INHERITANCE OF EARLINESS, YIELD AND YIELD COMPONENTS IN SOYBEAN (Glycine max L.)

Habeeb, M.B.[1]; M.I.A. Sherif[2]; A.A. El-Hosary[3]; M.A. Naseeb[1] and A.M. Hablas[2]

1) Agriculture Research Centre, Cairo.

2) Department of Genetics, Faculty of Agriculture, Minufiya Uiv.

3) Department of Agronomy, Faculty of Agriculture, Moshtohor.

وراثة التبكير والمحصول ومكوناته فى فول الصويا (Glycine max, L.)

١ ـ محمود بسطويسى حبيـــــب   مركز البحوث الزراعية ـ القاهـــــرة

٢ ـ محمد ابراهيم عبد البارى شريـف   قسم الوراثة ـ كلية الزراعة ـ جامعة المنوفية

٣ ـ على عبد المقصود الحصـــــرى   قسم المحاصيل ـ كلية الزراعة ـ مشـتـهر

٤ ـ محمد عبد الله نصيـــــب   مركز البحوث الزراعية ـ القاهـــــرة

٥ ـ عبد المنعم محمد حبلـــــص   قسم الوراثة ـ كلية الزراعة ـ جامعة المنوفية

ملخص البحث

درست كل من قوة الهجين ، دليل السيادة ، والانهيار الوراثى نتيجة التربية الداخليه ، تأثير الجينات ، المكافئ الوراثى ، والتحسين الوراثى المتوقع نتيجة الانتخاب ، لكل من صفتى التبكير ، والمحصول ومكوناته فــى الهجينين Maple presto x Crawford (I), McCull x Crawford (II) . وقد أستخدم فى ذلك الستة عشائر الخاصة بكل من هذين الهجينين وهــى: P_1, P_2, F_1, F_2, BC_1, BC_2 . بينت النتائج المتحصل عليها قــوة هجين معنوية فى الاتجاه الموجب بالنسبة للمحصول ومكوناته . بينما كانـت قوة الهجين معنوية وفى الاتجاه السالب بالنسبة لميعاد الازهار . وقد كانـت التقديرات الخاصة بالانهيار الناتج عن التربية الداخلية فى اتجاه متضاد مـــع تقديرات قوة الهجين وبالنسبة لعدد البذور فى القرن ووزن مائة بذرة كانـــت السيادة فائقة فى اتجاه الأب الأكبر فى الهجين الأول . وبالنسبة لتاريـــخ الازهار كانت السيادة جزئية فى اتجاه الأب الأصغر فى كلا الهجينيـــن ، بينما كانت السيادة جزئية فى اتجاه الأب الأكبر بالنسبة لبقية الحالات . وقد كان التأثير الوراثى المضيف معنويا بالنسبة لجميع الصفات ، بينما كانـــت

التأثيرات الوراثية السائدة معنوية لكل من تاريخ الازهار ومحصول البذرة بالنسبة للنبات فى كلا الهجينين . أيضا كانت التأثيرات السائدة معنوية بالنسبة لعدد القرون فى النبات ووزن مائة بذرة وذلك فى الهجين الثانى . وقد كانت التقديرات معنوية بالنسبة لواحد أو أكثر من طرز التفوق فى الهجينين بالنسبة لمعظم الحالات . وقد كان معامل التباين الوراثى عالى أو متوسط لكل الحالات وقد كانت القيم الخاصة بالمكافئ الوراثى بمعناه الضيق ومعناه العام وكذا التحسين الوراثى المتوقع عن الانتخاب عالية أو متوسطة فى كلا الهجينين بالنسبة لجميع الصفات المدروسة .

ABSTRACT

Heterosis, Potence ratio, inbreeding depression, gene action, heritability and predicted genetic gain for earliness, yield and yield components in the two crosses (Maple presto x Crawford) (I) and (McCull x Crawford) (II) were studied. Six populations in each cross, namely, P_1, P_2, F_1, F_2, BC_1 and BC_2 were used. Results obtained showed significant positive heterotic effects for yield and yield components in both crosses; however, highly significant negative heterotic effects were detected for flowering date. Inbreeding depression estimates were conflicting to heterosis estimates. Over dominance towards the higher parent was found for number of seeds per pod and 100-seeds weight in the first cross. Partial dominance towards the lower parent have been detected for flowering date in both crosses; however, partial dominance towards the higher parent have been detected in the remainign cases. Additive genetic effects were significant for all traits; while, dominance effects were significant for flowering date and seed yield/plant in both crosses. Also, significant dominace effects were detected for number of pods per plant and 100-seed weight in the second cross. Significant estimates for one or more of the three types of epistasis were detected in the two crosses for most cases. High to moderate G.C.V. % values were detected for all traits. High to moderate values were detected, in both crosses for all traits, with respect to heritability (broad and narrow) and predicted genetic advance as a percentage of the mean.

INTRODUCTION

Basic to progress in improving quantitative traits in plants is the relative importance of type of gene action involved. After dividing the genotypic variance into additive, dominance and epistatic variances by Fisher (1918), many genetic models were introduced to estimate the different genetic effects (Griffing, 1953; and Hyman and Mather, 1955).

Estimation of genetic variance is very essential among the basic information required for the breeders. Partitioning of the genetic variance should definitely help the breeders. If most of the genes controlling yield proved to be mainly of additive nature in the crosses, the improvement of yield could be achieved by simple selection.

The main abjective of the present work was to study the main genetical aspects of earliness and yield and yield components in intervarietal crosses of soybean.

MATERIALS AND METHODS

The present investigation was carried out at the Sakha Agriculture Research Station, during the three successive seasons, 1984, 1985 and 1986. Three varieties of soybean namely; Maple Presto, McCall and Crawford were used in this study. The first two varieties were very early, while the third one was late (commercial variety). The two crosses used (Maple Presto x Crawford and (McCall x Crawford) and their segregating generations were developed in 1984 and 1985 growing seasons. In 1986, two experiments of a randomized complete block design with three replications were carried out. Each experiment include the six populations, i.e., P_1, P_2, F_2, F_1, BC_1 and BC_2. Each plot consisted of one ridge 3 m. in length and 60 cm. in width. Hills were spaced 20 cm. apart with one seed per hill. Each replicate consisted of 15 plots for F_2, five plots for each of BC_1 and BC_2; and two plots for any nonsegregating population. Data were recorded on all guarded plants for flowering date, maturity date, maturity period, number of pods per plant, number of seeds per pod, 100 seeds weight and seeds yield per plant.

The genetic variance within F_2 population was firstly evaluated. If that variance is significant, various genetical parameters were then derived. Heterosis (H %), inbreeding depression (I.d. %) and heritability in broad and narrow sense were calculated according to Mather's Method, 1949. F_2 deviation (E_1) and backcross deviation (E_2) were estiamted as suggested by Mather and Jinks (1971). In addition, the six parameters model proposed by Gamble (1962) was used to estimate different gene effects.

RESULTS AND DISCUSSION

The validity of varietal differences and the existance of genetic variance within F_2 populations were examined. The differences between the two parents and the genetic variance within F_2 population were significant in each of the two crosses for all traits studied, except for number of seeds per pod in the second cross.

Heterosis, inbreeding depression, potence ratio, F_2 deviation, backcross deviation and gene action in the two crosses are given in Table (1).

Table (1) showed significant positive heterotic effects for yield and yield components in both crosses. Hence, heterotic increase, if found in one or more of the three components, may lead to favourable yield increase in hybrids. It is worth noting that heterotic effect for seeds yield was larger in magnitude than that for any one of its components which is logically expected. The

Table (1). Heterosis, inbreeding depression, potence ratio, F_2 deviation, backcross deviation and parameters of gene effects for earliness, yield and yield components in the two crosses.

Character	Cross	Heterosis %	Inbreeding depression %	Potence ratio	F_2 Deviation (E_1)	BC Deviation (E_2)	Gene action six parameters (Gamble procedure) m	a	d	aa	ad	dd
Flowering date	I	-15.19**	-11.95**	-0.77	0.85**	0.50	31.75**	4.76**	- 7.48**	+ 2.40*	+ 1.88**	1.40
	II	- 9.15**	-10.51**	-0.60	1.72**	3.71**	34.70**	6.31**	- 2.63*	0.54	1.03*	- 7.95**
Maturity date	I	- 0.33	- 2.43**	-0.01	2.20**	1.99	99.34**	19.83**	- 5.14	- 4.82	- 1.87	0.84
	II	0.11	- 0.79	0.01	0.86*	2.01*	102.16**	16.54**	0.71	0.60	- 1.36*	- 4.62
Maturity period	I	8.21**	0.44	0.35	2.30**	1.97*	68.20**	15.01**	- 0.06	- 5.26**	0.16	1.32
	II	4.83**	3.56**	0.26	- 0.88*	- 1.78*	67.46**	10.18**	3.19	- 0.04	- 2.45**	3.59
Number of pods per plant	I	18.40**	13.23**	0.30	- 6.91**	-20.56**	109.89**	45.68**	6.21	-13.48**	-19.10**	54.59**
	II	23.44**	25.00**	0.47	-22.01**	22.99**	106.42**	49.06**	610.95**	134.00**	- 7.74**	-179.98**
Number of seeds per pod	I	9.89**	5.86*	1.48	- 0.03	- 0.17*	2.25**	0.18**	0.02	- 0.20	0.04	0.53
	II	-	-	-	-	-	-	-	-	-	-	-
100-seed weight	I	21.19**	4.34**	1.62	0.76**	0.14	16.52**	1.64**	0.26	- 2.76**	- 0.22	2.48*
	II	9.50**	5.76**	0.76	- 0.22	1.05**	14.72**	1.39**	4.34**	2.98**	- 0.39	- 5.07**
Seed yield per plant	I	42.13**	22.46**	0.60	- 4.05**	-11.16**	41.11**	2.81**	9.62**	- 6.10*	- 3.21**	28.41**
	II	46.02**	35.54**	0.76	-11.35**	6.30**	36.98**	22.46**	77.08**	59.00**	- 1.48	-72.60**

I = Maple presto X Crawford II = McCall X Crawford

* Significant at 5% level.
** Significant at 1% level.

results indicated that the number of pods per plant was the major contributing factor to heterosis followed by 100-seed weight for seed yield. Weber et al. (1970) Paschal and Wilcox (1975); El-Hosary (1981, 1982 and 1987); Mehta et al. (1984) and Randull and Bernard (1984) found significant positive heterosis for yield and some of its components.

A highly significant negative heterotic effect was detected for flowering date in both crosses (Table 1), reflecting the posibility of producing earlier hybrids of soybean. Similar results were reported by Selim et al. (1970) and El-Hosary (1981 and 1982) in field bean.

Earliness, if found is fovourable to escape destructive injuries caused by stress conditions. Besides, breeding early maturity cultivars may allow intensive production. Both crosses expressed significant negative heterosis for flowering time. Hence, it could be concluded that both populations are valuable in breeding for earliness, as flowering time is a good indicator of earliness.

Both heterosis and inbreeding depression result from a similar phenomenon, therefore, it is logical to anticipate that heterosis in the F_1 will be followed by an appreciable reduction in the F_2 performance. In most cases, results obtained were in agreement with this expectation. Maturity period in the first cross showed significant heterosis, but insignificant inbreeding depression was detected. The conflicting heterosis and inbreeding depression estimates may be due to the presence of Linkage between genes in this material (Van der Veen, 1959).

Maturity date in the first cross did not show any heterosis. However, a highly significant value for inbreeding depression was detected. The differences in direction of dominance type and the epistatic ones by means of most parameters may lead to the observed absence of heterotic effects (Marani, 1968). Also, the reduction in the values of non-additive genetic components logically caused by means of inbreeding may be equal in magnitude, therefore, significant inbreeding depression was detected.

Overdominance towards the higher parent was found for number of seeds/pod and 100-seed weight in the first cross. These results are in agreement with Sirvastava et al. (1978) in soybean and El-Hosary (1981) in field bean. Prtial dominance towards the lower parent was detected in both crosses for flowering data, suggesting that earliness partially dominated lateness. Also, the partial dominance towards the higher parent was detected in the remaining cases. Similar results were obtained by Leffel and Weiss (1958) in soybean, Selim et al. (1970) and El-Hosary (1982) in field bean.

The results indicated that significant F_2 deviation (E_1) and backcross deviation (E_2) were obtained for most cases. These results clearly show the contribution of epistatic effects in the performance of these traits.

With respect to the nature of gene effect estimated according to Gamble procedure (1962), the results indicated that the additive genetic estimates were significant for all traits (Table 1). In addition, the additive type of gene action was higher in magnitude than dominance type in most cases. These results indicate the potentiality of improving the performance of these traits, by using pedigree selection program. Similar results were obtained by El-Hosary and Nawar (1984) and El-Hosary (1987) in field bean.

For flowering date and seed yield/plant in both crosses and number of pods/plant and 100-seed weight in the second cross, the results showed significant estiamtes of dominance gene effects.

Significant (a) and (d) components indicated that both additive and dominance effects were important in these cases. A similar conclusion was reached by El-Hosary and Nawar (1984) and El-Hosary (1981, 1982 and 1987) in field bean.

Significant estimates for the three types of epistasis were exhibited in the two crosses for all traits, except maturity date and number of seeds/pod in the first cross. These results are in harmony with those of E_1 and E_2 epistasis scales. Similar results were previously obtained by Dencescu (1983), and El-Hosary (1981, 1984 and 1987).

The absolute relative magnitudes of the epistatic gene effects to the mean effect were somewhat variable depending on the cross and trait studied. Generally, the absolute magnitude of the epistatic effects were larger than the additive effects in most cases. Therefore, it could be concluded that epistatic effect was important as a major contributor in the performance in most cases.

Heritability in broad and narrow sense, genetical gain and genetic coefficient of variation (G.V.C. %) for the studied traits are presented in Table (2).

The G.C.V. % was high for seed yield/plant in the second cross. While, the remaining traits and moderate values of G.C.V. % in both crosses. Therefore, it is impossible to estimate the magnitude of heritable variation, when the G.C.V. % is used alone. The heritable portion of the variation could be found out with the help of heritability estimates and genetic gain under selection (Swarup and Changall, 1962).

For seed yield/plant and number of pods/plant in the second cross, heritability values in both broad and narrow sense were high and nearly equal magnitudes; revealing that the genetic variance

Table 2: Heritability, percentage in broad and narrow sense, genetic advance, and genetic coefficient of variation for earliness, yield and its components in two crosses Maple Presto X Crawford (I) and MCCall x Crawford (II).

Character	Cross	h^2. broad %	h^2. narrow %	G S	G S %	G.C.V %
Flowering date	I	93.19	49.48	4.13	13.01	12.33
	II	91.35	63.01	4.97	14.33	10.55
Maturity date	I	97.62	59.02	12.74	12.83	10.43
	II	95.10	83.93	12.83	12.56	7.08
Maturity Period	I	91.26	64.09	8.19	12.01	8.69
	II	92.11	70.76	9.17	13.59	8.95
Number of Pods/plant	I	74.88	43.36	11.13	10.13	9.81
	II	91.18	89.53	37.86	35.58	18.42
Number of seeds/Pod	I	73.33	63.33	0.71	31.56	20.85
	II	-	-	-	-	-
100-seed weight	I	84.14	74.67	3.28	19.85	11.83
	II	84.84	75.06	3.20	21.74	12.96
Seed yield/Plant	I	79.44	66.86	14.16	34.44	22.28
	II	91.01	89.27	28.53	77.15	40.02

for both cases was mostly attributed to additive effects of genes. As previously reported, non-additive gene effects were found to be the major contributing factors in the performance of both cases (Table 1). On this basis, heritability in narrow sense was expected to be moderate or low. This expectation was not realized in this work. Comstock (1955) reported that the presencse of epistatic gene effects will cause in upward bias in the estimate of additive genetic variance. Gamble (1962) also pointed out that genetic models assuming negligable epistasis may be an important source of bias in the estimate of additive genetic variance, and inclusion of epistasis in such models would perhaps decrease the amount of additive ones. Since heritability herein calculated according to Mather model which assumes absence of epistasis; therefore, values for additive genetic variation computed by means of this model would be higher than the anticipated ones, causing an upward estimate for heritability in narrow sense.

For the remaining cases, high heritability values in broad sense were accompanied by moderate or low value for the narrow ones, revealing that the genetic variance for these traits was mostly attributed to both additive and non-additive gene effects. This finding is in line with that previously obtained by means of gene action studies.

Johanson et al. (1955) reported that heritability along with genetic gain are usually more useful than the heritability values alone in predicting the resultant effect for selecting the best individuals. On the other hand, heritability is not always associated with high genetic advance, but to make effective seleciton high heritability should be associated with high genetic gain. In the present investigation relative high genetic gain was found to be associated with rather high or moderate heritability estimates for all cases. Therefore, selection for these traits in these particular populations should be effective and satisfactory for successful breeding purposes.

REFERENCES

Comstock, R.E. (1955). Theory of quantitative genetics. Cold Spring Harbor. Symoposia in quantitative Biol., 20: 92-102.

Dencescu, S. (1983). Inheritance of yield components and oil and protein contents in soybean. Probleme de Genetica Teoretica Si Aplicata (1985) 15(2): 141-193. (C.F. Plant. Bred. Abst., 54(12):9354; 1984).

El-Hosary, A.A. (1981). Genetical studies in field beans (Vicia faba, L.). Ph.D. Thesis, Faculty of Agric, Shebin El-Kom, Minufiya Univ.

El-Hosary, A.A. (1982). Genetical studies in field beans (Vicia faba L.). II. Earliness and some growth attributes. Egypt. J. Agron. 7(1): 11-23.

El-Hosary, A.A. (1984). Heterosis and combining ability in diallel crosses among seven varieties of Faba bean. Egypt. J. Agron., 9: 17-28.

El-Hosary, A.A. and A.A. Nawar (1984). Gene effect in field beans (Vicia faba L.). II. Earliness and Maturity.Egypt. J. Genet. Cytol. 13: 109-119.

Fisher, R.A. (1918). The correlation between relatives on the Supposition of Mendelian inheritance. Trans. Roy. Soc. Edinbugh, 52: 399-433.

Gamble, E.E. (1962). Gene effects in Corn (Zea mays, L.). I. Separation and relative importance of gene effects for yield. Canad. J. Plant Sci., 42: 330-348.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallele crossing systems. Austr. J. Biol. Sci., 9: 463-413.

Hayman, B.I., and K. Mather (1955). The description of genetic interactions in continuous variation. Biometrics. 11: 69-82.

Johanson, H.; H.F. Robinson and R.E. Comstock (1955). Estimation of genetic and environmental variability in soybeans. Agron. J. 47: 314-318.

Leffel, R.C., and M.G. Weiss (1958). Analysis of diallel crosses among ten varieties of soybean. Agron. J., 50: 529-534.

Marani, A. (1968). Heterosis and inheritance of quantitative characters in interspecific crosses of cotton. Crop Sci., 8:299.

Mather, K. (1949). Biometrical Genetics 1st. Edition, Metheum and Co. London, 162 pp.

Mather, K., and J.L. Jinks (1971). Biometrical Genetics. 2nd ed.) Chapman and Hill Ltd., London 382 pp.

Mehta, S.K.; M.S. Lal and A.B.L. Heohar (1984). Heterosis in soybean crosses. Indian J. Of Agric. Sci., 54: 682-684.

Paschal, E.H., and J.R. Wilcox (1975). Heterosis and combining ability in exotic soybean germplasm. Crop Sci., 13: 344-349.

Randull, L.N., and R.L. Bernard (1984). Production and Performance of hybrid soybeans. Crop Sci., 24: 549-552.

Selim, A.K.A.; S.H. Hassanein; A.M. Omar and S.M. Abdel-Hafez (1970). Inheritance of earliness in broad bean (Vicia faba). Res. Bull. 627. Agric., Ain Shams Univ.

Srivastava, R.L.; Z. Ahmed; H.G. Singh and J.K. Saxena (1978). Combining ability for yield and related attributes in soybean. Indian J. of Agric. Sci., 48: 148-155.

Swarup, V., and D.D. Changale (1962). Studies on genetic variability in sorghum. I. Phenotypic variation and its heritable components in some important quantiative characters contributing towards yields. Ind. J. Genet. 22: 31.

Van der Veen, J.H. (1959). Test of non-allelic interaction and linkage for quantitative chracters in generations derived from two diploid pure lines. Genetica, 30: 201.

Weber, C.R.; L.T. Emping, and J.C. Thorne (1970). Heterotic performance and combining ability of two-way F_1 soybean hybrids. Crop Sci., 10: 159-160.