GENETICAL STUDIES OF MATURITY, YIELD AND YIELD COMPONENTS IN SOYBEAN (<u>Glycine</u> <u>max</u>).

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ملخص البحث

أستخدمت فى هذه الدراسة ستة عشائر لكل هجين من هجن ثلاثة تم اجراؤها لتحديد المقاييس الوراثية المختلفة والتأثير الجينى فى ثمانية صفات كمية · هذه العشائر الستة هى P_1 ، P_2 ، F_1 والثلاثة أجيال الانعزالية المشتقة من كل هجين من الهجن الثلاثة :

I. D79-10455xCrawford, II. CelestxCrawford, III. PI 317-3348xCarwford ·

بينت النتائج المتحصل عليها أن قوة الهجين كانت موجبة ومعنوية بالنسبة : ميعاد التزهير ، ميعاد النضج ، عدد القرون فى النبات فى الثلاث هجن · أيضا كانت قوة الهجين موجبة ومعنوية بالنسبة لفترة النضج فى الهجين الأول والثانى ، وبالنسبة لوزن المائة بذرة فى الهجين الثانى والثالث· من ناحية أخرى كانت قوة الهجين سالبة ومعنوية بالنسبة لفترة النضج ، عدد البذور بالقرن ووزن المائة بذرة فى الهجين الثانى والثالث والأول على التوالى ، وقد كان معامل التربية الداخلية معنويا لكل الصفات باستثناء ميعاد النضج وعدد البذور بالقرن فى الهجين الثالث والأول على التوالى · بالنسبة لطبيعة فعل

Minufiya J. Agric. Res. Vol.13 No.1, 1988

الجينات كان أثر فعل الجينات السيادى معنويا بالنسبة لكل الصفات ماعدا صفة ميعاد التزهير والنضج فى الهجين الثالث ، وميعاد النضج وعدد البذور بالقرن فى الهجين الأول ، وفترة النضج ووزن المائة بذرة فى الهجين الثانى . وكان فعل الجينات من النوع التفوقى معنويا لواحد أو أكثر من أنواعه الثلاثة بالنسبة لكل الصفات . بالنسبة لمعامل التباين الوراثى ، كانت قيمته بين متوسطة الى منخفضة لكل الصفات . وكانت قيمة المكافئ الوراثى بمعناه العام عالية بالنسبة لكل الصفات ماعدا صفة عدد البذور بالقرن فى الهجين الثالث . ولقد كانت قيمة المكافئ الوراثى بالمعنى الضيق عالية الى متوسطة لكل الصفات ماعدا صفة المحصول البيولوجى فى الهجينين الثانى والثالث . وكانت النسبة المئوية للتحسين الوراثى المتوقع بالانتخاب عالية الى متوسطة لمعظم الصفات تحت الدراسة .

ABSTRACT

Six populations, i.e., P_1, P_2, F_1, F_2, BC_1 and BC_2 constitute the two parents, F_1 and the three segregating generations derived from each of the three crosses D 79-10455 x Crawford (I), Celest x Crawford (II), and PI 317-3348 x Crawford (III) were used to study the genetic parameters and types of gene action in eight quantitative characters. Significant positive heterotic effects were found for; flowering date, maturity date and number of pods per plant in the three crosses; maturity period in the first and second cross; and 100 seed weight in the second and third cross. However, significant negative heterotic effects were detected for; maturity period, number of seeds per pod and 100 seed weight in the second, third and first crosses, respectively. The additive genetic estimates were significant for all traits. Significant dominance estimates were detected for all cases except flowering and maturity date in the third cross, maturity date and number of seeds per pod in the first cross, and maturity period and 100-seed weight in the second cross. Significant estimates for epistasis gene effects for one or more of the three types of epistasis were exhibited in the three crosses for all traits. Moderate to low genetic coefficient of variation (G.C.V %) were obtained for all cases. High heritability values in broad sense were computed for all traits except number of seeds per pod in the third cross. High to moderate values of heritability in narrow sense were detected for all cases except biological yield in the second and third crosses. Genetic advance (Ag %) was high to moderate for most cases.

INTRODUCTION

Genetic variability-present in any population is a prerequisite for any breeding programme. Also, the extent of expected genetic gain through selection should be known in order to formulate good breeding programmes. Previous studies on the estimation of genetic parameters were mostly performed on crosses between varieties of soybean. Variance analysis using different varieties and strains were also used by Johanson et al. (1955), Leffel and Weiss (1958), Weber et al. (1970) and Thseng (1981) who reported varying estimates of genetic variability, heritability, and genetic gain according to material, time and place of each investigation.

The present study aims to study heterosis, inbreeding depression, gene action, heritability and genetic gain for developmental stages of earliness; and yield and yield components.

MATERIALS AND METHODS

The present investigation was carried out at the Sakha Agricultural Research Station, during the three successive seasons, 1984, 1985 and 1986. Four varieties of soybean were used in this work, i.e., D 79-10455, Celest, PI 317-334B and Crawford (Commercial variety).

The experimental populations used in this study were derived from three crosses among parental material. The original crosses, namely D79-10455 x Crawford, Celest x Crawford and PI 317-334B x Crawford; referred to in the text as the first, second and third cross, respectively; were developed in 1984 growing season. In 1985 season, F_1 plants were selfed and backcrossed to each parent. In the 1986 season three experiments of a randomized complete block design with three replications were carried out. Each experiment

included the six populations, i.e., P_1, P_2, F_1, F_2, BC_1 and BC_2 refered to each of the three crosses. Each plot consisted of one ridge 3 m long and 60 cm. wide. 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 non-segregating population. Data were recorded on guarded plants for flowering date, maturity date, maturity period, number of pods/plant, number of seeds per plant, 100-seed weight, seed yield/plant and biological 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 %) was expressed as percent increase of the F_1 performance above the mid-parent value. Inbreeding depression (I.d. %) was estimated as the average decrease of F_1 from the average of F_1. F_2 deviation (E_1) and backcross deviation (E_2) were estimated as suggested by Mather and Jinks (1971). In addition, the six parameters model proposed by Gabmble (1962) was followed. Both broad and narrow sense heritabilities (h^2_b and h^2_n, respectively) were calculated according to Mather's procedure (1949). The predicted genetic advance from selection (Δg) and genetic coefficient of variation (G.C.V. %) were calculated according to Johanson *et al*. (1955). Also, potence ratio (P) was estimated according to Smith (1952).

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 genetic variance within F_2 population were significant in each of the three crosses for all studied traits, except the number of seeds per pod in the second cross.

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

Significant positive heterotic effects were found for; flowering date, maturity date, number of pods/plant, seed yield/plant and biological yield/plant in the three crosses; maturity period in the first and second cross; and 100-seed weight in the second and third cross. While, significant negative heterotic effects were detected for; maturity period, number of seeds per pod and 100-seed weight in the second, third and first crosses, respectively. Number of pods/plant, number of seeds/pod and 100-seed weight are the main components for seed yield/plant. 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 seed yield was larger in magnitude than that for any one of its components which is logically expected. The results indicate that number of pods per plant was the major contributing factor to heterosis followed by 100-seed weight for seed yield. This agree with results obtained by Weber et al. (1970), El-Hosary (1981, 1982 and 1984), and, Rondall and Bernard (1984); who found significant positive heterosis for yield and some of its components.

Significant values of inbreeding depression were detected for all cases, except maturity date and number of seeds/pod in the third and first crosses, respectively. Since both heterosis and inbreeding depression effects coincide with same phenomena, therefore, it is logically to expect the expression of heterosis in the F_1 will be followed by appreciable reduction in the F_2 performance. In most cases, results obtained were in agreement with this expectation. Maturity date in the third cross showed significant heterosis, but insignificant inbreeding depression were detected. The conflicting heterosis and inbreeding depression estimates may be due to the

Table (1). Heterosis, inbreeding depression, potence ratio, F_2 deviation backcross deviation and parameters of gene effects in the three crosses for the studied characters.

Character		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	6.48**	6.11**	0.21	- 1.94**	7.07**	59.13**	-20.24**	25.71**	21.88**	-1.71	- 36.02**
	II	8.79**	4.45**	0.38	- 0.24	- 0.48	54.73**	-11.47**	4.61*	0.02**	0.84	0.98
	III	19.22**	3.86**	9.33	2.07**	2.16**	47.28**	- 6.41**	3.99	- 3.94	-5.56**	- 0.38
Maturity date	I	4.76**	7.66**	0.36	- 7.82**	-18.46**	134.01**	-19.11**	0.98	- 5.62*	-0.70	42.53**
	II	1.34**	3.25**	0.17	- 3.40**	- 4.23**	127.25**	- 8.61**	6.88**	5.14**	1.63*	3.32
	III	9.41**	0.54	1.92	4.69**	1.85	123.88**	- 4.94**	-4.33	-15.04**	-10.53**	11.34*
Maturity period	I	3.48**	8.85**	24.04	- 5.89**	-25.53**	74.88**	1.13	-24.74**	-27.50**	1.02	78.55**
	II	- 3.80**	2.51**	- 1.40	- 3.33**	- 4.35**	72.36**	2.90**	1.67	4.60*	0.81	4.10
	III	3.80**	- 1.59*	0.43	2.58**	- 0.28	76.55**	1.48*	- 8.12**	-10.88**	-4.96**	11.44**
Number of pods per plant	I	91.37**	36.05**	3.72	- 44.48**	-97.76**	233.62**	-60.73**	156.79**	-17.62*	-13.82**	213.14**
	II	34.41**	3.91**	10.26	16.74**	80.12**	180.97**	-149.74**	141.50**	93.28**	-154.44**	-253.52**
	III	260.70**	46.83**	4.41	- 41.38**	28.00**	205.67**	-142.90**	501.12**	221.52**	-206.30**	-277.52**
Number of seeds per pod	I	- 0.90	- 1.82	- 0.18	0.03	0.07	2.24**	- 0.20**	0.00	0.02	0.28**	- 0.16
	II	-	-	-	-	-	-	-	-	-	-	-
	III	-13.90**	- 6.77*	- 6.20	- 0.03	- 0.03**	2.05**	0.65**	-0.81*	-0.50**	0.60**	1.10**
100-seed weight	I	- 8.64**	- 8.18**	- 0.36	0.42**	- 2.62**	13.10**	1.97**	-8.05**	-6.90**	- 1.18**	12.13**
	II	7.90**	10.31**	0.69	- 1.39**	- 3.56**	17.75**	- 1.63**	-0.27	-1.58**	0.28	8.70**
	III	6.42**	13.83**	0.49	- 2.14**	- 2.02**	17.01**	- 4.69**	5.69**	4.50**	- 2.24**	- 0.46
Seed yield per plant	I	77.06**	28.81**	18.43	- 6.69**	-19.66**	67.52**	10.14**	28.72**	-12.56*	7.90**	51.88**
	II	40.52**	10.29**	15.87	3.43*	22.62**	74.54**	-70.14**	55.48**	31.52**	-68.63**	- 76.76**
	III	233.21**	47.97**	4.61	- 17.54**	-18.80**	70.35**	-37.40**	127.19**	32.56**	-57.93**	5.03
Biological yield per plant	I	75.51**	39.67**	3.89	- 46.91**	-51.78**	155.85**	-41.72**	195.22**	84.08**	-13.13**	19.48**
	II	31.37**	11.85**	3.43	0.17	89.58**	154.94**	-166.65**	220.47**	178.50**	-154.42**	- 357.66**
	III	255.39**	50.18**	6.20	- 49.73**	-67.95**	173.90**	-81.26**	313.88**	63.04**	-1[illegible].75**	72.85**

I = D79-10455 X Crawford II = Celest X Crawford

III = PI 317-3348 X Crawford

Significant at 5% level.

Significant at 1% level.

presence of linkage between genes in this material (Van der Veen, 1959). The obtained results for all cases were in harmony with this expectation which was also previously reached by El-Hosary (1981) in field bean for number of pods and seed yield/plant; Thseng (1981) for number of pods/plant, and El-Hosary and Nawar (1984) for earliness.

Over dominance towards the higher parent was detected for; flowering date and maturity date in the third cross, maturity period in the first cross, number of pods, seed yield and biological yield/ plant in the three crosses. These results are in agreement with Srivastava et al. (1978), and El-Hosary (1981 and 1983), for number of pods and seed yield/plant. However, over-dominance twoards the lower parent was obtained for maturity period in the first cross and number of seeds per pod in the third cross. Partial dominance towards the lower parent was found for number of seeds/pod and 100-seed weight in the first cross. While, partial dominance towards the higher parent was detected for the remaining cases. Generally potence values followed the same trend as heterotic effect for all traits.

Significant F_2 deviations (E_1) were detected for all cases except flowering date and biological yield in the second cross, and number of seeds/pod in the first and second cross. Also, significant backcross deviation (E_2) was found for all cases except flowering date in the second cross, number of seeds/pod in the first cross, maturity date and maturity period in the third cross. This result indicates that the epistatic gene effects had major contributions in the inheritance of these traits.

Nature of gene action was computed according to relationships illustrated by Gamble (1962). The larger mean performing variety in each trait was usually considered as P_1. In all traits, the mean

effects parameter (m) was highly significant. With the exception of maturity period in the first cross, the additive genetic estimates were significant for all cases. These results indicate the potentiality of improving the performance of these traits by using pedigree selection program. Similar results were obtained by Dencescu (1983), El-Hosary (1981 and 1982) for yield and yield components, and El-Hosary and Nawar (1984) for earliness.

Significant dominance estimates were found for all cases, except flowering and maturity date in the third crosses, maturity date and number of seeds/pod in the first cross, and maturity period and 100-seed weight in the second cross.

Significant estimates for either one or more of the three types of epistasis were exhibited in the three crosses for all traits. Additive x additive gene effects were significant for most traits except flowering date and number of seeds/pod in the third and first cross, respectively. Additive x dominance gene effects were significant for all cases except flowering date and maturity period in the first and second crosses, maturity date in the first cross, and 100-seed weight in the second cross. Dominance x dominance gene effects were significant for all traits in the three crosses except, flowering date in the second and third cross, maturity date and maturity period in the second cross, number of seeds in the first cross, and 100-seed weight and seed yield/plant in the second cross. The heterotic effect previously obtained in these traits may be due to both dominance and epistatic effects of nearly equal magnitudes in most cases. Also, it is worth noting that the three epistatic types were accompanied by significant estimates for E_1 and E_2 epistatic parameters.

Heritability in broad and narrow sense, genetical gain and genetic coefficient of variation (G.C.V. %) for the studied traits are presented in Table (2). In the three crosses, genetic coefficient of variation was moderate for flowering date, and number of pods/plant. While the remaining traits had low values of G.C.V. %. It is rather difficult to estimate magnitude of heritable variation, when the G.C.V. % is used alone. The heritable portion of variation could be easily estimated with the help of other heritability estimates, and genetic gain are available (Swarup and Changale, 1962).

High heritability values in broad sense were computed for all cases except number of seeds per pod in the third cross whereas moderate values were detected. Heritability in narrow sense was estimated according to Mather's procedure on the basis of F_2 and backcrosses. For flowering date, maturity period and 100-seed weight in the third cross, and number of pods/plant in the second and third cross; heritability values in both broad and narrow sense were high and nearly equal magnitudes; revealing that the genetic variance for these case was mostly attributed to additive gene effects. As previously reported, non-additive gene effects were found to be the major contributing factors in the performance of these cases. On this basis, heritability in narrow sense was expected to be low. This expectation was not realized in this work. Comstock (1955) reported that the presence of epistatic gene effects will cause an 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's model which assumes 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.

Table 2: Heritability, genetic advance and genetic coefficient of variation for the studied traits in three crosses D79-10455 x Crawford (I), Celest x Crawford (II) Pl 317-3348 x Crawford (III).

Character	Cross	h^2. broad %	h^2 rarrow %	G S	G S %	G.C.V. %
Flowering date	I	94.82	47.37	10.11	17.1	17.06
	II	96.09	79.36	13.73	25.09	15.04
	III	97.67	93.89	15.67	33.15	16.94
Maturity date	I	98.27	79.18	11.56	8.63	5.24 -
	II	95.81	63.61	7.74	6.08	4.54 -
	III	97.96	74.09	14.11	11.39	7.39 -
Maturity period	I	97.15	66.25	10.20	13.62	9.84
	II	94.53	69.78	9.30	12.86	8.70
	III	96.26	96.24	14.71	19.22	9.51
Number of pods/plant	I	87.19	70.89	36.16	15.48	9.90
	II	89.83	86.22	52.89	29.23	15.60
	III	86.41	81.28	38.98	18.95	10.52
Number of seeds/pod	I	83.33	58.33	0.42	18.75	14.12
	II	-	-	-	-	-
	III	54.55	36.36	0.25	12.20	11.95
100 seed weight	I	77.24	54.48	1.35	10.31	8.08
	II	83.11	70.95	2.51	14.14	8.84
	III	77.42	73.87	2.68	15.76	9.11
Seed yield/plant	I	83.01	54.70	15.92	23.58	19.06
	II	73.43	53.23	8.70	11.67	9.12
	III	90.16	80.21	20.78	29.54	15.26
Biological yield/plant	I	70.27	58.80	18.55	11.90	8.24
	II	64.16	35.51	10.19	6.58	7.20
	III	79.53	37.10	17.03	9.79	11.43

For the remaining cases, high value for heritability in the broad sense was accompanied by moderate or low value for narrow one. These results revealed that the non-additive genetic variance has greater role in the existence of variability in these cases. This finding ascertained the previous studies on the nature of gene action where estimates of dominance and/or epistasis were mostly predominant.

High to moderate values for heritability in broad sense were previously recorded; for earliness by Selim et al. (1970), El-Hosary (1981 and 1982) and El-Hosary and Nawar (1984) in field bean; for 100-seed weight by El-Hosary (1981 and 1983); for number of seeds/pod and seed yield/plant by Martin and Wilcox (1973) and El-Hosary (1981) in Soybean. Heritability in narrow sense was previously found to be of high magnitude; for earliness. El-Hosary (1981) and El-Hosary and Nawar (1984), for number of seeds/pod and 100-seed weight by El-Hosary (1981 and 1983) in field bean.

Quantitative characters having high heritability values may be of great help for selection on the basis of phenotypic performance. Johanson et al. (1955) in their studies on soybean reported that heritability estimates 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, Dixit et al. (1970) pointed out that high heritability is not always associated with high genetic gain. In the present work relative moderate genetic advance was found to be associated with rather high or moderate heritability estimate for; flowering date, maturity period, number of pods, number of seeds/pod, 100-seed weight and seed yield/plant in the three crosses. Therefore, seleciton would be effective for superior lines.

Low genetic advance and moderate heritability values were obtained for remaining cases. Consequently, selection for these cases would be less successfull than in the first case.

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