HETEROSIS, GENE EFFECT, HERITABILITY AND GENETIC ADVANCE OF SOME QUANTITATIVE CHARACTERS ON SOYBEAN CROSSES

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ABSTRACT.

Four crosses of soybean (Quinitz x Giza 22), (Giza 22 x Ware), (Crawford x Quinitiz) and (Crawford x Ware), each with six populations (P_1, P_2, F_1, Bc_1, Bc_2 and F_2) were tested for yield, some of yield components and some growth attributes. Significant negative hesterosis were detected for flowering date for mid-parent in the four crosses, significant positive heterotic effects were detected for other traits .Over dominance towards the higher and lower parent was found for plant height, first pod height, number of branches per plant, number of pods per plant, number of seeds per plant, number of branches per plant, number of pods per plant, number of seeds per plant, number of seeds per pod, 100-seed weight and seed yield per plant. Partial positive and negative dominance was found for flowering, maturity date and filling period. Highly significant positive value in breeding deperission were detected for filling period, plant height, frist pod height, number of branches per plant, number of seeds per pod, 100–seed weight and seed yield per plant, while highly significant negative values were detected for flowering and maturity date of inbreeding depression. Highly significant E_1 and E_2 were detected for all studied traits of all crosses, except number of seeds per pod in the first cross. Additive gene effects were significant exhibited in all traits, except flowering, maturity date, filling period, number of pods per plant, number of seeds per plant, number of seeds per pod and seed yield plant in the first cross were non-significant. Also, some traits of the second cross such as first pod height, number of branches per plant and number of seeds per plant were non-significant. Dominance and additive x additive types of gene action were found to be significant for most traits of all crosses, respectively. Also additive x dominance and dominance x dominance types of gene effects were found to be significant for most traits. Heritability estimates in broad sense were high to moderate in magnitude with values between 60.49 for number of branches per plant to 97.53% for number of seeds per plant. The predicated genetic advance was rather moderate for number of pods per plant and seed yield plant, while was high for number of seeds per plant and low for the remaining traits in most crosses.

Key words: soybean, gene effect, heritability and genetic advance.

INTRODUCTION

Soybean (*Glycin max* (L.) Merril 2n=40) is one of the most important legume crops for oil and protein production. Information about the types and magnitude of genetic variation and the relative importance of additive and non-additive gene action would assist soybean breeders in carrying out the most suitable breeding programs for soybean improvement. Accordingly, the Plant breeder usually has in mind an ideal plant that combines maximum number of desirable characteristics. One of the aims of virtually every breeding project is to increase the yield. Early maturity is another important character since it free land quickly, often allowing an additional planting of the same crop or other crop in the same year. The plant breeder is 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 45 to 48% protein (Brim and Burton, 1979) . It is widely used in Egypt for human and poultry consumption. Moreover in Egypt, the quantity of oil seeds produced, including main oil crops; i.e., cotton, sesame, flax seeds and peanut, is far from being sufficient for excessive demand. Therefore, Egyptian plant breeders have intensified their efforts to increase soybean yield and yield components to meet the increasing demand for oil and protein production. Such improvement is strongly dependent upon the genetic improvement of soybean germplasm (Mansour, 1991; Ibrahim et al., 1996; Bastawisy et al., 1997 ; Ragaa Eissa et al., 1998; Fahmi er al., 1999 and El-Hosary et al., 2001). For achieving this goal, many genetic models were proposed by Mather (1949), Gamble (1962), Hyman and Mather (1955) and Mather and Jinks(1971). The present investigation was designated to estimate the gene action, heritability, heterosis and predicated genetic gain for some agronomic characters in four soybean crosses.

MATERIAL AND METHODS

The present study was carried out at Sakha farm, Sakha agricultural research station (SARS), Kafr El-sheikh, Egypt, during the three summer seasons of 2003, 2004 and 2005. Four soybean genotypes of wide divergent origin were used as parental material:

namely, Crawford, Giza 22, Quinitz and Ware. The genotypes Quinitz and Ware belong to the maturity group III; i.e; it requires 110 days from sowing to the maturity, while the genotypes Giza 22 and Crawford belong to the maturity group IV it requires 120 days to maturity.

Four crosses; namely, cross I (Quinitz x Giza 22), cross II (Giza 22 x Ware), cross III (Crawford x Quinitz) and cross IV (Crawford x Ware) were made in 2003. In the second season parents and F1's of each cross were planted. F1 plants in each cross were self-pollinated and back crossed to both parents to obtain the F2,s and the back crossed seeds. Crosses between the parental varieties were repeated to obtain F1 hybrid seeds.

In the third season (2005), the six populations; namely (P1, P2, F1, BC1, BC2 and F2) of each cross were arranged in (RCBD) with three replications. Each consisted of two rows for non-segregating generations; i,e; P1, P2 and F1, four rows of back crosses whereas the F_2 population was presented by eight rows. Each row was 4 m. long, 60 cm width and 20 cm between hills. One seed was planted per hill at one side of the ridge. Before flowering, 20, 40 and 80 plants were kept with caution for non-segregating generation, back cross and F_2 and were tagged in each one of the three plots. A total tagged plants for each cross was 60 P_1, 60 P_2, 60 F_1, 120 BC_1, 120 BC_2 and 240 F_2 plants. Eleven agronomic characters related to seed yield were chosen for this study these characters were flowering date, maturity date, filling period, plant height, first pod height, number of branches per plant, number of pods per plant, number of seeds per plant, number of seeds per pod, 100 seed weight and seed yield per plant.

Statistical analysis

Statistical analysis was used to calculate the means and variances for the six generations. Population means and variances were used to estimate the type of gene action for each character.

A one-tail F-ratio was calculated to test the significance of the F_2 variance from environmental variance, as follows:

$$F = \frac{F_2 \text{ variance}}{\text{Environmental variance}}$$

If the F-ratio was significant, Mather's procedure was used to calculate the components of genetic variance.

Heterosis and inbreeding depression were determined according to Mather and Jinks (1971). The two estimates of epistatic deviation (E_1) and (E_2) were calculated as the deviation of segregating populations;i.e., F_2 and (BC_1 and BC_2) from their non segregating populations (F_1 and mid-parents).

$$E_1 = F_2 - ½ F_1 - ¼ P_1 - ¼ P_2$$

$$E_2 = BC_1 + BC_2 - F_1 - ½ P_1 - ½ P_2$$

E_1 being the epistatic deviation of F_2 and E_2 the epistatic deviation of $BC_1 + BC_2$ (Mather and Jinks, 1971).

The relative of potence ratio (P) was used to determine the degree of dominance and its direction according to (Mather and Jinks, 1971) as follows:

$$\text{(Potence ratio)} = \frac{F1 - M.P}{½ (P_2 - P_1)}$$

where, P_1 the mean of low parent and P_2 the mean of the high parent.

The six population means in each cross were used to estimate the six parameters for gene effects using the relationships given by Gamble (1962); namely, a, d, aa, ad and dd. Where a= additive effect, d= dominance effect, aa= additive x additive types of epistasis, ad= additive x dominance types of epistasis and dd= dominance x dominance types of epistasis.

Mather (1949) derived the expected genetic variance of VBC_1, VBC_2 and VF_2 interms of additive (1/2D) and dominance (1/4H) genetic variance as follows:

$$½ D = 2VF_2 - (VBC_1 + VBC_2)$$

$$¼ H = VBC_1 + VBC_2 - VF_2 - VE$$

The variance of each of the genetic variance components was estimated as linear function of the variance of the mean squares. The variance of a mean square was calculated as a given by (Anderson and Bancroft (1952). The standard error of the estimate is the squar root of variance.

Heritability estimates were calculated in the F2 generation as follows:

$$h^2 \text{ (broad sense)} = \frac{½ D + ¼ H}{½ D + ¼ H + E}$$

$$h^2 \text{ (narrow sense)} = \frac{½ D}{½ D + ¼ H + E}$$

$$E = VP_1 + VP_2 + VF_1 / 3$$

Expected and predicated values of genetic advance (GS and GS %) were calculated according to Johanson et al (1955)

Genetic advance as percent of the F_2 mean (GS %) was calculated as given by **Miller** et al, (1958).

$$GS = K \times h_{2\,n\text{-}s} \times \sigma ph$$

$$GS\,\% = \frac{GS}{F} \times 100$$, Where; K=selection differential

(**K = 2.06** when selection intensity 5%), σ **Ph** = phynotypic standard deviation of F_2.

RESULTS AND DISCUSSION

Earliness if found is favorable to escape destructive injuries caused by cotton leafworm and white fly.

Generation means

Table (1) shows that F_1's were intermediate between there parental genotypes for the time required for flowering and maturity, while F_2's later than their F_1's in all crosses. While, back crosses were closer to back cross parent. The parent Ware was the shortest plant height (about 46 cm.), the parent Quinitz was the earliest variety for flowering and maturity (about 32 and 105 days) and the parent Crawford was the highest for number of branches per plant (5.23) .. The F_1 means for the yield characters were higher than those four parents, except number of seeds / pod for crosses II and IV, 100. seed weight for cross IV, this was reflected in the appearance of positive highly significant heterosis for the following traits; number of pods per plant, number of seeds per plant, number of seeds per pod, 100 seed weight and seed yield (Table 2).

Table (1) : Average and standard error values of the parents, F_1, F_2 and back crosses for studied characters in the four soybean crosses.

Character	No. of plants	Generation	Cross I	Cross II	Cross III	Cross IV
(1) flowering date	60	P_1	32.13±0.14	38.73±0.16	37.75±0.18	38.20±0.20
	60	P_2	38.88±0.15	35.40±0.15	31.53±0.10	35.73±0.18
	60	F_1	34.73±0.17	35.35±0.14	33.30±0.18	35.83±0.23
	120	Bc_1	36.28±0.27	40.07±0.32	34.16±0.19	40.03±0.39
	120	Bc_2	36.53±0.29	40.93±0.29	33.38±0.20	42.94±0.34
	240	F_2	38.86±0.23	40.65±0.28	36.78±0.17	41.93±0.32
(2) maturity date	60	P_1	105.67±0.23	121.68±0.13	118.13±0.18	118.47±0.23
	60	P_2	121.98±0.24	127.167±0.14	105.80±0.22	126.83±0.19
	60	F_1	113.45±0.26	124.03±0.19	113.18±0.26	120.27±0.28
	120	Bc_1	113.02±0.35	123.93±0.34	115.48±0.29	119.81±0.46
	120	Bc_2	113.30±0.46	128.92±0.29	112.41±0.35	121.14±0.53
	240	F_2	118.71±0.35	128.13±0.30	113.02±0.30	123.04±0.46

Table (1): Cont.

Character	No. of plants	Generation	Cross I	Cross II	Cross III	Cross IV
(3) filling period	60	P_1	73.50±0.25	82.95±0.20	80.38±0.20	80.27±0.26
	60	P_2	83.10±0.27	91.77±0.23	74.27±0.19	91.10±0.24
	60	F_1	78.72±0.30	88.68±0.32	79.88±0.29	84.43±0.29
	120	Bc_1	76.74±0.46	83.87±0.41	81.32±0.34	80.28±0.42
	120	Bc_2	76.73±0.58	87.99±0.37	79.03±0.37	78.19±0.50
	240	F_2	79.90±0.44	87.48±0.36	76.24±0.34	81.11±0.43
(4) plant height (cm)	60	P_1	66.75±0.33	88.48±0.20	86.97±0.19	87.35±0.19
	60	P_2	88.35±0.21	46.00±0.15	67.28±0.18	46.28±0.15
	60	F_1	100.00±0.44	102.53±0.24	81.70±0.25	104.42±0.33
	120	Bc_1	77.43±0.73	88.27±0.53	81.92±0.43	88.88±0.32
	120	Bc_2	82.42±0.77	71.18±0.61	72.10±0.47	69.43±0.36
	240	F_2	75.22±0.61	75.50±1.55	69.95±0.43	71.34±0.30
(5) first pod height (cm)	60	P_1	6.02±0.10	8.08±0.12	8.15±0.13	8.37±0.13
	60	P_2	7.82±0.13	7.10±0.12	6.50±0.14	6.93±0.13
	60	F_1	9.52±0.17	12.65±0.16	7.78±0.15	15.10±0.16
	120	Bc_1	6.60±0.16	8.31±0.22	7.47±0.16	9.42±0.20
	120	Bc_2	6.81±0.15	8.23±0.26	6.34±0.14	7.65±0.21
	240	F_2	6.41±0.14	8.73±0.24	6.30±0.13	9.28±0.19
(6) No. of branches / plant	60	P_1	4.28±0.09	4.12±0.10	5.23±0.10	5.12±0.09
	60	P_2	4.13±0.10	3.52±0.07	4.17±0.08	3.67±0.06
	60	F_1	6.35±0.07	6.22±0.12	7.22±0.10	9.21±0.16
	120	Bc_1	4.90±0.09	4.7±0.10	5.28±0.10	5.10±0.09
	120	Bc_2	4.33±0.08	4.94±0.09	4.41±0.11	4.85±0.12
	240	F_2	4.46±0.07	4.36±0.08	4.30±0.10	4.66±0.08
(7) No. of pods / plant	60	P_1	119.03±0.74	117.45±0.71	122.7±0.72	123.40±0.74
	60	P_2	118.12±1.28	91.93±0.59	120.58±0.84	92.68±0.54
	60	F_1	173.33±2.52	176.65±1.35	170.92±1.95	186.70±1.66
	120	Bc_1	125.43±2.32	144.27±2.41	133.80±2.11	158.53±2.60
	120	Bc_2	130.44±1.98	124.31±1.92	127.03±2.27	146.14±2.61
	240	F_2	113.81±1.78	129.43±2.04	115.05±1.90	136.80±2.53
(8) No. of seeds / plant	60	P_1	258.01±2.08	272.41±1.82	279.466±1.81	276.73±1.58
	60	P_2	259.02±2.11	191.06±1.58	256.72±1.45	193.66±1.47
	60	F_1	433.51±3.18	418.57±2.28	454.06±2.36	415.68±2.78
	120	Bc_1	293.44±4.33	372.76±4.09	332.38±5054	363.42±7.01
	120	Bc_2	302.17±4.79	269.35±4.76	319.91±6.20	310.34±5.26
	240	F_2	269.80±4.22	284.07±4.09	272.52±5.60	304.16±5.00
(9)No. of seeds / pod	60	P_1	2.17±0.17	2.33±0.02	2.28±0.02	2.25±0.03
	60	P_2	2.20±0.02	2.08±0.02	2.13±0.01	2.09±0.02
	60	F_1	2.52±0.02	2.41±0.03	2.67±0.02	2.24±0.04
	120	Bc_1	2.38±0.03	2.63±0.05	2.50±0.03	2.34±0.06
	120	Bc_2	2.33±0.03	2.18±0.04	2.52±0.04	2.14±0.05
	240	F_2	2.41±0.03	2.37±0.05	2.35±0.03	2.36±0.05
(10) 100- seed weight (gm)	60	P_1	14.00±0.06	12.63±0.04	13.48±0.06	13.45±0.08
	60	P_2	13.22±0.03	18.05±0.05	14.29±0.05	18.13 ±0.05
	60	F_1	15.84±0.07	18.58±0.11	15.62±0.09	16.91±0.19
	120	Bc_1	15.17±0.09	15.84±0.13	14.05±0.10	16.07±0.15
	120	Bc_2	14.47±0.12	16.56±0.13	14.98±0.09	16.82±0.17
	240	F_2	14.00±0.10	17.15±0.12	15.04±0.08	16.15±0.13
(11) seed yield per plant (gm)	60	P_1	36.04±0.27	34.38±0.27	37.61±0.20	37.51±0.20
	60	P_2	34.24±0.28	34.47±0.28	36.69±0.20	35.08±0.20
	60	F_1	68.73±0.59	77.83±0.87	70.96±0.68	68.69±0.57
	120	Bc_1	44.64±0.72	59.43±1.02	46.90±0.86	58.18±1.31
	120	Bc_2	45.31±0.85	48.13±1.13	48.15±1.07	53.13±1.12
	240	F_2	37.66±0.68	49.34±0.99	41.08±0.91	49.33±1.08

Cross I Quinitz x Giza 22, Cross II Giza 22 x Ware, Cross III Crawford x Quinitz, Cross IV Crawford x Ware
* and ** significant at 0.05 and 0.01 levels of probability, respectively.

Heterosis, inbreeding depression, F_2 deviation and potence ratio

The data presented in Table (2) indicated that heterosis of mid and high parent for all characters were highly positive & negative significant except maturity date in crosses I and II, cross I for filling period for mid-parent, cross II and IV for flowering date for better parent were non-significant.

Table (2) : F_2 deviation (E_1), Bach cross deviation (E_2), heterosis, inbreeding depression percentage and potence ratio for character studied in four crosses of soybean.

Character	Cross	(E_1)	(E_2)	Heterosis		Inbreeding depression %	Potence ratio (P)
				M.P.	B.P.		
(1) flowering date	I	3.74**	2.57**	-2.18**	8.09**	-11.88**	-0.23
	II	41.51**	8.58**	-4.63**	-0.14	-14.99**	1.03
	III	2.81**	-0.41	-3.87**	5.61**	-10.46**	0.43
	IV	5.53**	10.18**	-3.07**	0.28	-17.02**	0.92
(2) maturity date	I	5.07**	-0.96	-0.33	7.36**	-4.63**	-0.05
	II	128.33**	4.39**	-0.32	1.93**	-3.31**	0.14
	III	0.45	2.73**	1.09**	6.98**	0.14	0.20
	IV	1.58**	-1.97*	-1.94**	1.52**	-2.31**	-0.57
(3) filling period	I	1.33**	-3.57**	0.51	7.10**	-1.44*	0.08
	II	86.82**	-4.18**	1.52**	6.91**	1.35*	-0.30
	III	-2.37**	3.14**	3.31**	7.55**	4.56**	0.84
	IV	-3.95**	-11.66**	-1.46**	5.15**	3.94**	-0.23
(4) plant heiht (cm)	I	-13.55**	-17.70**	28.95**	13.19**	24.78**	-2.08
	II	57.85**	-10.33**	52.49**	14.58**	26.37**	-1.66
	III	-9.46**	-4.81**	5.93**	-6.06**	14.38**	-0.46
	IV	-14.28**	-12.92**	56.27**	19.54**	31.68	-1.83
(5) first pod height (cm)	I	-1.81**	-3.03**	37.59**	58.14**	32.66**	-2.89
	II	6.20**	-3.70**	66.63**	78.17**	30.96**	10.29
	III	-1.25**	-1.30**	6.26**	19.69**	19.06**	0.56
	IV	-2.09**	-5.68**	97.39**	117.89**	38.52**	10.40
(6) No. of branches / plant	I	-0.82**	-1.33**	50.89**	48.36**	29.72**	-28.56
	II	3.16**	-0.39*	62.88**	50.97**	29.89**	8.00
	III	-1.65**	-2.23**	53.55**	38.05**	40.36**	4.72
	IV	-2.14**	-3.66**	109.78**	79.88**	49.44**	-6.65
(7) No. of pods / plant	I	-32.14**	-36.04**	46.18**	45.62**	34.34**	-119.47
	II	93.43**	-12.77**	68.73**	50.40**	26.74**	5.64
	III	-31.23**	-31.73**	40.51**	39.29**	32.68**	46.56
	IV	-10.57**	9.93*	72.80**	51.29**	26.73**	-5.12
(8) No. of seeds / plant	I	-76.21**	-96.41**	67.69**	67.37**	37.76**	-146.08
	II	190.66**	-8.20	80.62**	53.64**	32.13**	4.59
	III	-88.56**	-69.86**	69.37**	62.47**	39.98**	16.35
	IV	-21.27**	22.89*	76.74**	5.03	26.83**	4.35
(9)No. of seeds / pod	I	0.06	0.00	15.38**	15.07**	4.44**	-22.40
	II	2.26**	0.20**	9.25**	3.43**	1.54	1.66
	III	-0.09*	0.14*	21.00**	14.61**	11.87**	6.25
	IV	0.16*	0.08	3.01	-0.44**	-5.58	-0.84
(10) 100-seed weight (gm)	I	-0.70**	0.20	16.49**	13.14**	11.51**	-5.91
	II	15.53**	-1.52**	21.13**	2.94**	7.69**	-1.19
	III	0.28**	-0.48**	12.47**	9.31**	3.73**	-4.24
	IV	-0.20	0.19	7.13**	-6.73**	4.51**	0.48
(11) seed yield per plant (gm)	I	-14.27**	-13.93**	95.59**	90.70**	45.20**	37.39
	II	27.63**	-4.71**	126.11**	125.79**	36.61**	-21.43
	III	-12.98**	-13.07**	91.02**	88.67**	42.12**	72.98
	IV	-3.16**	6.33**	89.28**	83.12**	28.18**	26.72

E_1 refer to F_2 deviation E_2 refer to Bc-deviation.
* and ** significant at 0.05 and 0.01 levels of probability, respectively.

The inbreeding depression was positive and negative highly significant for all traits studied except, maturity date in cross III and plant height in cross IV were non-significant, while were significant for filling period in crosses I and II.

F_2 deviation (E_1) and back cross deviation (E_2) for all traits studied were either positive or negative significant or highly significant, however (E_1) for maturity date and (E_2) for flowering date in cross III were non-significant.

Over dominance was observed for flowering date in cross II, for plant height and first pod height in crosses II and IV and for number of branches per plant in all crosses, while partial dominance was observed for the remaining of crosses for most of traits

Over dominance towards both the higher and lower parents was detected for yield and yield components such as number of pods per plant, number of seeds per plant, number of seeds per pod, 100 seed weight and seed yield per plant in all studied crosses, except number of seeds per pod and 100-seed weight for cross IV were partial dominance.

Inbreeding depression % was highly significant for all the studied traits in the four crosses except number of seeds per pod in cross II (Giza 22 x Ware) and cross IV were not significant..

Type of gene action using generation means:

The data presented in Table (3) indicated that the additive and dominance effect estimates (a, d) for all characters were significant and highly significant in the four studied crosses except a few cases. Estimates of additive X additive gene effects "aa" were significant and highly significant in the four studied crosses except crosses II and IV for flowering date, crosses I and II for first pod height and cross I for number of branches were non-significant. The additive X dominance gene effects "ad" for all traits was significant and highly significant in all crosses except crosses II and III for filling period, first pod height and cross III for plant height were non-significant. Dominance x dominance gene effects "dd" were non-significant in cross II for maturity, plant height and number of branches per plant, also for first pod height in cross III.

Regarding to yield characters, the estimated mean effect(m) which reflects the contribution due to the overall mean plus the locus effects and interaction of the fixed loci was highly significant. The additive effect (a) was highly significant in the second cross (Giza 22 x Ware) for all studied traits except number of seeds per plant, while was highly significant also for 100-seed weight only in the first cross (Giza 22 x Quinitz) and was insignificant for the remaining traits in the same cross. Regarding to crosses III and IV were significant and highly significant for all studied traits except number of seeds per plant, number of seeds per pod and seed yield plant for cross III (Crawford x Quinitz).

Table (3): Gene action parameters using generation means in the four soybean crosses characters .

character	Cross	m	a	D	aa	ad	dd
(1) flowering date	I	38.86**	-0.26	-10.59**	-9.82**	3.12**	4.68*
	II	40.65**	-0.86*	-2.33	-0.62	-2.53**	-16.53**
	III	36.78**	0.783**	-13.41**	-12.07**	-2.33**-	12.88**
	IV	41.93**	-2.91**	-2.91	-1.78	4.14**	-18.57**
(2) maturity date	I	118.71**	-0.28	-22.58**	-22.20**	7.88**	24.12**
	II	128.13**	-4.98**	-7.23**	-6.83**	2.24**	-1.95
	III	113.02**	3.07**	4.90**	3.68*	-3.10**	-9.150**
	IV	123.04**	-1.33	-12.65**	-10.27**	2.85**	14.20**
(3) filling period	I	79.85**	0.02	-12.07**	-12.47**	4.80**	19.60**
	II	87.48**	-4.13**	-4.89*	-6.22**	0.28	14.58**
	III	76.24**	2.28**	18.31**	15.75**	-0.87	-22.03**
	IV	81.11**	2.07**	-8.76**	-7.51**	7.49**	30.83**
(4) plant height (cm)	I	75.22**	-4.98**	41.27**	18.82**	5.82**	16.58**
	II	75.50**	17.08**	52.19**	16.90**	-4.16**	3.75
	III	69.95**	9.82**	32.79**	28.22**	-0.03	-18.60**
	IV	71.34**	19.45**	68.85**	31.25**	-1.08*	-5.41*
(5) first pod height (cm)	I	6.41**	-0.21	3.78**	1.18	0.69**	4.87**
	II	8.73**	0.08	3.21**	-1.85	-0.42	9.25**
	III	6.30**	1.13**	2.88**	2.42**	0.30	0.18
	IV	9.28**	1.76**	4.45**	-2.99**	1.05**	14.35**
(6) No. of branches / plant	I	4.46**	0.57**	2.76**	0.62	0.49**	2.03**
	II	4.36**	-0.24	4.25**	1.85**	-0.54**	-1.07
	III	4.30**	0.87**	4.67**	2.15**	0.33*	2.32**
	IV	4.65**	0.25**	6.08**	1.26**	-0.47**	6.06**
(7) No. of pods / plant	I	113.81**	-5.02	111.24**	56.48**	-5.48	15.60
	II	129.41**	19.96**	91.46**	19.50	7.20*	6.03
	III	115.05**	6.78*	110.71**	61.43**	5.72	2.03
	IV	136.80**	12.40**	140.78**	62.12**	-2.96	-81.98**
(8) No. of seeds / plant	I	269.79**	-8.74	287.01**	112.02**	-8.23	80.81*
	II	284.07**	103.41	334.76**	147.92**	62.73**	-131.52**
	III	272.52**	12.47	400.47**	214.50**	1.09	-74.78
	IV	304.16**	53.09**	311.36**	130.88**	11.55	176.65**
(9)No. of seeds / pod	I	2.41**	0.04	0.11	-0.23	0.06	0.23
	II	2.37**	0.45**	0.35	0.15	0.33**	0.55
	III	2.35**	-0.02	1.09**	0.62**	-0.09	-0.91**
	IV	2.36**	0.19**	-0.41	-0.47	0.12	0.32
(10) 100-seed weight (gm)	I	14.02**	0.71**	5.44**	3.19**	0.33*	-3.59**
	II	17.15**	-0.72**	-0.56	-3.80**	1.99**	6.83**
	III	15.04**	-0.93**	-0.37	-2.10**	-0.52**	3.07**
	IV	16.15**	-0.76**	2.30**	1.18	1.58**	-1.55
(11) seed yield per plant (gm)	I	37.66**	-0.68	62.83**	29.24**	-1.57	-1.39
	II	49.34**	11.30**	61.16**	17.75**	11.34**	-8.34
	III	41.08**	-1.25	59.61**	25.79**	-1.71	0.34
	IV	49.33*	5.05**	57.71**	25.31**	3.83**	-37.97**

m refer to mean effect of F_2 generation .

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

Dominance gene effects (d) were highly significant for seed yield and its major components in the four crosses except number of seeds per pod for crosses I, II and IV and 100-seed weight for crosses II and III which exhibited insignificant value. Thus would suggest that dominance gene effects have a significant contribution to the inheritance of these traits in these crosses. The interaction between additive x additive (aa) was also highly significant for all studied traits in the four crosses except number of pod per plant for cross II and number of seeds per pod in crosses I, II and IV, 100-seed weight in cross IV which exhibit non significant. The additive x dominance effect (ad) was significant and highly significant for all studied characters in all crosses except number of pods per plant, number of seeds per plant and number of seeds per pod in the three crosses I, III and IV were non significant, also seed yield per plant in crosses I and III showed also non significant.

The dominance x dominance effect (dd) was insignificant in crosses I, II and III for number of pods per plant and seed yield plant, either non significant was observed for number of seeds per plant for cross III, number of seeds per pod for crosses I and II and 100-seed weight for cross IV.

While positive and negative significant, highly or significant were observed for the remaining of the studied characters in those crosses. Generally, significant one or more of the three types of epistatic gene effects were exhibited in all crosses for all the studied traits. These result were in a grement with those reported by **El-hosary** (1981), **Bastawisy** et al (1997) and **El-hosary** et al (2002).

Heritability and genetic advance:

The data presented in Table (4) indicated that broad sense heritability estimates for flowering date, plant height and first pod height in cross II were above 91%. However broad sense heritability estimates for maturity date and filling period in cross IV were also above 90 % indicated that these characters were affected by additive and non-additive gene actions. In the same time these traits in same crosses showed high values for narrow sense heritability above 87%.

Genetic advance expressed as percentage of the F_2 mean for flowering, maturity date and filling period for all crosses were (3.44 – 7.65 %), (6.65 – 12.23 %) and (7.73 – 12.11 %) respectively, however for plant height, first pod height and number of branches per plant were (9.8 – 16.37 %), (2.86 – 6.72 %) and (1.01 – 2.22 %) for all crosses.

Table (4) Heritability in broad and narrow senses and genetic advance of the four crosses for the studied characters.

characters	Cross	Heritability		Genetic advance	
		Broad sense	Narrow sense	Δ G	Δ G %
(1) flowering date	I	88.85	46.98	3.44	8.84
	II	92.79	75.56	6.66	16.39
	III	79.89	67.95	3.79	10.30
	IV	89.90	73.77	7.65	18.25
(2) maturity date	I	87.67	60.30	6.65	5.60
	II	92.81	86.16	8.25	6 45
	III	85.88	84.74	8.25	7.30
	IV	93.47	82.87	12.23	9.94
(3) filling period	I	89.90	55.64	7.73	9.68
	II	86.96	77.47	8.78	10.05
	III	87.78	84.87	9.14	11.99
	IV	90.50	87.00	12.11	14.93
(4) plant heiht (cm)	I	92.21	50.09	9.80	13.03
	II	96.75	92.85	16.37	21.68
	III	94.15	92.21	12.79	18.28
	IV	84.51	77.06	7.56	10.59
(5) first pod height (cm)	I	74.83	69 55	3.00	46.77
	II	91.43	89.55	6.72	76.94
	III	71.89	66.77	2.86	45.41
	IV	86.85	85.57	5.35	57.62
(6) No. of branches / plant	I	60.49	51.99	1.18	26.42
	II	63.06	39.75	1.01	23.16
	III	76.19	73.39	2.22	51.69
	IV	55.02	38.25	1.05	22.47
(7) No. of pods / plant	I	77.33	52.95	29.99	26.35
	II	94.60	85.78	55.86	43.17
	III	88.40	67.02	40.63	35.31
	IV	95.31	94.45	76.39	55.84
(8) No. of seeds / plant	I	91.15	82.53	111.03	41.15
	II	94.48	82.02	106.94	37.65
	III	97.53	89.83	160.60	58.93
	IV	97.12	93.29	178.69	58.75
(9)No. of seeds / pod	I	83.47	64.11	0.52	21.46
	II	94.58	93.83	1.38	58.37
	III	93.47	79.07	0.82	34.95
	IV	90.68	83.77	1.30	54.87
(10) 100-seed weight (gm)	I	91.21	82.14	2.56	18.23
	II	90.46	85.04	3.33	19.44
	III	77.40	42.96	1.03	6.88
	IV	77.60	56.56	2.42	15.01
(11) seed yield per plant (gm)	I	91.07	63.83	13.85	36.77
	II	92.43	82.04	26.09	52.87
	III	94.53	86.08	24.96	60.76
	IV	97.05	73.32	25.33	15.34

This means that when heritability estimates are high the selection is effective in early generations, therefore, additive gene effects were though important. The obtained data indicate the predominance of additive gene effects in determining the tested characters. Such results were previously recorded by **Mahmoud** and **Kramer** (1951), **Caviness** (1969), **Raut** et al. (1988), Mansour (1991), **Ibrahim** et al (1996). **Ragaa Eissa** et al. (1998) and **El Hosary** et al. (2001).

Thus, it can be recommended that hybridization followed by selection are the most suitable breeding programes to improve soybean for earlines and yield components.

Heritability and genetic advance:

Heritability values are important to the breeder since it quantifies the expected improvement upon selection to achieve genetic improvement through selection, heritability must be reasonably high. In the present investigation the data in table (4) showed high values of heritability in broad sense were obtained. This parameter measures the proportion of phenotypic variance in population that is due to genetic differences, the highest values obtained was above 95% for number of pods per plant in cross IV, above 97% for number of seeds per plant in the two crosses III and IV, while was above 94% for number of seeds per pod in cross II, 91% for 100-seed weight in cross I and 97% for seed yield plant in cross IV. The values of heritability in narrow sense which indicate to the proportion of phenotypic variance that results from additive genetic variance, were high in magnitude but were lower than their corresponding broad sense values.

The estimates of genetic advance from selection 5% superior plant of the F_2 generation reflected heigh values for the traits of four crosses for number of seeds per plant, 111.03, 106.94, 160.6 and 178.69, low values for the traits of all crosses for number of seeds per pod, 0.52, 1.38, 0.82 and 1.30, 100-seed weight, 2.56, 3.33, 1.03, and 2.42 and intermediate values for number of pods per plant 29.99, 55.86, 40.63 and 76.39, seed yield plant, 13.85, 26.09, 24.96 and 25.33. while the genetic advance as percentage of F_2 mean (G.S/F2%) ranged from 26.35 to 55.84 for number of pods per plant, from 37.65 to 58.75 for number of seeds per plant, from 21.46 to 58.37 for number of seeds per plant, from 6.88 to 19.44 for

100-seed weight and from 15.34 to 60.76 for seed yield plant of all the four crosses. The genetic advance under selection depends on the amount of genetic variability, the magnitude of masking effect of the environment and intensity of selection that is practiced. In terms of the progress expected, the confounding of non-additive with the additive genetic variance will have an effect in future generations, due to the non-additive variance included in the estimates. Therefore, the expected genetic advance for characters in this study was derived by using heritability in narrow sense.

These data strongly reflect the presence of non allelic gene interaction in the inheritance of these characters in all crosses. Heterosis mainly contributed by dominance components, which were two many times higher than the additive component. Both heterosis and inbreeding depression are correlated phenomena, therefore, it is logical to predict that heterosis in F_1 will be followed on appreciable reduction in F_2 performance these results are in agrement with those reported by **Weber** et al (1970), **Theng** and **Tseng** (1973), **EL-Hosary** (1981), **Bastawisy** et al, (1997), **El-Hosary** et al. (2001) and **Mansoure** (2002).

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الملخص العربي

قوة الهجين و التأثير الجينى و معامل التوريث و التحسين الوراثى لبعض الصفات الكميه فى هجن فول الصويا

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أجرى هذا البحث خلال ثلاثة مواسم هى ٢٠٠٣ و ٢٠٠٤ و٢٠٠٥ بمحطة البحوث الزراعية بسخا محافظة كفر الشيخ على أربعة هجن من فول الصويا الأول (Quintz x Giza 22) و الثانى (Giza 22 x Ware) و الثالث (Crawford x Quintz) و الرابع (Crawford x Ware) و شملت الدراسة فى كل منها الأبوين و الجيلين الأول و الثانى و جيلى الهجينين الرجعيين لصفات ميعاد التزهير – ميعاد النضج – فترة النضج – طول النبات – ارتفاع أول قرن – عدد فروع النبات – عدد قرون النبات – عدد بذور النبات – عدد بذور القرن – وزن ال١٠٠ بذره و محصول النبات و يمكن تلخيص النتائج كالآتى :-

كانت قوة الهجين معنوية و سالبه لصفات ميعاد التزهير و ميعاد النضج فى كل الهجن ماعدا الهجين الثالث كانت موجبة و كانت قوة الهجين معنوية و موجبة أيضا لبقية الصفات المدروسة فى كل الهجن.

بالنسبة لدرجة السيادة فقد كانت السيادة جزئية لصفات ميعاد التزهير و النضج و فترة النضج لكل الهجن و كانت سيادة فائقة فى اتجاه الأب الأعلى لصفات ارتفاع النبات و ارتفاع أول قرن و عدد فروع النبات

و عدد قرون النبات و عدد بذور النبات و عــدد بــذور القــرن و وزن ال١٠٠ بذره و محصول النبات فى كل الهجن.

بالنسبة لمعامل التربية الداخلية فقد أظهر معنويه موجبة لصــفات طول النبات و ارتفاع أول قرن و عدد فروع النبات و عدد قرون النبات و عدد بذور النبات و عدد بذور القرن و وزن ال١٠٠ بــذره و محصــول النبات لكل الهجن. بينما أظهر معنوية سالبة لصفات ميعــاد التزهيــر و ميعاد النضج فى كل الهجن و أظهر معنوية سالبة أيضا لصفة فترة النضج فى الهجين الأول.

كانت قيمة الانحراف الراجع الى التفاعل الجينى E_1, E_2 معنــوى لمعظم الصفات فى كل الهجن عدا الهجين الثالث لصفتى ميعاد التزهير و النضج كان غير معنويا.

بالنسبة لطبيعة فعل الجينات كان أثر فعل الجينــات مــن النــوع المضيف معنوى لمعظم الصفات فى الهجين الثانى و الثالث و الرابع على التوالى أما الهجين الأول كان فعل الجين المضيف غير معنوى باســتثناء صفتى عدد فروع النبات ووزن ١٠٠ بذرة كان معنويا بينما كــان فعــل الجينات من النوع السيادى و التفوقى من النوع المضيف x المضــيف معنويا لكل الصفات فى معظم الهجن وأيضا كان فعل الجينات من النوع المضيف x السيادى أو السيادى x السيادى معنويا لكل الصفات فــى معظم الهجن.

كانت قيمة المكافىء الوراثى بمعناه الواسع عالية إلى متوســطه و تراوحت من ٦٠,٤٩ % لصفة عدد فروع النبات إلى ٩٧,٥٣% لصــفة عدد بذور النبات.

كانت النسبة المئوية للتحسين الوراثى المتوقع متوســطة لصــفتى عدد فروع النبات و محصول النبات و كانت عالية لصفة عدد بذور النبات فى كل الهجن و كانت منخفضة للحالات الأخرى فى معظم الهجن.

و من النتائج السابقة يمكن ملاحظة تفوق الهجــين Giza 22 x (Ware) عن كل الهجن فى معظم صفات المحصول و مكوناته.