomized complete block design with three replications during 1999 and 2000 seasons.*

Significant genotypes mean squares were detected for all traits, P_4 behaved as earliest one. P_3 was at the top of the tested parental variety for yield and yield components.

The crosses (1 x 3), (1 x 4), (1 x 5), (1 x 6), (3 x 4), (3 x 5), (3 x 6), (4 x 5) and (5 x 6) gave the highest mean values for seed yield per plant.

Significant mean square values for general and specific combining ability GCA and SCA were detected for all traits. The magnitudes of the ratios of GCA/SCA revealed that additive and additive x additive types of gene action were the more important expression for all traits except number of seeds per plant.

The parental variety (P_1 & P_5) gave desirable significant ($\hat{g}i$) effects for number of days to maturity, maturity a period, number of branches per plant, plant height number of pods plant and seed yield per plant. Seven crosses showed desirable positive SCA effects. The highest desirable SCA effects were obtained in the crosses (1 x 6) and (4 x 5) for yield and most of its components. Heterotic effects for mid parent were generally pronounced in all traits studied except for maturity period and weight of 100 seed. The cross (2 x 6) gave the best heterotic effect for yield (seed yield per plant gm). Also, it gave negative heterotic effects for flowering, making and filling period.

Key words: *soybean, combining ability, heterosis, yield.*

INTRODUCTION

Soybean (*Glycine max* L. (Merril) is of potential value for Egypt both as an oil and protein crop. Its seeds contain about (12-24% oil and 30-35% protein in the seed).

Yield of soybean, as in other field crops is a complex trait. Therefore, the behaviour of yield components is considered important for soybean breeders to deal effectively with such trait. In Egypt, soybean (*Glycine max* L.) is one of the most important nutritive and industrial seed crops. It is being used for human and poultry consumption. Therefore, it is of interest to increase its yield quantity. The approximate world cultivated area is about one million-hectare producing million tons of oil and protein (USDA report, 1997).

The development of more efficient breeding procedures is dependent upon a better understanding of the types of gene action controlling the inheritance of quantitative traits.

One of the most important procedures used to supply genetic information about the parents and their crosses is the diallel analysis method. Therefore, the main objectives of this investigation were to study heterosis expression for all studied traits and combining ability analysis to help the breeder to identify and select superior genotypes for seed and major yield attributes. In addition, it facilitates the determination of type of gene action governing the inheritance of these traits.

MATERIALS AND METHODS

This investigation was carried out at Agricultural Research and Experimental Center of Faculty of Agriculture at Menofiya University, during the two successive seasons (1999 and 2000). Six soybean varieties and/or lines, *Glycine max* (L.), representing a wide range of diversity for several agronomic characters were selected for the study. The names, pedigree and origin of these varieties and/or line are presented in Table (1).

Table (1): Maturity group, country of origin, growth habit and flower color of the studied soybean varieties.

Cultivar	Maturity group	Country of origin	Growth habit	Flower color
1- Elgin	V	United States	Determinate	Purple
2- PI 416937	V	United States	Determinate	Purple
3- Giza 21	IV	Egypt	Indeterminate	Purple
4- K-73	I	United States	Indeterminate	White
5- Lumar	VI	United States	Indeterminate	White
6- Giza 83	I	Egypt	Indeterminate	White

Cited from origins and pedigrees of public soybean varieties in the United States and Canada "USDA, ARS, Techn. Bull. No. 1746, 1988.

In 1999 growing season, seeds from each of the parental varieties and/or lines were sown at a various dates in order to overcome the differences in time of heading. During this season, all possible parental combinations without reciprocals were made between the six parents giving a total of fifteen crosses.

In 2000 season, the six parents and their fifteen possible F_1 crosses were grown in a randomized complete block design with three replications on 15^{th} of April.

Data for the following traits were recorded on ten individual plants per plot, randomly from the guarded ones: Number of days to inflorescence, number of days to maturity, maturity period, number of branches per plant, plant height, first pod height, number of pods per plant, number of seeds per plant, number of seeds per pod, seed yield per plant (g) and weight of 100-seed (g).

Statistical analysis:

The data obtained for each trait were analyzed on individual plant mean basis. The effects of genotypes were assumed to be fixed. A one trait of F ratio was used to test the significance of different sources of variation. When the differences between genotypes reached the significant level, further appropriate analysis were carried out.

Genetical analysis:

1. Heterosis:

Heterosis for each trait computed as parent vs. hybrids sum of squares was obtained by partitioning the genotypes sum of square to its components. In this procedure, genotypes were subdivided to parents, crosses and parents vs. crosses. This procedure made it possible to test the significance of the probable heterosis as an average overall the studied crosses.

Heterosis was also determined for individual crosses as the percentage deviation of F_1 mean performance from the mid parents value.

$$\text{The mid-parent heterosis} = \frac{\overline{F_1} - \overline{MP}}{MP} x100$$

Appropriate L.S.D. values were computed according to the following formulae to test the significance of these heterotic effects.

$$L.S.D. \text{ for heterosis to mid-parent} = t\sqrt{\frac{3MSE}{2r}}$$

2. General and specific combining ability estimates:

General and specific combining ability estimates (GCA and SCA) were obtained by Grifing's diallel cross analysis (1956) designed as method 2 model 1.

RESULTS AND DISCUSSION

The present study was carried out to investigate the heterosis and combining ability in some parental soybean variety or lines by means of diallel cross system for some growth and yield characters. To achieve this target, half diallel cross was studied.

For better representation and discussion of the results obtained, it was preferred to outline these results into three parts; i.e. analysis of variance, heterosis and combining ability.

Analysis of variance:

Pertinent portions of analysis of variance for all the traits studied in Table (2). Results indicated that genotypes mean squares were highly significant for all the studied traits. Results also showed that mean squares due to parents and F_1 hybrids were highly significant in all traits. Such results indicated that the tested genotypes varied from each other.

The mean performances of the six parents of soybean is present in Table(3). The parental (P_1) expressed the highest values for number of branches per plant, number of pods per plant and weight of 100-seeds. the parental (P_2) showed the highest values for number of days to maturity and maturity period. The parental (P_3) was the top of the tested parents for number of branches per plant, plant height, number of seeds per plant and seed yield per plant. The parental (P_4) gave the lowest values for first pod height and number of days to inflorescence. The parental (P_6) expressed the highest values for number of seeds per pod.

Mean performances of hybrids are presented in Table (3). For maturity period, the two crosses (2 x 3) and (4 x 5) gave the highest. While, for number of branches per plant the twelve crosses (1x2), (1x3), (1x4), (1x5), (1x6), (2x3), (2x5), (3x4), (3x5), (3x6), (4x5) and (5x6) expressed the highest number.

For plant height, the five crosses (1x4), (1x6), (3x4), (3x5) and (4x5) gave the highest values for this measurement. While, for number of seeds per plant, all hybrids expressed highest values. Moreover, the crosses (2x3), (2x4), (2x6), (4x6) gave the lowest one. For number of seeds per pod, the crosses (3x4), (3x6), (4x5) and (4x6) gave the highest values.

For seed yield per plant, the seven crosses (1x3), (1x4), (1x5), (1x6), (3x4), (3x5), (3x6) and (5x6) exhibited the highest values for this trait. While, for weight of 100 seed the cross (4x5) gave the heaviest seeds.

Correlation coefficient values between mid-parent and F_1 hybrids mean values in each of the studied traits are presented in Table (3). Significant positive correlation coefficient values were detected for number of days to inflorescence, number of days to maturity, maturity period, number of branches per plant, plant height and seed yield per plant.

Such results clarified good agreement between mid-parent values and F_1 performance. Consequently, the best performance of F_1 combinations could be achieved by crossing between parental lines of high values.

Insignificant correlation coefficient values were detected for the other traits, indicated that certain high and low parental lines may produce outstanding F_1 hybrids in this concern. A relationship between the mean performance of the parental lines and the average performance of their crosses were previously reached by Ansari (1990), Hassan and Ibrahim (1993) and Al-Assily *et al.* (2002).

Heterosis:

Mean squares for parent vs. crosses as an indication to average heterosis overall crosses was appreciable magnitude except for maturity period and weight of 100 seed.

Table (2): Observed mean squares from analysis of variance for all traits studied.

Source of varation	df	Number days to inflorescence	Number of days to maturity	Maturity period	Number of branches per plant	Plant height	First pod height	Number of pods per plant	Number of seeds per plant	Number of seeds per pod	Seed yield per plant (gm)	Weight of 100 seed (gm)
Replicate	2	6.143	17.387**	8.049*	0.01	1.878	1.797*	8.572	316.476	0.00937	5.002	2.548**
Genotype	20	171.40**	449.843**	78.74**	7.501**	694.071**	8.008**	8206.69**	51407.8**	0.1364**	932.069**	13.421**
P	5	307.7**	694.8**	95.3**	3.716**	676.1**	18.425**	7262.66**	22513.7**	0.2524**	635.745**	16.480**
F_1	14	132.51**	392.85**	78.371**	4.780**	655.14**	4.4728**	4098.35**	25603.14**	0.0778**	532.789**	13.221**
P.Vs.F_1	1	34.30**	22.86*	1.1	64.512**	1328.93**	5.433**	70443.72**	557143.5**	0.3773**	8003.606**	0.9133
Error	40	1.943	3.285	2.399	0.544	6.057	0.5561	35.93	140.926	0.01857	6.952	0.22933

Table (3):The genotype mean performance for all traits studied.

Genotype	Number days to inflorescence	Number of days to maturity	Maturity period	Number of branches per plant	Plant height	First pod height	Number of pods per plant	Number of seeds per plant	Number of seeds per pod	Seed yield per plant (gm)	Weight of 100 seed (gm)
P_1	48	127	79	6.0	57	10.0	178.0	228	1.62	46.0	16.0
P_2	50	130	80	5.0	38	8.0	93.0	200	2.15	18.33	9.13
P_3	36	115	79	6.0	78	11.5	165.0	366	2.22	51.6	14.10
P_4	27	95	68	4.8	66	5.5	108.0	217	2.01	27.3	12.60
P_5	48	125	77	5.4	67	6.0	177.0	357	2.02	42.11	11.80
P_6	30	98	68	3.0	44	10.5	62.8	167	2.50	18.20	11.60
1 x 2	40	118	78	8.0	50	8.0	260.0	525	2.02	48.3	9.20
1 x 3	40	120	80	8.2	60	9.5	198.0	436	2.20	66.2	15.20
1 x 4	44	122	78	9.2	85	11.0	196.0	450	2.30	68.9	15.30
1 x 5	46	125	79	8.1	69	8.7	230.0	483	2.10	71.5	14.80
1 x 6	46	125	79	8.1	80	10.5	185.0	426	2.30	63.1	14.80
2 x 3	44	125	81	7.3	65	6.2	162.0	338	2.09	46.7	13.82
2 x 4	30	100	70	6.0	48	8.0	164.0	376	2.30	38.4	10.20
2 x 5	48	127	79	6.2	52	9.0	210.0	454	2.16	50.8	11.20
2 x 6	32	107	70	5.0	45	9.2	157.0	321	2.04	36.9	11.50
3 x 4	30	100	70	7.2	81	9.8	248.8	622	2.50	71.2	11.45
3 x 5	39	118	79	9.1	86	9.8	269.0	619	2.30	78.6	12.70
3 x 6	32	102	70	6.7	78	10.3	229.0	579	2.53	64.8	11.20
4 x 5	40	121	81	8.1	87	10.0	190.0	456	2.40	73.8	16.20
4 x 6	29	95	66	5.8	63	8.5	158.0	383	2.43	47.9	12.50
5 x 6	33	105	72	6.1	76	10.0	213.0	467	2.20	56.0	12.00
LSD 5%	1.91	2.486	2.125	1.012	3.376	1.023	14.24	28.20	0.3237	6.264	1.137
LSD 1%	2.75	3.581	3.060	1.457	4.862	1.473	20.514	40.628	0.4663	9.023	1.639
Correlation	0.7085	0.7386	0.694	0.732	0.7016	0.0279	0.618	-0.0306	-0.976	0.6443	-0.3382

Heterosis expressed as the percentage deviation of F_1 mean performance from mid-parent value for all the studied measurements, are presented in Table (4). With regard to number of days to inflorescence three crosses expressed significant positive heterosis effects relative to mid-parent. The cross (2x4) gave highest positive heterotic effects. Seven crosses, i.e., (1x2), (1x3), (1x5), (2x4), (2x6), (3x4) and (3x5) gave significant negative heterotic effects relative to mid-parent value. The cross (2x6) gave the highest heterotic effects for maturity date and filling period relative to mid-parent value.

For number of days to maturity, six crosses expressed significant positive the effects relative to mid-parent. Meanwhile, the cross (4x5) showed highest heterotic effects. Meanwhile, four crosses (1x2), (2x6), (3x6) and (5x6) gave significant negative heterotic effects relative to mid-parent value. With respect to filling period, four crosses (1x4), (1x6), (3x6) and (4x5) expressed significant positive heterotic effects relative to mid-parent. Meanwhile, three crosses (2x4), (3x4) and (5x6) gave significant negative heterotic effects relative to mid-parent values.

For number of branches per plant, all hybrids equal to or significantly surpassed the mid-parent. The crosses (1x8) and (2x6) showed the best heterotic effects.

For plant height, eleven parental combinations expressed significant positive heterotic effects relative to mid-parent value. The cross (1x6) showed the best heterotic effects.

With respect first pod height the crosses (1x2), (1x3) and (2 x 3) exhibited significant negative heterotic effects relative to mid-parent value.

For number of pods per plant thirteen crosses significantly surpassed the mid-parent value. The cross (2 x 6) showed the best heterotic effects.

Regarding number of seeds per plant all hybrids equal to or significantly surpassed the mid parent.

For number of seeds per pod ten crosses significantly surpassed the mid-parent. The cross (1 x 4) showed the best heterotic effects.

For seed yield per plant (gm) thirteen significant positive heterotic relative to mid-parent value. The cross (2 x 6) gave the best heterotic effects. Also, it gave negative heterotic effects for flowering milking and filling period. This cross is excellent for high potentials yield and earliness. With respect weight of 100-seed the crosses (1x4), (1x5), (1x6), (2x5), (3x4) and (4x5) exhibited significant positive heterotic effects relative to mid-parent value.

Combining ability:

Analysis of variance for combining ability, as analyzed by Griffing (1956) method 2 model 1, in each for all the studied traits is presented in Table (5).

The mean squares associated with general and specific combining ability were significant for all traits studied. High (GCA/SCA) ratio largely exceed the unity were obtained for all traits studied except number of seeds plant, Table (4): Percentage of heterosis over mid parent (M.P) for the diallel cross studied.

Crosses	Number days to inflorescence	Number of days to maturity	Maturity period	Number of branches per plant	Plant height	First pod height	Number of pods per plant	Number of seeds per plant	Number of seeds per pod	Seed yield per plant (gm)	Weight of 100 seed (gm)
1 x 2	-18.38**	-8.17**	-1.88	45.4**	5.26	-11.11*	91.88**	146.30**	7.16	2.439	-47.87**
1 x 3	-4.76*	-0.82	1.65	36.66**	-11.11**	-11.627*	6.471**	46.80**	14.583**	19.57**	-18.93**
1 x 4	17.33**	9.90**	6.122**	50.0**	39.3**	41.93**	37.06**	102.247**	26.72**	87.99**	6.99**
1 x 5	-4.16*	-0.79	1.282	42.1**	11.29**	8.75	29.57**	65.12**	15.38**	62.30**	6.97**
1 x 6	17.94**	11.11**	7.48**	80.0**	58.4**	2.43	53.65**	121.29**	11.65**	96.57**	7.24**
2 x 3	2.32	2.04**	1.886	32.72**	12.06**	-36.41**	25.58**	29.328**	-4.347	47.57**	-16.82**
2 x 4	-22.07**	11.11**	-5.405**	22.4*	-6.74*	18.518	64.17**	80.335**	10.576*	68.21**	-35.67**
2 x 5	-2.04	-0.393	0.636	19.23*	-0.95	28.57**	55.55**	63.016**	3.697	68.10**	23.69**
2 x 6	-20.0**	-6.194**	-5.40**	75.0**	9.75*	-0.541	101.54**	79.83**	-12.258**	102.02**	-25.15**
3 x 4	-4.76	4.76**	-4.76**	33.33**	13.286**	15.29**	82.27**	113.37**	18.20**	80.48**	8.73**
3 x 5	-7.14**	-1.66	1.28	59.64**	18.621**	51.0*	57.307**	71.23**	8.491*	67.775**	-1.93
3 x 6	-3.03	-4.22**	7.48**	48.8**	27.86**	-6.36	101.05**	121.64**	7.203*	85.67**	-12.84**
4 x 5	6.66**	10.0**	11.72**	58.82**	31.818**	73.91**	33.33**	58.88**	19.106**	-21.33**	32.78**
4 x 6	1.75	-1.554	-2.94*	48.71**	15.596**	6.25	85.01**	104.812**	7.76*	110.54**	3.44
5 x 6	15.38**	-5.829**	-0.689	45.23**	36.93**	21.21**	77.648**	81.712**	-2.65	85.69**	2.586

Table (5): Observed mean squares of general and specific combining ability from the diallel cross analysis for all studied traits.

Source of varation	df	Number days to inflorescence	Number of days to maturity	Maturity period	Number of branches per plant	Plant height	First pod height	Number of pods per plant	Number of seeds per plant	Number of seeds per pod	Seed yield per plant (gm)	Weight of 100 seed (gm)
Replicate	2	6.143	17.387**	8.049*	0.01	1.8758	1.797	8.572	316.476	0.00937	5.002	2.548**
Genotype	20	171.40**	449.843**	78.74**	7.501**	694.071**	8.008**	8206.69**	51407.8**	0.1364**	932.069**	13.421**
GCA	5	511.75**	1354.0**	223.9**	12.2845**	1777.8**	12.63**	11742.794**	5116.16**	0.28062**	1798.453**	30.279**
SCA	15	57.95**	148.45**	30.35**	5.906**	332.828**	6.468**	7028.0**	66838.36**	0.0883**	643.274**	7.802**
Error	40	1.943	3.285	2.399	0.544	6.057	0.5561	35.93	140.926	0.01857	6.952	0.22933
GCA/SCA		8.83	9.12	7.377	2.08	5.34	1.952	1.670	0.077	3.178	2.796	3.8809

indicating that the largest part of total genetic variability associated with those measurements was result of additive and additive x additive types of gene action. Similar results were reported by Darwish (1993), Bastwisy (1996), Cho and Scott (2000) and El-Seidy and Khattab (2001).

Estimates of general combining ability effects (g^i) for individual parental lines in each trait are presented in Table (6). Such effects are being used to the average performance of each parental line with other lines and facilitate selection of lines for further improvement. Theoretically, an estimate of (g^i) effect of a line is not an absolute value.

It actually depends upon the group of lines to which this particular line was crossed in the dialled crossing system. If the line is exactly average in its general combining ability, the expected estimate (g^i) would be zero.

Significant departure from zero, either positive or negative, would indicate that the line is much better or much poorer than the overall average of the parental lines involved in the test high positive values would be of interest under all traits in question, except for. Number of days to inflorescence maturity date, hilling period and first pod height where high negative values would be useful from the breeder point of view.

The parents P_1, P_3 and P_5 seem to be the best combiners for filling period, number of branches per plant, plant height, number pods per plant, seed yield per plant (g^) and weight of 100 seed (g). Also, P_1 and P_5 gave significant desirable $\hat{g}i$ effects for number days to maturity. While, P_3 and P_5 exhibited significant high number of seed per plant. Also in addition it expressed significant negative $\hat{g}i$ effects for first pod height.

The parental P_2 expressed significant positive ($\hat{g}i$) effects for number of days to maturity and maturity period, while it had significant negative ($\hat{g}i$) effects for first pod height.

The parental P_4 exhibited significant negative $\hat{g}i$ effects for number of days to inflorescence. Also, it had significant positive ($\hat{g}i$) for plant height and weight of 100 seed.

The parental P_6 expressed significant negative $\hat{g}i$ effects for number days to inflorescence. While, it had significant positive ($\hat{g}i$) for number of seed per plant and number of seed per pod.

It is interest for plant breeder to ask whether the $\hat{g}i$ for a parent agrees with its own performance or where some parents are more potent when crossed than would be expected from their own performance. The results obtained herein showed and excellent agreement between the parental performance and its gi effects for all traits except number of branches per plant. For the exceptional case, suggesting that hybrids characterized by a high values could be expected by crossing between varieties with low values. GCA effects were previously reported in soybean by Radi (1990), Radi and El-Refaey, 1998, Fahmi *et al.*, 1999 and El-Seidy and Khattab (2001).

Specific combining ability effects were only commuted wherever significant SCA variance were obtained Table (7). For all traits, the absolute general higher than the specific combining ability values of the corresponding crosses, indicating the predominate of the additive genetic variance. This ascertained the previous conclusion drawn on combining ability mean square basis.

For number days to inflorescence, five crosses had significant negative SCA effects. Meanwhile, the two crosses (1 x 2) and (2 x 4) had the highest negative SCA values. For maturity period, seven parental combinations gave significant negative SCA effects. While the cross 4 x 6 gave the best SCA effects followed by crosses (2 x 4), (1 x 2) and (2 x 6).

Regarding filling period, four crosses expressed significant negative SCA effects. The cross (2 x 6) gave significant negative SCA effects for number of days to inflorescence, maturity data and filling period and it insignificant SCA effects for first pod height.

With regard to the number of branches per plant, six crosses had significant positive SCA values. The crosses (1x4) and (3 x 4) had the highest SCA values.

For plant height six crosses exhibited significant positive S.C.A. effects. Results indicate that the cross (1 x 6) had the highest SCA values.

For first pod height, four crosses had significant negative SCA effects. While the cross (2 x 3) produced the lowest first pod height.

Regarding number of pods per plant, four cross had significant positive SCA effects. The cross (1 x 2) gave the highest SCA value.

For number of seeds per plant, results indicated that the crosses (1 x 2) and (3 x 4) had significant positive SCA effects.

Twelve crosses had significant positive SCA effects for number of seeds per pod. The crosses (1 x 3) and (4 x 5) produced the highest SCA values.

For weight of 100 seed (gm) nine crosses exhibited significant positive (S.C.A.) effects the crosses (1 x 4) and (4 x 5) had the highest SCA values.

For seed yield per plant (gm) crosses exhibited significant specific combining ability effects the crosses (4 x 5) and (1 x 6) had the highest SCA values. In the previous crosses showing desirable specific combining ability involving only one good combines, such combinations would show with desirable transgressive segregates, providing that the additive genetic system present in the good combiner as well as the complementary and epistatic effects present in cross, act in the same direction to reduce undesirable plant characteristics and maximize the character in view. Therefore, the most previous crosses might be of prime importance in breeding program for traditional breeding procedures. A similar results was reported by El-Hosary (1987).

These results were in accordance with those reported in soybean by Loiselle *et al.* (1990), El-Refaey and Radi (1991), Darwish (1993), Ibrahim *et al.* (1996), Habeeb (1998) and El-Seidy and Khattab (2001).

Table (6): Estimates of general combining ability effects.

Parent		Number days to inflorescence	Number of days to maturity	Maturity period	Number of branches per plant	Plant height	First pod height	Number of pods per plant	Number of seeds per plant	Number of seeds per pod	Seed yield per plant (gm)	Weight of 100 seed (gm)
P_1	gi	5.166**	8.208**	3.04**	0.8958**	0.0001	0.5458	17.55**	-5,509	-0.1629**	5.975**	1.525**
P_2	gi	2.916**	4.208**	1.291**	-0.4916**	-15.25*-*	-0.866**	-18.191**	-50.75**	-0.0691**	-13.055**	-1.865**
P_3	gi	-1.708**	-0.4166	1.291**	0.50833**	8.5**	0.658**	19.033**	63.25**	-0.07995**	8.5608**	0.43375**
P_4	gi	-5.45**	-8.7916**	-3.330**	-0.06666	4.5**	-0.629**	-13.96**	-12.375	0.0608**	-0.926	0.21875**
P_5	gi	3.916**	5.958**	2.04**	0.2458**	5.75**	-0.479**	22.683**	46,624**	-0.0329**	6.588**	0.175**
P_6	gi	-4.833**	-9.1666**	-4.33**	-1.0916**	-3.500**	0.7708**	-27.116**	41.25*	0.1295**	-7.139**	-04845**
L.S.D.	5%	0.47988	0.6898	0.50379	0.11424	1.27197	0.1167	7.54533	29.594	0.003899	1.4599	0.048153
	1%	0.5876	0.9937	0.7256	0.16456	1.8322	0.1682	10.8688	42.630	0.005617	2.103	0.06936
L.S.D.	5%	0.8159	1.3797	1.00758	0.22848	2.5439	0.23356	15.0906	59.189	0.007799	2.9198	0.096306
(gi-gj)	1%	1.1753	1.9874	1.4513	0.32912	3.664	0.3364	21.737	85.06	0.011235	4.20596	0.13872
Correlation		0.9747**	0.9673**	0.95**	0.1673	0.939**	0.8628*	0.9877**	0.96258**	0.84474**	0.951**	0.9596**

Table (7): Estimates of specific combining ability effects for the crosses studied.

Crosses		Number days to inflorescence	Number of days to maturity	Maturity period	Number of branches per plant	Plant height	First pod height	Number of pods per plant	Number of seeds per plant	Number of seeds per pod	Seed yield per plant (gm)	Weight of 100 seed (gm)
1 x 2		-6.75**	-8.466**	-1.714	0.9625**	-0.178	-0.726**	77.128**	178.39*	0.0429**-	3.6385	-3.1886**
1 x 3		-2.125*	-1.842	0.2856	0.1625	-13.928**	-0.7518**	15.128	-24.608	0.07916**	-0.0789	0.5125**
1 x 4		5.625**	8.533**	2.910*	1.7375**	5.07	2.035**	8.903	65.016	0.1929**	12.108**	10.373**
1 x 5		-1.75	-3.216*	-1.463	0.325	-2.178	-0.414	6.253	39.16	0.0866**	7.193*	0.371*
1 x 6		70.0**	11.908**	4.910**	1.6625**	18.07**	0.1356	11.053	69.89	0.124**	12.52**	1.0338**
2 x 3		4.125**	7.158**	3.035*	-0.303	6.321*	-2.634**	-22.34	-77.358	-0.1245**	-0.598	2.522**
2 x 4		-6.125**	-9.467**	-3.339**	-0.075	-6.678*	0.498	12.653	36.266	0.09916**	0.63856	2.737**
2 x 5		2.5*	2.783	0.2856	-0.1875	-3.928	1.298**	22.003	55.266	0.0529**	5.523	0.1613
2 x 6		-4.75**	-7.091**	-2.339*	-0.05	-1.678	0.248	18.80	10.14	-0.22958**	5.35	1.1238**
3 x 4		-1.5	-4.842**	-3.339**	0.125	2.571	0.7232**	60.228**	168.27*	0.1554	11.821**	-1.931**
3 x 5		1.875*	-1.592	0.5856	1.713**	6.321*	0.573*	43.795*	106.266	0.04916**	11.706**	0.6374**
3 x 6		-0.125	-2.467	-2.339*	0.65*	7.571*	-0.1768	53.595**	66.26	0.1167**	11.6335**	-1.4749**
4 x 5		2.875**	24.98**	6.9140**	1.2875**	11.321**	2.06**	-2.221	18.89	0.1629**	16.393**	3.077**
4 x 6		0.625	-15.841**	-1.714	0.325	-3.428	-0.6893*	15.578	33.766	0.0304**	4.221	0.04008
5 x 6		-4.75**	-6.2167**	-1.089	0.3125	8.3213**	0.6606*	33.928*	58.767	-0.1058**	4.806	-0.41616**
L.S.D.	5%	1.7527	2.9635	2.164	0.4907	5.4654	0.5016	32.405	127.138	0.01675	6.2718	0.2068
(S^ij)	1%	2.5247	4.2689	3.1175	0.7069	7.871	0.7226	46.679	183.138	0.02413	9.0344	0.2979
L.S.D.	5%	3.263	5.518	4.0303	0.9139	10.175	0.934	60.36	236.75	0.03192	11.67936	0.38522
(S^ij-S^ij)	1%	4.701	7.9497	5.8056	1.3165	14.65	1.3457	86.9506	341.041	0.044939	16.823	0.55490

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قوة الهجين والقدرة على التآلف فى فول الصويا

على عبد المقصود الحصري[١] ــ إبراهيم حسيني إبراهيم دوريش[٢] ــ محمود بسطويسى حبيب[٣]
[١] قسم المحاصيل ــ كلية الزراعة بمشتهر ــ جامعة الزقازيق
[٢] قسم المحاصيل ــ كلية الزراعة شبين الكوم ــ جامعة المنوفية
[٣] قسم بحوث المحاصيل البقولية ــ معهد بحوث المحاصيل الحقلية ــ مركز البحوث الزراعية بالجيزة

الملخص العربي

أجرى هذا البحث بمزرعة كلية الزراعة بشبين الكوم ــ جامعة المنوفية خلال موسمي ١٩٩٩ ، ٢٠٠٠م بهدف دراسة قوة الهجين والقدرة على الائتلاف فى الجيل الأول باتباع الهجن التبادلية النصفية لستة أصناف من فول الصويا. ودونت البيانات على صفات ميعاد التزهير، وميعاد النضج، وفترة النضج، وعدد الفروع بالنبات، طول النبات، ارتفاع أول قرن، وعدد القرون بالنبات، وعدد البذور فى القرن والنبات، محصول النبات ووزن المائة بذرة. هذا ويمكن تلخيص أهم النتائج المتحصل عليها كما يلي:

١-كان التباين الراجع للتراكيب الوراثية معنويا لكل الصفات المدروسة وكان الأب (P4) أبكر الآباء بينما كان الأب P3 أعلاهم في المحصول ومعظم مكوناته كما كانت الهجن ١ × ٣ ، ١ × ٤ ، ١ × ٥ ، ١ × ٦، ٣ × ٤، ٣ × ٥، ٣ × ٦، ٤ × ٥، ٥ × ٦ احسن الهجن لصفة محصول البذور للنبات.

٢-كان التباين الراجع لكل من القدرة العامة والخاصة على الائتلاف معنويا لكل الصفات. وكانت النسبة بين القدرة العامة والخاصة على الائتلاف ذات قيمة تفوق الوحدة عدا عدد البذور فى النبات. مما يدل على أن الجزء الأكبر من الاختلافات الوراثية المرتبطة بهذه الصفات يرجع إلى فعل الجينات من النوع المضيف والتفوقي من الطراز المضيف × المضيف.

٣-أظهر الأب P1, P5 قدرة عامة على الائتلاف لصفات فترة النضج ، عدد الفروع للنبات ، وطول النبات ، وعدد القرون في النبات وعدد البذور في النضج، وميعاد النضج.

٤-أظهرت سبعة تراكيب هجينية تأثيرات عالية المعنوية وموجبة وذلك للقدرة الخاصة على الائتلاف لصفة محصول البذره كما أعطت الهجن (١ × ٦) ، (٤ × ٥) افضل الهجن للقدرة الخاصة على الائتلاف للمحصول ومعظم مكوناته.

٥-أعطى الهجين (٢ × ٦) قوة هجين موجبة للمحصول وكذلك افضل قوة هجين سالبة لميعاد التزهير والنضج.

٦- يمكن الاستفادة من هذا البحث فى استنباط سلالات عالية فى المحصول ومبكرة فى النضج.