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HETEROSIS AND COMBINING ABILITY IN FABA BEAN (*VCIA FABA* L.)

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Abstract

A half diallel set of crosses involving six parental lines of faba bean were evaluated in a randomized complete block design in two seasons. Significant seasons mean squares were detected for all traits except no. of branches per plant. Significant mean squares for genotypes, crosses and genotypes x seasons were detected for all studied traits. Significant mean squares for heterosis were detected for most traits. Six crosses in the combined analysis, i.e., 1.31 x R.B., 402 x R.B., 61/1311 x F.402, I. 131 x Giza 1, I. 131 x 61/1311/66 and 61/1311/66 x R.B. showed high desirable heterotic effects relative to the better parent for seed yield/plant up to 87.1%.

The variance associated with general combining ability (GCA) was significant for all traits except no. of seeds/pod and no. of pods/plant in the combined analysis. Specific combining ability (SCA) mean squares were significant for all traits. GCA/SCA ratio of less than unity was deterected for seed yield/plant and no.of pods/plant. However, GCA/SCA ratio above unity was detected for flowering date, no. of branches/plant 100-seed weight. Interaction mean squares involving GCA and SCA with seasons were significant for all the studied traits. The parental lines I. 131, M-3 and F. 402 had significantly positive GCA effects for seed yield/plant. The combinations (I. 131 x G.1), (I.131 x R.B.), (61/1311/66 x M-3), (61/1311/66 x F.402), (F.402 x R.B.), (I.131 x 61/1311/66 x M-3), (61/1311/66 x F.402), (F.402 x R.B.), (I.131 x 61/1311/66) and (M-3xR.B.) exhibited desirable (SCA) effects for seed yield plant and the latter cross M-3 x R.B. for total shedding. Also, they appeared to be the most promising in breeding for high yielding potential.

INTRODUCTION

Faba bean (Vicia faba L.) is an important leguminous crop in Egypt and increasing its yield is a primary goal of the plant breeder. Yield is a complex character and is an ultimate product of the action and interaction of a number of quantitative characters, which are known to be controlled by different sets of polygenes. In faba bean, yield is made up of several components, including number of pods per plant, no.of seeds per pod and 100-seed weight. The way in which these characters are inherited is thus of considerable importance to the breeders. Genetics of yield and its components in faba bean has been studied by several workers (Bond, 1967, 1989, Mahmoud, 1977; El-Hosary, 1985, 1987, 1988 and 1989; Polignano et al.1989; Hendawy et al 1988; El-Hosary and Sedhom, 1988 and El-Hosary et al. 1992). Also, the number of investigations on heterosis and combining ability in faba bean had increased greatly since the discovery of cytoplasmic male sterility and fertility restoration which enhanced the possibility of developing faba bean hybrids for commercial production. In addition, a knowledge of the magnitude of the genotype x year interaction is particularly interesting to plant breeders. This because they reflect fluctuations in environment which for the most part cannot be predicted in advance and hence can only be encounterd developing hybrids or varieties in which developmental sequences are canalized along a pathway that leads to high performance.

The present study was carried out to estimate heterosis and combining ability for characters of croses between yield and its components. Therefore, inquiries about the projected populations aiming to improve yielding potentiality of Egyptian faba bean could be made.

MATERIALS AND METHODS

Six faba bean genotypes, namely; I. 131 (P1), Giza 2 (P2), 61/1311/66 (P3), Mutant-3 (P4), Family-402 (P5) and Reina Blanca (P6) were used in this study. The parents P1 and P6 are introductions from Libya and Spain, respectively; P2, P3, and P5 are local Egyptian varieties, while P4 is a mutant variant of Giza 2 treated by. 0.25 DES. All possible crosses without reciprocal; between the six parents were produced twice in 1994/95 and 1995/1996. The 15 crosses and the six parental lines were sown in a randomized complete block design with three replications on Nov. 20 both in 1995/96 and 1995/1996 at the Agricultural Experimental Station, Moshtohor, Egypt. Plots consisted of one ridge 4 m long and 60 cm. wide with single-plant. Hills spaced 20 cm. apart on one side of the ridge. common cultural practices were followed for good faba bean production. Data were recorded on

10 guarded plants randomly chosen from each plot for flowering date, plant height, number of branches/plant, number of seeds/pod, number of pods/plant, 100-seed weight, seed yield/plant and total shedding percentage. Data of plot means were analized for combining ability and estimation of genetic effects according to Griffing (1956) method 2 model 1 for each season. A combined analysis of the two seasons was carried out whenever homogeneity of variances was detected. Heterosis expressed as the percentage deviation of F1 or F2 mean performance from better parent was also compouted .

RESULTS AND DISCUSSION

The combined analysis of variance of the data for growth, yield and its components is presented in Table (1). Mean squares for seasons were significant for all studied traits except number of branches per plant and total shedding%, indicating a significant season effect of the performance of most faba bean traits. For most traits the mean values in the second season were higher than in the first one.

Significant differences among genotypes were detected for all the studied traits in the combined analysis, indicating wide diversity between the parents used. Significant genotype x season interaction mean squares were also obtained for all traits.

Results also showed that mean squares due to parents were significant for all the traits, except number of seeds per pods and total shedding percentage. Significant mean squares due to the interaction between parental varieties and seasons were obtained for all traits except number of branches per plant and yield per plant. These findings indicate that parental lines differed in their mean perfomance in most traits under test. Also, it revealed that parental lines varied in their response to seasonal changes in all traits except number of branches and yield/plant.

The mean performance of the parents from the combined analysis is given in Table (2). Mutant-3 (M3) was earliest to flower and produced significantly higher seed yield and number of pods per plant. The parental lines Riena Blanca (RB) and I 131 were best in 100-seed weight and number of branches per plant but had the shortest plant height. Line I. 131 was lowest in total shedding. While it expressed moderate values for the other traits. Giza 1 was highest in number of pods per plant but showed moderate values for the other traits. Lines 61/1311/66 and F.402 gave

Tabl 1. Mean squared from combined analysis of variance for growth and yield characteristics of faba bean genotypes.

Source of variation	D.F.	Flowering date	Plant height (cm)	No. of branches / plant	No. of seeds /pod	No. of seeds /plant	100-seed weight (g)	Seed yield plant (g)	Total shedding
Year	1	2.71**	2233.06**	0.00	0.01*	4.45**	2505.44**	436.39**	1.20
Year in block	4	0.07*	88.53	0.07*	0.01*	0.36*	72.99*	77.91**	2.65
Genotypes	20	0.33**	318.10**	0.14**	0.01*	1.01**	803.69**	661.70**	37.25**
Parents	5	0.42**	813.80**	0.10**	0.01	0.45**	367.83**	80.41**	16.64
Crosses	14	0.27**	163.74**	0.09**	0.01*	0.71**	846.62**	407.19**	47.15**
Parent. Vs crosses	1	0.63**	0.72	1.06**	0.05**	7.97**	2381.88**	7131.43**	1.84
Genotypes x Year	20	0.26**	386.92**	0.08**	0.01*	0.52**	204.61**	267.69**	41.55**
parents x year	5	0.23**	246.92**	0.02	0.01*	0.63**	160.38**	12.37	54.11**
Crosses x year	14	0.28**	457.44**	0.10**	0.01*	0.52**	209.46**	370.30**	37.83**
Parents Vs crosses x year	1	0.06	83.17	0.05	0.07**	0.02	357.81**	107.83**	30.91
Error	80	0.03	40.88	0.02	0.00	0.12	26.94	10.68	8.36

the highest values for number of seeds per pod and plant height, respectively but were intermediate in yield and other traits. It is interesting to note that the superiority of the two parental lines I. 131 and Mutant-3 in seeds per plant. resulted from a high seed index and a high number of pods per plant, respectively. The same conclusion was reached by El-Hosary (1987) and El-Hosary et al. (1992).

Data presented in Table (1) show that crosses mean squares were significant for all the studied traits, revealing an overall differences between these hybrids. Significant interaction between F1 hybrids and seasons was detected for all traits indicating variable response to environmental fluctuations.

The mean performance of F1 crosses is presented in Table (2). It is noticed that all crosses surpassed the highest parent for each studied trait.

Results indicated that cross 61/1311/66 x G.1 was the earliest in flowering and the cross 61/1311/66xR.B. was latest. For plant height, The cross I 131 x F. was highest and F. 402 x R.B was lowest in plant height.

The cross F. 402 x R.B had the greatest number of branches per plant and the cross I. 131 x F. 402 had the least number of branches. The general mean of hybrids was within the range of parental lines for number of seeds/pod.

The cross I. 131 x M-3 showed the highest value for number of pods per plant. However, the cross 61/1311/66 x R.B had the lowest value of number of pods per plant. The cross I. 131 x R.B had the highest values of seed index. On the contrary, the cross G. 1 x 61/1311/66 in the combined data gave the lowest expression in this trait. In the combined analysis, the cross I. 131 x R.B had the highest seed yield per plant followed by crosses I. 131 x G. 1.131 x 61/1311 /66, 61/1311/66 x M-3, 61/1311/66xF.402, and F. 402 x R.B.

The high seed yield per plant in cross 61/1311/66x M-3 could be attributed to the high number of pods per plant while the high seed yield/plant of other hybrids could be attributed to a high seed index or an increased number of pods per plant. The cross M-3 x R.B. gave the lowest total shedding value but showed no significant superiority in yield.

Correlation coefficients between means of F1 hybrids and mideparent values for each studied trait are presented in (Table 2). Significant positive correlation coefficient values were detected for number of branches per plant and 100-seed

Table 2. Mean performance over seasons for faba bean parents and thier F1 crosses.

Genotypes	Flowring date (days)	Plant height (cm)	No.of bra-nches/ plant	No.of seed /pod	No. of pods /plant	100-seed weight (g)	Seed yield / plant (g)	Total shedding
1.131	C-E 56.99	GH 77.48	D-G 4.14	EF 3.4	GH 14.24	D-F 61.42	HI 27.03	F 78.65
G.1	F-H 52.83	B-E 88.10	FG 3.74	D-F 3.36	B-F 18.33	I 44.50	J 21.01	C-F 80.58
61/1311/66	F-H 52.83	B-F 87.80	FG 3.73	E-F 3.53	H 13.41	D-F 61.13	IJ 24.74	AB 82.65
M.S	1 47.33	A-C 91.80	G 3.54	F 3.24	D-G 17.78	HI 50.69	FG 31.98	D-F 81.70
F.402	AB 56.33	A 97.95	G 3.58	EF 3.3	F-H 15.46	EG 57.90	I 25.27	D-F 81.71
R.B	B-E 57.66	1 65.23	BC 4.99	E-F 3.56	H 12.88	CD 65.55	IJ 24.06	B-D 85.89
1.131XG.1	A-C 59.50	E-H 81.03	BC 5.06	A 3.79	AB 21.66	B 79.23	B 49.61	D-F 83.80
1.131x61/1311/66	F-H 53.16	E-H 81.13	C-F 4.33	A-D 3.66	A-C 21.49	C 71.78	BC 48.30	F 78.83
1.131 xM.3	A-C 54.83	E-H 80.56	C-G 4.21	A-E 3.59	A 23.36	DE 63.44	D 43.66	D-F 82.40
1.131xF.402	B-D 58.50	A-C 92.02	E-G 4.00	C-F 3.41	A-D 21.19	CD 66.81	DE 41.76	D-F 80.88
1.131xR.B	C-E 57.16	E-H 80.97	BC 5.01	A 3.79	B-F 18.20	A 93.74	A 54.74	BC 78.34
G.1x61/1311/66	H 51.00	A-D 90.40	C-F 4.48	A-D 3.66	E-G 17.99	HI 50.58	FG 31.67	B-E 84.81
G.1xM.3	F-H 53.33	B-G 85.50	B-D 4.93	A-C 3.71	GH 14.44	FH 55.58	GH 30.21	E-F 80.59
G.1xF.402	E-G 54.83	F-H 79.20	C-F 4.43	EF 3.3	C-G 17.64	D-F 60.87	FG 32.48	D-F 82.07
GG.1xR.B	E-G 55.00	AB 92.80	BC 4.94	EF 3.28	AB 22.36	GH 52.01	FG 32.85	C-F 83.21
61/1311/66xM.3	B-D 58.83	D-H 82.00	B-D 4.98	B-F 3.43	A-E 19.88	B 74.26	B 50.85	C-F 83.08
61/1311/66xF.402	GH 52.00	C-H 83.40	B-E 4.61	A-F 3.58	A 22.94	F-H 54.67	B 49.34	F 78.08
61/1311/66xR.B	A 62.16	B-F 87.70	B 5.48	A-F 3.58	GH 14.21	B 75.61	E 39.13	F 78.66
M.3xF.402	E-G 55.00	A-C 90.70	C-E 4.41	A-F 3.46	A-E 20.98	D-F 60.27	F 35.07	A 91.33
M.3xR.B	D-F 56.00	B-G 85.61	BC 4.99	A-F 3.51	AB 22.14	DF 62.66	CD 44.81	F 79.35
F.402xR.B	B-E 57.66	H 75.33	A 6.38	AB 3.76	AB 21.79	B 76.87	B 50.53	F 78.20
r	0.18	0.07	** 0.61	0.09	-0.11	** 0.09	0.25	D-F 80.94

I : Values followed the same letters are not different at probability 0.05 by Duncan's (L.S.R.) test.
r : Correlation coefficient between mid parent and F1 mean performance.
* and ** significant at 0.05 and 0.01 levels of probanility, respectively.

Tabl 3. Parcentage of heterosis in the F1 generation over mid parent (MP) and better parent (BP) for bean traits.

Crosses	Flowing date (days)		Plant height (cm)		No. of braan ches/		No. if seed /pod		No. of pods/plant		100-seed weight (g)		Seed yield/plant (g)		Total shedding	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
1.131xG.1	8.3**	12.62**	-2.12	-8.02	28.42**	22.20*	13.13**	12.80**	33.05**	18.16	47.71**	27.36**	106.50**	83.53**	5.25	6.55
1.131x61/1311/66	-3.19	0.62	-1.82	-7.59	10.18	4.55	6.70*	3.68	55.50**	50.91**	17.14**	16.86**	86.55**	78.69**	-2.22	0.23
1.131xM.3	5.12**	15.85**	-4.81	-12.24	9.63	1.65	9.12**	7.48*	45.09**	31.39**	13.17**	3.28	47.97**	36.52**	2.77	4.77
1.131xF.402	3.25*	3.85	4.91	-6.05	3.63	-3.38	2.40	2.096.4	42.69**	37.06**	11.95**	8.77	59.67**	54.49**	0.87	2.63
1.131xR.B	-0.30	0.30	13.47**	5.01	9.87	0.40	9.85	6	34.22**	27.80*	47.64**	43.00**	114.27**	102.51*	6.17	11.05**
G.1x61/1311/66	-3.46	-3.46	2.78	3.17	20.11*	19.78*	6.39	3.68	11.60	-1.85	-4.22	-17.25	38.44**	*	3.92	5.26
G.1xM.3	6.49*	12.67**	-4.94	-6.86	35.44**	31.82**	12.42**	10.41**	-21.94	-21.22	16.77**	9.64	14.02*	28.01**	-0.68	0.01
G.1xF.402	0.46	3.78	-14.86	-19.14*	21.04*	18.45	-0.30	-0.89	4.44	-3.76	18.87**	5.09	40.37**	-5.53	1.15	1.85
G.1xR.B	0.45	4.11	21.04**	14.42**	13.30	-1.00	-5.20	-7.86	43.33**	21.98*	-5.48	-20.65	45.79**	28.53**	-0.02	3.26
61/1311/66xM.3	17.47**	24.3**	-8.68	-10.67*	37.19**	33.51**	1.48	-2.83	-27.52	11.81	32.82**	21.47**	79.28**	34.99**	1.11	1.69
61/1311/66xF.402	-4.73	1.57	-10.20	-14.85*	26.30**	23.55*	3.37	1.41	58.97**	48.38**	-8.14	-11.54	97.31**	59.00**	-4.26	-3.73
61/1311/66xR.B	12.51**	17.66**	14.62**	-0.11	25.69**	9.82	1.13	0.56	8.14	5.96	19.37**	15.34**	60.38**	95.25**	8.38**	10.50**
M.3xF.402	6.12*	16.2**	-4.40	-7.40	23.87	23.18*	5.49	3.90	26.23**	17.99	10.97*	4.41	22.52**	9.66	-2.87	-2.87
M.3 x .B	6.67**	18.32**	9.04*	-6.74	17.13*	0.00	3.23	-1.40	44.42**	42.52*	7.81	-4.40	59.91**	40.11**	-6.67	-4.26
F.402 X R.B	1.18	2.36	-7.67	-23.03*	49.06**	27.85**	9.30**	5.62	53.77**	40.94**	45.51**	15.50*	104.84*	99.96**	-3.41	-0.94

MP and BP mid and better parent, respectively.

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

weight, indicating good agreement between mid parent values and F1 performance. Correlations involving other traits were not significant indicating that certain high and low parental lines may produce outstanding F1 hybrids. That the mean performance of the parental lines related to the average performance of their crosses were previously shown by El-Hosary (1985 and 1988), El-Hosary and Sedhom (1988) and El-Hosary et al. (1992).

The mean squares for parents vs. crosses which is a measure of average heterosis was of appreciable magnitude for all traits except plant hight (Table 1). This component interacted significantly with seasons for number of seeds per pod, 100-seed weight and seed yield per plant. These results indicated that, heterosis was affected by seasonal changes. The same trend was obtained by El-Hosary (1987).

Mid-parent and better parent heterosis percentage averaged over seasons for all traits studied are presented in Table (3).

For plant height, four crosses exhibited significant positive heterotic effects relative to mid parent in the combined analysis. Positive heterosis for plant height was reached before by El-Hosary (1987), Hendawy et al. (1988), and El-Hosary et al. (1992). Concerning number of branches per plant, nine and seven crosses expreseed significant positive heterotic effects relative to mid-parent and better parent in the combined analysis, respectively. These results are in harmony with that recorded by El-Hosary (1988). For number of seeds per pod. Six and three crosses significantly exceeded the mid parent and better parent in the combined data, respectively. With respect to number of pods per plant, most hybrids were either equal to or significantly superior to the mid-parent in the combined in the combined analysis, while eight crosses showed significant positive heterotic effects relative to better parent. Both crosses 61/1311/66 x F.402 and I. 131 x F.402 and I. 131 x 61/1311/66 gave the highest values for this trait at the combined analysis. Significantly positive heterotic effects for number of pods per plant over the better parent were recorded by Mahmoud (1977), El-Hosary (1987), El-Hosary and sedhom (1988) and El-Hosary et al. (1992). For 100-seed weight ten and six hybrids showed significantly positive heterotic effects relative to midparent and better parent in the combined analysis, respectively. These results are in harmony with Mahmoud (1977), El-Hosary (1988), El-Hosary and Sedhom (1988), Hendawy et al. (1988), and El-Hosary et al. (1992). Concerning seed yield per plant, all hybrids were equal to or significantly superior to the mid and/or better parent. In the combined analysis, the six crosses i.e. I. 131 x R.B. x F. 402, 61/1311/66 x F.402, I.131 x G1, I. 131 x 61/1311/66 and 61/1311/66x R.B. showed high desirable heterotic effects relative to better parent in the F1 generation with the greatest advantage being (87.1%). Heterosis values for seed yield per plant were generally higher than for individual components of yield (Table 3). The components of yield for individual crosses also showed in most cases high heterosis for seed yield of faba bean. [Bond (1967 and 1989), Mahmoud (1977), El-Hosary (1987 and 1988), El-Hosary and Sedhom (1988), Hendawy et al. (1988), and El-Hosary et al. (1992)).]. The cross M3 x R.B. had significantly negative heterotic effect relative to mid parent. None of the hybrids had significantly negative heterosis relative to better parent for this trait. Significantly negative heterosis effects for shedding were obtained by El-Hosary et al. (1988) and El-Hosary et al. (1992).

Analysis of variance for combining ability as outlined by Griffing's (1956) method 2 model 1 in the combined data for all the studied traits is shown in Table (4). The variance associated with general combining ability (GCA) was significant for all traits except number of seeds per pod and number of pods per plant. Specific combining ability (SCA) mean squares were significant for all characters under study. It is evident that non additive type of gene action was the more important part of the total genetic variability for number of seeds per pod and number of pods per plant. For the other studied traits, both additive and non additive gene effects were involved in determining the performance of single cross progeny. High (GCA) / (SCA) ratios which exceeded unity were detected for all studied traits except seed yield per plant. Such results indicated that additive and non additive x additive types of gene were more important. For the exceptional trait. however, non additive type of gene action seemed to be more prevalent. The genetic variance was reported to be mostly additive for yield and its components (El-Hosary, 1987, 1988 and 1989; El-Hosary et al. 1992 a and b).

The interactions between seasons and both types of combining ability were significant for all the studied traits. Thus the magnitude of all types of gene action would vary with season. It is evident that mean squares of (SCA) x season was higher than (GCA) x season for all traits except 100-seed weight, total shedding % and number of seed/pod. Thus non additive effects were much more influenced by the environmental conditions than additive genetic effects in these traits. These conclusions are in agreement with Polignano et al (1989). For the exceptional trait, however, the higher magnitude of (GCA) x season interaction showed that the additive and additive x additive effects were more affected by environment than the nonadditive effects.

Tabl 4. Mean squares for general and specific combining ability in the F1 eneration over two seasons.

Source of variation	D.F.	Flowering date	Plant height (cm)	No.of bra-nches/plant	No. of seeds/pod	No. of pods/plant	100-seed weight (g)	Seed yield plant (g)	Total shedding
G.C.A.	5	0.07**	77.02**	0.040**	0.001	0.06	229.96**	73.15**	8.64*
S.C.A.	15	0.05**	45.01**	0.02**	0.002*	0.20**	101.94**	122.66	5.39*
G.C.A. X year	5	0.096**	97.56**	0.046**	0.006*	0.148**	257.43**	139.38**	28.68**
S.C.A. X year	15	0.159**	208.76**	0.056**	0.008**	0.41**	183.72**	219.56**	17.18**
Error	80	0.01	13.62	0.008	0.001	0.04	8.98	3.56	2.78
G.C.A./S.C.A.		1.5	1.71	1.85	0.33	0.31	2.25	0.6	1.59

* and ** significant at 0.05 and 0.01 levels of probability, respectively
G.C.A. and S.C.A general and specific combining ability, respectively.

Estimates of (GCA) effects for individual parental lines in each trait from the combined analysis are presented in Table (5). High negative effects for flowering date and high positive effects for other traits would be useful for the breeder. The variety G. 1 showed significant negative effects for flowering date. Also, the lines 61/1311/66 and M. 3 showed significant negative effect for this trait, indicating that the three parental lines are good combiners for earliness. For plant height, significant negative GCA were detected for R.B. and I. 131, suggesting the possibility of utilizing these parents in breeding short varieties. On the other hand, large positive GCA effects were detected for M.3 and F. 402, hence can be used in breeding tall varieties.

The parental variety R.B. appears to be an excellent parent in breeding varieties characterized by higher number of branches per plant. Rine Blanca and I. 131 showed significant positive GCA effects for seed index, and I. 131, M. 3 and F. 402 had large positive GCA effects for seed yield/ plant. Line I.131exhibited the highest GCA effect and Giza 1 was the poorest combiner for seed yield/plant. It is worthnoting that the parent possessing high GCA effect for seed yield might show the same for one or more of the traits contributing to seed yield. For example, I. 131 showed the highest positive GCA effects for seed yield, 100-seed weight and number of pods. These findings are in agreement with those obtained by Bond (1967), El-Hosary (1988), Hendawy et al. (1988) and El-Hosary et al. (1992). However, the parental line which had high GCA effects for yield components may not necessarily be a high combiner for seed yield as observed for R.B. which had the highest positive effects for seed yield. Similar results were obtained by El-Hosary (1987 and 1988) and El-Hosary and Sedhom (1988).

Significant correlation coefficients between parental performance and GCA effects were obtained for all traits except number of seed/pod, number of pods per plant and seed yield per plant and total shedding% (Table 5). These findings indicate that performance of the parental lines was a good indication of thier GCA. Thus, selection of parents based on mean performance of GCA would have the same efficiency.

For the traits where no significant correlation was detected between per se performance and GCA, hybrids with high performance for these traits could be expected by crossing parents of low or high performance meain. A rather good agreement between ranking the parental lines according to their GCA effect and ranking parental performance was reported by Bond (1967), El-Hosary (1987), El-Hosary

Tabl 5. Estimares of general combining ability effects in the F1 generation.

Parent		Flowering date	Plant height (cm)	No.of seeds/plant	No.of seeds/pod	No.of seeds/plant	100-seed weight (g)	seed yield plant (g)	Total shedding
1.131	gi	0.110**	-2.69*	-0.03	0.01	-0.06	6.330**	3.636**	-0.47
	mean	7.53	77.48	2.02	1.82	3.75	61.42	27.03	63.03
S.I	gi	-0.06	1.61	-0.02	-0.01	-0.01	-7.49**	-5.52**	0.22
	mean	7.26	88.09	1.93	1.83	4.24	44.50	21.00	65.56
61/1311/66	gi	-0.06	1.00	-0.02	0.01	-0.12	0.37	0.716*	0.39
	mean	7.26	87.80	1.92	1.87	3.63	61.13	24.74	69.83
M.3	gi	-0.10	1.96	-0.04	-0.01	0.08	-3.58**	0.69	-0.88
	mean	6.87	91.80	1.88	1.80	4.16	50.69	31.97	65.10
F. 402	gi	0.01	3.035*	-0.03	-0.01	0.08	-1.36	-0.41	-1.03
	mean	7.49	97.94	1.88	1.82	3.90	57.92	25.27	64.74
R.B.	gi	0.117**	-4.92	0.139**	0.01	-0.09	5.723**	0.89	1.77
	mean	7.56	65.23	2.22	1.88	3.52	65.55	24.06	69.15
L.S.D. 0.05	(gi-gi)	0.10	3.67	0.09	0.04	0.20	2.98	1.87	2.34
L.S.D. 0.01	(gi-gi)	1.13	4.87	0.12	0.05	0.27	3.95	2.49	3.10
r		0.860*	0.980**	0.940**	0.75	0.74	0.920**	0.59	0.67

and Sedhom (1988) and El-Hosary et al. (1992).

Specific combining ability effects for cases where SCA was significant are presented in (Table 6). Large effects were prevalent for seed yield per plant than for any of its components. For flowering date, two crosses exhibited significant negative specific combining ability effects. Results indicated that crosses I. 131 x 61 /66 and 61/1311/66 x F.402 had the best desirable (SCA) values for this trait. Regarding plant height, three crosses showed significant positive (SCA) effects. while two crosses had significant negative effects. But the rest of crosses showed the highest desirable (SCA) effect for height followed by crosses I. 131 x F. 402 and 61/1311/66.

Two crosses showed significantly positive (SCA) effects for number of branches per plant. The cross F. 402 x R.B. had the highest (SCA) effect for this trait followed by cross I. 131 x G. 1. The crosses I. 131 x G. 1 and G. 1 x M. 3 had significant (SCA) effects for number of seeds per pod. For number of pods per plant, six crosses gave significant positive (SCA) values. Meanwhile, the cross 61/1311/66 x F. 402 gave the highest (SCA) effects followed by cross G. 1 x R. B. for this trait.

Considering 100-seed weight, six crosses had significant positive (SCA) effects. The crosses I. 131 x G. 1 and 61/1311/66 x M. 3 had the highest desirable (SCA) effects for this trait. Also, the cross M3 x R.B. had the highest desirable (SCA) effects for total shedding percentage.

Regarding seed yield/plant, seven crosses showed significant positive (SCA) effects. In conclusion, the best combinations were 1.131 x G.1, I. 131 x R.B, 61/1311/66 x M3, 61/1311/66 x F. 402, F. 402 x R. B and I. 131 x 61/1311/66. Theses crosses also had the highest mean values in the combined analysis. These crosses are the best combinations showing significant (SCA) effects for seed yield per plant and most of yield components. The cross M3 x R.B. showed high SCA cross for yield per plant and total shedding.

In crosses showing high SCA and one of the parents has involving only good GCA desirable transgressive segregation may be expected as a results of additive genes from one parent with the complementary and epistatic genes present in the cross. Therefore, the above crosses appear to be useful for initiating a selection program to improve yield and economic traits.

Tabl 6. Estimares of general combining ability effects in the F1 generation.

Grosses	Flowering date (days)	Plant height (cm)	No. of branch-es/ plant	No. of seed /pod	No.of pods /plant	100-seed weight (g)	Seed yield /plant (g)	Total shedding
1.131xG.1	0.231*	-2.490	0.162*	0.067*	0.300	15.650**	13.920**	1.180
1.131x61/1311/66	-0.214*	-1.780	-0.002	0.017	0.400*	1.338	6.370**	-2.590
1.131xM.3	0.300**	-3.313	-0.006	0.024	0.390*	-3.055	1.760	1.300
1.131x F.402	0.076	7.070*	-0.067	-0.024	0.180	-1.900	0.960	0.480
1.131xR.B	-0.125	3.980	-0.002	0.049	0.008	17.939**	12.64**	2.560
G.1x61/1311/66	-0.175	3.180	0.018	0.033	-0.019	-6.040	-1.100	1.240
G.1 x M.3	0.031	-2.684	0.140	0.067*	-0.580**	2.900	-2.530	-0.650
G.1 x F.402	0.022	-10.050**	0.022	-0.031	-0.184	9.967**	0.850	0.390
G.1 x R.B	-0.070	11.500	-0.026	-0.073*	0.51**	-9.980**	-0.090	-1.540
61/1311/66xM.3	0.36**	-5.570	0.145	-0.019	0.197	13.72**	11.860**	0.760
61/1311/66xF.402	-0.195*	-5.240	0.068	0.018	0.55**	-8.080	11.460**	-2.190
61/1311/66xR.B	0.37**	7.020*	0.086	-0.010	-0.318	5.770*	-0.052	5.480*
M.3 x F.402	0.041	1.088	0.044	0.015	0.125	1.459	-2.780	-0.390
M.3 x R.B	0.005	3.960	0.008	-0.001	0.42*	3.230	5.650**	-3.830
F.402 x R.B	0.011	-7.393*	0.283**	0.065*	0.380	8.760*	12.470**	-1.020
L.S.D. 0.05 (sij -sik)	0.267	9.660	0.240	0.094	0.538	7.890	4.943	4.370
L.S.D. 0.01 (śij -sik)	0.360	12.890	0.320	0.125	0.717	10.460	6.591	5.830
L.S.D. 0.05 (sij -sik)	0.240	8.950	0.220	0.087	0.498	7.260	4.600	4.040
L.S.D. 0.01 (sij -sik)	6.330	11.930	0.290	0.116	0.664	9.690	6.102	5.390

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

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تأثير مواعيد الشتل والكثافات النباتية على محصول وجودة الأبصال فى صنف البصل جيزة ٢٠ فى الوجه القبلى

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تم دراسة تأثير ميعادى الشتل (١٥ نوفمبر و ٥ فبراير) وكثافة الشتلات (٨٠ ، ١٢٠ ، ١٦٠ شتلة /م٢) على صفات المحصول وبعض مكوناته وكانت النتائج كالاتى:

١ – زاد المحصول الكلى والمحصول التسويقى والمحصول التصديرى معنويا بالشتل المبكر (١٥ نوفمبر) والكثافات المرتفعة (١٦٠ نبات/م٢).

٢ – نقص محصول النقضة (الأبصال المستبعدة) معنويا بتأخير الشتل الى ٥ فبراير وكثافة ٨٠ نبات/م٢ .

٣ – نقصت النسبة المئوية للابصال المزدوجة والابصال الحنبوط نقصا معنويا بالزراعة فى ٥ فبراير.

٤ – نقصت نسبة الابصال المزدوجة معنويا عند زراعة ١٦٠ شتلة لكل متر مربع.

٥ – نقص متوسط وزن البصلة معنويا بشتل ١٦٠ / م٢ فى ٥ فبراير.

٦ – تم نضج وتقليع النباتات التى تم شتلها فى ١٥ نوفمبر و ٥ فبراير فى ١٧ ، ٢٧ أبريل على التوالى.

٧ – أدى الشتل المتأخر فى ٥ فبراير الى انتاج أبصال صغيرة الحجم غير صالحة للتسويق.