Variability and Gene Action for Earliness and Yield Components of Some Faba Bean Hybrids at Nubaria Region

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ABSTRACT: Three crosses of faba bean *(Vicia faba* L.*)*(Giza 716 X BPL710),(T.W.X BPL 710) and (TW X NA112), each with six populations (P_1,P_2,F_1,F_2,BC_1 and BC_2) were evaluated in the winter season of 2010/2011 for earliness traits, yield components and some growth attributes. Significant negative heterotic effects over mid-parents were detected for flowering and maturity dates with regard to both crosses I and II. On the other hand, the three crosses showed highly significant positive heterotic effects relative to the better parent for both traits in the three crosses. Significant positive heterotic effects relative to mid and better parents were detected for plant height, number of branches/plant, seeds/plant, 100- seed weight and seed yield/plant in the first cross. Over dominance towards the higher parent was found for plant height, number of branches/plant, seeds/plant, 100- seed weight and seed yield/plant, in the first cross. Significant negative values of inbreeding depression were detected for all studied characters in the three crosses except number of seeds/plant in the three crosses and days to flowering and maturity dates in the second and first crosses, respectively. Highly Significant positive or negative deviation for F_2 (E_1) and back crosses (E_2) were detected for all traits. Additive gene effects were significantly exhibited in all traits except number of seeds/ plant and 100- seed weight for the cross LLI and cross I, respectively. Dominance and other gene action effects were significant for most of the studied characters in the three crosses. Heritability estimates in board sense were high to moderate in magnitude with values ranged from 66. 57% for plant height in cross I to 94-54% for 100 seed weight in the same cross. The predicted genetic advance from selection was rather higher to moderate for all traits in the three crosses except maturity date in the three crosses.

Keywords: faba bean, heterosis, cross, growth attributes, yield components

INTRODUCTION

Leguminous crops in Egypt are very important especially faba bean (*Vicia faba L.*) crop for human foods. Information about the type and magnitude of genetic variation and the relative importance of additive and non additive gene action types would assist faba been breeders in carrying out the most suitable breeding programs for faba been improvement.

Several investigators studied the types of gene action affecting yield and yield components such as El-Hosary (1982), EL-Hady *et al.* (1997) and EL-Tabbakh and Ibrahim (2000). However the type of gene action would depend upon the varieties under study. This information is essential to plan the most efficient breeding methodology for improving the faba bean crop. The present investigation was designated to estimate the types of gene action, heterosis and heritability.

MATERIALS AND METHODS

The present investigation was carried out at Nubaria Research Station during the three successive seasons 2008/09, 2009/10 and 2010/11.

Five faba bean genotypes were used in this work, i.e. Giza 716, ILB710, TW, Nubaria1, and NA 112 as shown in Table (1).

Table (1): The origin, pedigree and some characteristics of five faba bean genotypes

Genotypes	Origin and Pedigree	Characteristics
Giza716	FCRI,Egypt,461/842/83X 503/453/83	Early maturing, medium seeds adapted for North Delta
ILB710	Colombia, Developed by mass selection from ILB 938	Medium seeds type (70-80 g) with green colored seed coat (Late flowering)
T.W	Sudan	Early maturing, medium seeds
Nubaria 1	FCRI, Egypt An individual plant selection from Spanish variety (Reina Blanca)	Lat maturity, medium seeds adapted for new reclaimed land at Nubaria
N.A112	Pakistan	Early maturing, medium seeds with black colored seed coat

The experimental populations used in this study were derived from three crosses among parental material developed in 2008-2009under insect proof cages. The three crosses (Giza 716 x ILB 710, Nubaria1 x NA 112 and TW x NA 112) made in 2009/10 growing season under insect proof cage. F1 plants of each cross were selfed and backcrossed to the two parents. In 2010/11 season, randomized complete block design with three replications was conduced for the six crosses to achieve the objectives of this study. Each trial contained the six related populations (P_1, P_2, F_1, F_2, BC_1 and BC_2) for each cross. Each plot consisted of one ridge 3m long and 60cm width. Hills were spaced 25 cm apart with one seed/hill.

Data were recorded on guarded plants for days of flowering date, days of maturity date, number of branches/plant, plant height, number of pods/plant, number of seeds/plant, 100- seed weight and seed yield/plant .Gene effect estimates were determined using six parameters model of Gamble (1962). Heterosis was calculated as the percentage increase or decrease of the F_1 performance above the mid and better parent values. Inbreeding depression (I.D %) was estimated as the decrease in F_2 mean compared with F_1 mean. F_2 deviation (E_1) and backcross deviation (E_2) were estimated as suggested by Mather and Jinks (1971). Heritability, in both narrow and broad sense estimates were calculated according to procedures of Mather (1949). The predicted genetic advance from selection and genetic coefficient of variation were estimated according to Johanson *et. al.* (1955).

RESULTS AND DISCUSSION

Table (2) presents the means and standard errors of the studied traits in the six populations for the three studied crosses. It could be noticed that F_1 means for the earliness characters were intermediate between their parental genotypes, while F_2's were earlier than their F_1's. While, back crosses were close to back cross parent. The cross III was the earliest for flowering and maturity cross. For plant height, F_1 plants of the cross II was the tallest (125.0cm) regarding the six populations in three studied crosses. While, P_2 plants in the cross III gave the lowest value (91.66cm) .The cross II regarding their six population (P_1, P_2, F_1, F_2, BC_1 and BC_2) gave the highest values for number of branches/plant. It is also clear that the F_1 means for yield and yield component traits were higher than their corresponding parents in the three crosses except number of pods and seed yield /plant in the second cross and number of seeds /plant and 100-seed weight in the third one. The highest value given in crosses I (57.86 g) as compared with another two crosses.

The data presented in Table (3) indicated that heterosis of days to flowering showed significant negative value in cross I for the mid parents. Heterosis for plant height and number of branches/plant in the three crosses exhibited highly significant positive except cross II for number of branches/plant which was highly significant negative relative to the better and mid parents. For number of pods/plant, number of seeds/plant and seed yield/plant, the three crosses were highly significant positive heterotic effects relative to the mid parents except 100-seed weight in the third cross. The maximum heterosis value for the seed yield/plant was recorded in the first cross (74.57%).Significant negative inbreeding depression observed for days to flowering and maturity in cross I Table(3). For plant height, number of branches/plant, number of pods/plant, 100- seed weight and seed yield/plant were highly significant negative inbreeding depression in the three crosses. Inbreeding deoression for number of seeds / plant showed highly significant positive in three crosses. Such results were previously recorded by El-Refaey (1987), Abul-Naas *et al.*(1991), El-Hosary *et al.*(1992), El-Hady *et al.*(1997) and Farag and Darwish (2005). Potence ratio was also calculated in Table (3) and indicated that values exceeded unity in the three crosses for plant height, cross I and II for number of branches/plant and number of seeds/plant, cross I and III for number of pods/plant and seed yield/plant and 100-seed weight in the first cross. F_2 deviation (E_1) and backcross deviation (E_2) showed highly significant positive or negative for all characters in three studied crosses. In Table (3) presented also the values of six parameters, the estimated mean effect (m) which reflects the contribution due to the over all mean plus the locus effects and interaction of the fixed loci was highly significant. The additive effect (a) was highly significant in the all studied traits except days to flowering for two crosses I and II and except cross III for number of seeds / plant and 100-seed weight in the first cross. The dominance effect (d) was highly significant for most characters in the three crosses.

The interaction between (aa), (ad) and (dd) arranged from insignificant and significant in the three crosses for all traits. The data presented in Table (4) indicated that the high values of heritability in board sense were obtained. The highest values obtained 94.54% was for 100- seed weight in cross I.

Genetic advance expressed as a percentage of the F_2 mean for days to flowering and maturity for the three crosses were (11.34-4.86%), (12.63-4.52%) and (12.57-3.03%), respectively. The genetic advance showed high values for number of pods/plant in crosses I and II (54.15and 33.84%), respectively, and intermediate for the remaining yield components characters (Table, 4). These results are in agreement with those reported by El-Hosary (1981), El-Hosary (1982), El-Hosary (1985), El-Hady (1988), El-Hady *et al.*(1997), Harty (1999), El-Galaly (2003), El-Hady *et al.* (2009) and Mohamed and Mohamed (2012).Thus, it can be recommended that hybridization followed by selection is the most suitable breeding program to improve faba bean for earliness and yield components.

Table (2): Mean performance ($\bar{X}$) and standard error ($S\bar{x}$) of six populations in the three crosses of faba bean for the studied characters

Crosses	Population	Days to flowering (days)		Days to maturity (days)		Plant height (cm)		No. of branches /plant		No. of pods / plant		No. of seeds/ plant		100-seed weight (g)		Seed yield/plant (g)	
		$\bar{X}$	$\pm S\bar{x}$	$\bar{X}$	$\pm S\bar{x}$	$\bar{X}$	$\pm S\bar{x}$	$\bar{X}$	$\pm S\bar{x}$	$\bar{X}$	$\pm S\bar{x}$	$\bar{X}$	$\pm S\bar{x}$	$\bar{X}$	$\pm S\bar{x}$	$\bar{X}$	$\pm S\bar{x}$
I	P_1	54.40	0.57	154.73	0.69	111.83	0.53	5.10	0.26	19.77	0.24	54.37	0.35	85.76	0.23	47.46	0.33
	P_2	104.70	0.53	177.43	0.65	95.16	0.59	6.60	0.23	12.03	0.22	24.27	0.39	75.20	0.22	18.83	0.33
	F_1	74.90	0.33	165.00	0.37	120.97	0.41	8.16	0.15	22.40	0.21	62.03	0.31	92.73	0.19	57.86	0.32
	F_2	71.10	0.47	163.57	0.57	100.04	0.43	4.75	0.17	14.75	0.40	44.45	0.36	74.70	2.33	33.87	0.51
	BC_1	61.74	0.44	160.53	0.51	101.83	0.41	5.49	0.17	20.41	0.38	57.13	0.36	82.10	2.08	49.13	0.46
	BC_2	76.16	0.41	170.96	0.57	105.33	0.40	6.23	0.18	14.80	0.32	43.20	0.39	83.18	1.47	35.98	0.41
II	P_1	70.33	0.46	174.30	0.44	100.00	0.42	9.89	0.15	15.22	0.25	49.36	0.30	109.2	0.24	51.93	0.27
	P_2	57.30	0.42	165.00	0.43	95.00	0.33	12.3	0.14	47.30	0.32	64.50	0.22	39.27	0.19	26.47	0.32
	F_1	63.03	0.49	169.00	0.41	125.00	0.29	9.23	0.13	39.16	0.19	69.03	0.17	76.03	0.19	51.76	0.24
	F_2	61.57	0.46	168.00	0.46	96.67	0.45	9.10	0.22	21.36	0.39	54.38	038	65.33	1.85	36.49	0.32
	BC_1	68.67	0.48	166.33	0.51	110.00	0.53	8.84	0.24	38.85	0.40	62.28	0.39	63.39	1.81	36.53	0.37
	BC_2	62.65	0.50	173.03	0.49	115.00	0.40	10.4	0.21	57.25	0.39	81.77	0.41	45.58	1.84	45.17	0.53
III	P_1	42.30	0.31	144.87	0.51	108.30	0.34	2.40	0.07	23.70	0.38	48.56	0.34	48.50	0.37	23.43	0.40
	P_2	52.66	0.44	164.40	0.48	91.66	0.36	10.2	0.18	52.56	0.37	115.6	0.34	32.80	0.34	38.26	0.39
	F_1	50.83	0.23	153.83	0.42	120.13	0.26	8.16	0.16	55.20	0.26	106.6	0.31	44.50	0.34	46.76	0.36
	F_2	48.48	0.49	152.83	0.50	93.60	0.51	6.20	0.18	33.56	0.49	79.18	0.54	39.55	0.53	33.79	0.51
	BC_1	44.04	0.69	146.61	0.73	113.31	0.64	6.40	0.22	34.24	0.69	90.61	0.72	43.65	0.67	40.28	0.65
	BC_2	49.57	0.66	160.82	0.72	110.41	0.74	9.22	0.23	41.40	0.68	90.95	0.81	35.49	0.69	31.26	0.71

Table(3): Heterosis, inbreeding depression, potence ratio,F_2 deviation(E_1), backcross deviation(E_2) and gene actions in the three crosses of faba bean for the studied traits.

Character	Crosses	Heterosis		Inbreeding depression	Potence ratio	Epistatic deviation		Gene action of six parameters					
		Mid Parents	Better Parent			E_1	E_2	m	a	d	aa	ad	dd
Days to flowering (days)	I	-5.85**	37.68**	-5.07**	0.18	-6.12**	-16.55**	71.1**	- 14.42ns	- 13.25**	- 8.60**	10.73ns	41.7**
	II	-1.33*	10.00**	2.16**	-0.12	-1.85**	4.47**	61.67**	6.02ns	15.18**	15.96**	- 0.49ns	- 24.91**
	III	7.06**	20.16**	-4.62	-0.65	-0.67**	0.96**	48.48**	-5.53**	- 3.35ns	- 6.70ns	- 0.35ns	16.10ns
Days to maturity (days)	I	-0.65	6.63**	0.87*	0.01	-1.86**	0.71**	163.57**	- 10.43**	7.62*	8.70**	0.92ns	- 9.52**
	II	-0.38	2.42**	-0.59	-0.14	-1.32**	0.86**	168.00**	- 9.07**	6.72ns	6.72ns	- 11.35**	- 8.14**
	III	-0.52	6.18**	-0.65	0.08	-1.40**	-1.03**	152.83**	- 14.21**	2.74ns	3.54ns	- 4.44*	- 1.47ns
Plant height (cm)	I	16.88**	8.17**	-17.30**	2.10	-12.19**	-18.13**	100.04**	- 3.50**	31.63**	14.16**	- 11.84**	20.45**
	II	28.21**	25.00**	-22.66**	11.00	-14.58**	51.25**	96.67**	- 5.00**	90.82**	63.32**	- 7.50**	- 68.32**
	III	20.15**	10.93**	-22.08**	2.42	-16.45**	3.61**	93.60**	2.90**	93.19**	73.04**	- 5.42**	- 80.26**
Number of branches / plant	I	39.49**	23.64**	-41.79**	3.08	-2.26**	-2.20**	4.75**	- 0.74**	6.75**	4.44**	0.01ns	0.14ns
	II	-16.81**	-25.14**	-1.41**	1.51	-1.07**	-1.08**	9.10**	- 1.58**	0.26ns	2.12ns	- 0.35ns	0.01ns
	III	29.52**	-20.00**	-24.02**	0.48	-1.03**	1.16**	6.20**	- 2.82**	8.30**	6.44**	1.08**	- 8.76ns
No. of pods / plant	I	40.88**	13.30**	-34.15**	1.68	-4.4**	-3.09**	14.75**	5.61**	17.92**	11.42**	1.74**	- 5.24ns
	II	25.27**	-17.21**	-45.45**	-0.49	-13.85**	-3.09**	21.36**	- 18.40**	114.66**	106.76**	- 2.36**	- 158.12**
	III	44.77**	5.02**	-39.20**	1.18	-13.01**	-17.69**	33.56**	- 7.16**	34.11**	17.04**	7.27**	18.34**
No. of seeds/ plant	I	57.76**	8.57**	28.34**	1.51	-6.22**	-1.02**	44.45**	13.93**	45.57**	22.86**	- 1.12ns	- 20.82**
	II	21.25**	7.02**	21.22**	1.60	-8.6**	18.09**	54.38**	- 19.49**	82.68**	70.58**	- 11.92**	- 106.76**
	III	29.89**	-7.78**	25.74**	0.73	-15.18	-7.16**	79.18**	- 0.31NS	70.93**	46.40**	33.20**	- 32.07**
100-seed weight (g)	I	15.22**	8.12**	-19.44**	3.32	-11.90**	-7.93**	74.70**	- 1.08ns	44.01**	31.76**	- 6.36**	- 15.90**
	II	2.37**	-30.42**	-14.07**	0.05	-9.82**	-41.33**	65.33**	17.81**	- 41.62**	- 43.38**	- 17.19**	126.04**
	III	-5.01**	-28.84**	-16.58**	-0.15	-3.02	-6.01**	62.76**	22.80**	28.64**	32.60**	- 3.74**	- 7.39**
Seed yield / plant (g)	I	74.57**	21.91**	-41.62**	1.73	-11.63**	-5.89**	33.78**	13.15**	59.82**	35.10**	- 1.74ns	- 23.31**
	II	32.04**	-0.32	-29.50**	0.99	-8.99**	-9.46**	36.49**	- 8.64**	30.00**	17.44**	- 21.37**	1.08ns
	III	51.60**	22.22**	-27.74**	2.15	-5.01**	-6.06**	33.79**	9.02**	23.84**	7.92**	16.44**	4.21ns

n.s.: not significant. *, **: significant differences at 0.05and 0.01 levels of probability, respectively. a : Additive d: dominance

Table (4): Heritability estimates%, genetic advance from selection (g) and genetic advance expressed as percentage (g)

Characters	Heritability%		Genetic advance from selection	
	Broad sense	Narrow sense	g	g%
Cross I				
Days to flowering(days)	74.96	72.46	8.06	11.34
Days to maturity (days).	75.07	59.28	7.96	4.86
Plant height (cm)	66.57	59.64	6.05	6.04
Number of branches / plant	63.66	34.88	1.45	30.63
Number of pods / plant	92.55	83.56	7.99	54.15
Number of seeds/ plant	78.73	38.07	3.29	7.40
100-seed weight (g)	94.54	66.33	7.06	9.45
Seed yield / plant (g):	89.96	85.19	10.24	30.31
Cross II				
Days to flowering(days)	75.98	72.95	7.79	12.63
Days to maturity (days)	79.82	70.30	7.60	4.52
Plant height (cm)	85.51	80.53	8.51	8.80
Number of branches / plant	89.85	78.79	4.06	44.66
Number of pods / plant	89.33	79.25	7.23	33.84
Number of seeds/ plant	90.67	75.07	6.62	12.17
100-seed weight (g)	93.47	52.86	4.96	7.60
Seed yield / plant (g):	87.97	84.19	7.78	21.31
Cross III				
Days to flowering(days)	88.59	52.95	6.09	12.57
Days to maturity (days)	79.03	39.33	4.63	3.03
Plant height (cm)	90.60	61.22	7.38	7.88
Number of branches / plant	80.33	47.97	1.83	29.56
Number of pods / plant	88.44	50.83	5.85	17.44
Number of seeds/ plant	91.00	47.39	6.01	7.59
100-seed weight (g)	83.46	72.60	9.01	14.35
Seed yield / plant (g):	86.45	62.63	7.48	22.12

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الملخص العربى

التباين والفعل الجيني للتبكير ومكونات المحصول لبعض هجن الفول البلدي بمنطقة النوبارية

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تم تقييم ثلاثة هجن من الفول البلدي اولها هو (جيزة BPL710X 716) ا و الثاني (T.W X BPL 710و الثالث (TW x NA 112) بنظام الستة عشائر في الموسم 2010/2011- للتبكير في النضج والمحصول ومكوناته. ووجد أن قوة الهجين كانت معنوية وسالبة بالنسبة(لمتوسط الابوين) لصفتة ميعاد التزهير في الهجينين ا و ا ا ،وعلي الجانب الاخر سجلت كل الهجن قوة هجين معنوية عالية وموجبة طبقا للاب الافضل بالنسبة لهاتين الصفتين.- سجل الهجين الاول قوة هجين عالية المعنوية وسالبة بالنسبة للاب الافضل وايضا لمتوسط الابوين للصفات الاتية طول النبات وعدد القرون /نبات وعدد البذور /نبات عدا الهجين الثاني والثالث للصفتين الاخيرتين . كانت التربية الداخلية معنوية وسالبة في كل الصفات في كل الهجن ما عدا صفة عدد البذور/نبات وكذلك موعدي التزهير والنضج في الهجين الثاني والاول علي الترتيب . سجل التفوق الراجع الي كلا من الجيل الثاني.وكذلك الهجين الرجعي الثاني معنوية عالية سالبة او موجبة في كل الصفات المدروسة . التاثير المضيف كان عالي المعنوية في كل الصفات لكل الهجن الثلاثة ما عدا صفات عدد البذور/نبات ووزن ال100بذرة في الهجين الثالث والاول علي الترتيب وكذلك ميعاد التزهير في كل من الهجين الاول والثاني . التاثير السيادي كان معنوي في معظم الصفات المدروسة في كل الهجن الثلاثة. درجة التوريث بالمعني الواسع كانت متوسطة الي عالية وقد بلغت 66.57% لصفة طول النبات في الهجين الاول الي عالية 94.54% لصفة وزن ال100 بذرة في نفس الهجين. كانت قيم التحسين الوراثي المتوقعة متوسطة الي عالية في كل الصفات تحت الدراسة في الهجن الثلاثة .