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Heterosis and combining ability in F_1 and F_2 of faba bean (*Vicia faba* L.)

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Abstract:

This investigation was carried out under the screenhouse at New Valley research station during 2009/2010 to 2011/2012 seasons, to determine heterosis and general (GCA) and specific combining ability (SCA) for yield and yield attributes in five–parental diallel crosses. Five faba bean genotypes (*Vicia faba* L.) were used as parental lines. Highly significant differences among the tested entries were detected for different traits, indicating wide genetic variability for all traits. Several crosses recorded significant positive heterosis percentages relative to mid parent (MP) and better parent (BP) for number of pods/plant, 100-seed weight and seed yield/plant ranged from 6.3 to 42.4%, 2.8 to 23.0%, 3.1 to 12.8%, 3.2 to 6.6%, and 4.2 to 30.4%, 13.2 to 22.6% relative to MP and BP for each character, respectively. The ratios of (GCA/SCA) exceeded the unity for all studied traits indicating that the genetic variation among these traits in the F_1 and F_2 appeared to be additive. The parental genotype, P_4 (1706B/87/2003) was found to be a good combiner for 100-seed weight and seed yield/plant and P_5 (1706A/400/2003)expressed highly significant positive GCA effect for 100-seed weight. Moreover, one parent Wadi 1was good combiners for earliness. Five F_1's (P_1xP_2, P_1xP_3, P_2xP_4, P_2xP_5 and P_4xP_5) and only one F_2 (P_1xP_3) had significant positive (SCA) effects for 100 seed weight. Five F_1's (P_1xP_3, P_1xP_4, P_2xP_4, P_2xP_5 and P_4xP_5) as well as three F_2's (P_1xP_3, P_2xP_4 and P_2xP_5) had significant positive (SCA) effects for seed yield plant, indicating that the crosses may be of specific interest in hybrid faba bean breeding programe.

Introduction:

Faba bean (*Vicia faba* L.) is the important legume crop in the world. It is considered the popular diet in Egypt. The increasing gap between consumption and production necessitates increasing the production of faba bean in Egypt. This could be achieved through extending the cultivated area beside the productivity of unit area by adopting an efficient breeding program. Success of any plant breeding program depends largely upon a better understand of the genetic basis of the important economic traits. Information about heterosis, general and specific combining

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ability and the type of gene action may help faba bean breeder to formulate the most efficient breeding procedure for achievement of maximum genetic improvement among a particular set of genotypes. Superiority of hybrids over the mid and better parents for seed yield was found to be associated with manifestations of heterotic effects in main yield components i.e., number of branches, number of pods, number of seeds plant and seed index. The effects ranged from significant positive to significant negative for different traits and were very pronounced in F_1 of faba beans especially crosses among widely divergent materials and less occurred in hybrids between local varieties (Duc, 1997; Schill *et al*., 1998; Bond and Crofton, 1999; Filippetti *et al*., 1999; Darwish *et al*., 2005; El-Hady *et al*., 2006, 2007; Gasim & Link, 2007; Alghamdi, 2009; Salem, 2009; Hossam, 2010 and Farag & Afiah, 2012). Several researchers found the significance of both general and specific combing ability effects for yield and other important traits of faba beans (Abdalla *et al*., 2001; Attia *et al*., 2002; Attia & Salem, 2006; Salem, 2009; Alghamdi, 2009; Hossam, 2010 and Farag & Afiah, 2012). Salem (2009) found that the genetic variation among number of pods plant, number of pods main stem and 100-seed weight appeared to be additive. However the predominance of non-additive gene action were found for days to flowering, plant height, number of branches plant, number of seeds plant and seed yield plant. The present investigation aimed to understand the nature of gene action and relative magnitude of heterosis and combining ability of five faba bean genotypes and their F_1 and F_2 generations using diallel cross mating design

Materials and methods

This investigation was carried out under the screenhouse at New Valley Research Station to determine the heterosis for yield and yield attributes in five–parental diallel crosses, the effective of general combining ability (GCA) and specific combining ability (SCA) to choose the most effective breeding method. Five faba bean genotypes (*Vicia faba* L.) were used as parental lines in the present study

Table 1: Pedigree and characteristics of some faba bean parental genotypes used in the present study

Genotypes	Pedigree	Flowering	Seed size	Seed color	Hilum
P_1 (Giza 40)	An individual plant selected from Rebaya 40	Early	Medium	Beige	Black
P_2 (Wadi 1)	Derived from Giza blanca × Triple white	Early	Medium	Beige	White
P_3 (Giza 429)	An individual plant selected from Rebaya 402	Early	Medium	Beige	Black
P_4 (1706B/87/2003)	Derived from Giza blanca × Triple white	Late	Large	Greenish	White
P_5 (1706A/400/2003)	Derived from Giza 674 × Giza blanca	Early	Large	Beige	Black

A diallel cross set involving the five parents were grown in the screenhouse in the 2009/2010 season. The ten possible F_1 crosses with their respective parents were sown in 2010/2011 season. In 2011/2012 season, the five parents genotypes, 10 F_1 crosses and 10 F_2 populations were evaluated in a randomized complete block design with three replications. Each plot consisted of one ridge for parents and F_1 crosses and five ridges in F_2 populations of three meters in length and 60 cm. width. Hills were spaced by 20 cm with one seed per hill in one side of the ridge. Data were recorded on individual plant basis, therefore, 10 guarded plants for parent and F_1's and 50 guarded pl ants in F_2 were randomly chosen from each plot. The following traits were recorded: days to flowering, maturity, number of branches plant, number of pods plant, number of seeds plant, 100 seed weight and seed yield plant.The heterotic effects of F_1 crosses were estimated as percentage of mid parent and better parent. General and specific combining ability estimated as according to Griffing (1956) diallel cross analysis designated as method 2 model 1.

Results and discussions

Mean squares of genotypes in the F_1 and F_2 generations revealed highly significant differences among the tested genotypes for all characters under investigation which indicate a wide genetic variability for the studied characters and hence, the feasibility for genetic improvements in these materials (Table 2)

The mean performance of some faba bean traits presented in Table 3 showed that parent P_2 (Wadi 1) was the earliest and recorded 33.0 and 118 for days to flowering and maturity, respectively. On the other hand, the latest parent with regard to flowering was P_4 (1706B/87/2003) which recorded 50.7 days, but the latest one for maturity was P_3 (Giza 429) which registered 139 days.With respect to number branches plant, results showed that P_4 (1706B/87/2003) followed by P_5 (1706A/400/2003) had the highest number of branches plant, 4.3 and 4.0, respectively. Meanwhile, the lowest mean value (3.5) in this respect was recorded from P_2 (Wadi 1). Giza 40 produced the highest pods number/plant (31.8) while the lowest value (24.9) produced from P_5 (1706A/400/2003). With regard to number of seeds/plant, data showed that the P_4 (1706B/87/2003) followed by P_1 (Giza 40) had the highest number of seeds/plant, 89.9 and 88.5, respectively. The highest of seed index (112 g) was obtained from P_5 (1706A/400/2003) followed by P_4 (1706B/87/2003) which registered 107 g, while the lowest mean value (65 g) was obtained from P_1 (Giza 40). Also, the presented data showed

Table 2: Mean squares and combining ability for different studied traits in the F_1 and F_2 generations.

SOV	d.f.	Flowering		Maturity		No. of branches/plant		No. of pods/plant	
		F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Rep.	2	1.67	2.12	0.73	4.95	0.01	0.15	0.83	6.21
Geno.	14	86.14**	82.08**	85.17**	85.20**	0.57**	0.30	44.52**	32.38**
Parents	4	135.57**		230.71**		0.29		19.06	
Crosses	9	73.74**	67.37**	23.55**	12.14*	0.32**	0.26	44.62**	39.26*
P vs C	1	0.10	0.54	57.55**	160.61**	3.93*	0.75	145.44**	23.70**
G.C.V.	4	270.05**	261.62**	216.40**	199.52**	0.63**	0.48	76.77**	68.03**
S.C.A.	10	12.58**	10.26**	32.68**	39.46**	0.55**	0.23	31.62**	18.11
Error	28	0.67	2.95	1.25	4.18	0.06	0.25	1.79	11.57
GCA/SCA		21.47	25.50	6.62	5.05	1.14	2.09	2.43	3.76

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

Table 2: Cont.

SOV	d.f.	No. of seeds/plant		Seed yield/plant		100 seed weight	
		F_1	F_2	F_1	F_2	F_1	F_2
Rep.	2	7.29	44.34	1.29	3.71	10.46	37.98
Geno.	14	279.61**	205.82**	794.98**	683.66**	927.79**	814.76**
Parents	4	163.10**		780.54**		1428.83**	
Crosses	9	233.19**	181.77**	741.81**	620.90**	793.33**	631.16**
P vs	1	1663.38	593.11*	1331.33	860.94*	133.74*	10.82**

C		**	*	**	*	*	
G.C.V.	4	451.08**	375.17**	2078.79**	1627.37**	2909.68**	2538.55**
S.C.A.	10	211.02**	138.08**	281.45**	306.17**	135.02**	125.25**
Error	28	8.18	25.28	4.89	18.96	3.57	11.38
GCA/SCA		2.14	2.72	7.39	5.32	21.55	20.27

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

Table 3:Mean performance of five faba bean parental genotypes and their F_1 and F_2 generations for yield and some attributes.

Traits / Geno-types	Days to Flower-ing		Days to Maturi-ty		Num-ber of branch es plant		Number of pods Plant		Number of seed Plant		100 seed Weight		Seed yield Plant	
P_1	36.3		135		3.7		31.8		88.5		65.0		57.0	
P_2	33.0		118		3.5		26.9		77.6		94.0		73.0	
P_3	37.7		139		3.7		28.1		81.1		69.0		56.0	
P_4	50.7		137		4.3		28.4		89.9		107.0		93.0	
P_5	38.7		137		4.0		24.9		72.4		112.0		81.0	
Crosses	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
P_1 x P_2	35.3	35.3	130	134	4.2	4.1	38.8	36.7	98.7	96.6	98.8	81.4	80.2	75.4
P_1 x P_3	33.3	33.7	135	139	4.0	3.9	34.8	31.4	104.7	97.0	75.4	74.1	73.2	70.5
P_1 x P_4	43.7	44.7	136	137	4.7	3.9	34.5	31.2	100.2	95.8	90.0	80.6	93.7	77.3
P_1 x P_5	37.3	38.3	134	139	4.2	3.9	30.4	29.7	96.2	93.4	91.8	78.3	81.1	73.0
P_2 x P_3	34.7	35.7	136	138	4.6	4.0	30.1	27.9	84.7	83.5	82.2	80.0	71.3	67.4
P_2 x P_4	47.0	44.3	135	135	4.7	4.5	35.0	32.1	94.8	93.3	111.1	108.6	109.0	106.3
P_2 x P_5	38.7	37.0	136	137	4.7	4.3	25.5	23.1	76.1	73.7	118.1	111.5	96.8	92.5
P_3 x P_4	45.3	45.0	140	140	4.6	4.1	30.1	28.7	86.8	83.5	83.1	76.8	75.1	64.1
P_3 x P_5	35.3	33.3	137	138	4.0	3.7	28.9	27.5	86.5	84.9	85.6	79.9	74.3	68.1
P_4 x P_5	43.0	43.0	140	140	5.0	4.6	30.2	26.8	98.4	94.6	117.7	108.2	107.6	101.3
L.S.D. 0.05 for $P+F_1$	1.4		1.9		0.4		2.2		4.8		3.1		3.7	
L.S.D. 0.05 for $P+F_2$	2.9		3.4		0.6		5.7		8.4		5.6		7.3	

that the highest seed yield plant (93g) was obtained from P_4 (1076 B/87/2003) followed by P_5 (1706A/400/2003) which yielded 81 g. On the other hand, the lowest value in this respect was obtained from parental genotype P_3 (Giza 429) with no significant difference from the value registered from parental genotype P_1 (Giza 40) which gained 57g plant. The performance of the crosses indicated that none of the crosses was earliest than the earliest parent for days to flowering and maturity in both F_1 and F_2 generations. However, six (P_1xP_4, P_2xP_3, P_2xP_4, P_2xP_5, P_3xP_4 and P_4xP_5), four (P_1xP_2, P_1xP_3, P_1xP_4 and P_2xP_4), six (P_1xP_2, P_1xP_3, P_1xP_4, P_1xP_5, P_2xP_4 and P_4xP_5), two (P_2xP_5 and P_4xP_5) and four (P_1xP_4, P_2xP_4, P_2xP_5 and P_4xP_5) F_1 crosses. While, F_2 generations six (P_1xP_2, P_1xP_3, P_2xP_3, P_2xP_4, P_2xP_5 and P_4xP_5), two (P_1xP_2 and P_2xP_4), six (P_1xP_2, P_1xP_3, P_1xP_4, P_1xP_5, P_2xP_4 and P_4xP_5), two (P_2xP_4, P_2xP_5) and five (P_1xP_2, P_1xP_3, P_2xP_4, P_2xP_5 and P_4xP_5) populations exceed the highest parental genotypes for number of branches plant, number of pods plant, number of seeds plant, 100 seed weight and seed yield plant, respectively. It could be concluded that the above mentioned parents and crosses would prospect in faba bean breeding and therefore may be valuable for improving seed yield via its component characters.

Heterosis effect

Values of heterosis percentage relative to mid parent (MP) and Better parents (BP) were significantly differed between crosses (Table 4). Heterosis percentage relative mid parent (MP) were ranged from -9.9 to 12.3, -1.7 to 6.2, 0.8 to 27.8, -1.4 to 32.4, 1.4 to 23.4, -29.3 to 17.8 and -1.2 to 30.4 for days to flowering, days to maturity, number of branches, pods and seeds per plant, 100 seed weight and seed yield per plant, respectively. However, heterosis percentages relative to the better parent (BP) ranged from -8.3 to 42.4, -1.2 to 15.6, 0.8 to 23.2, -5.1 to 23.0, -3.5 to 18.3, -29.3 to 6.6 and -20.7 to 22.6 for days to flowering, days to maturity, number of branches, pods and seeds per plant, 100-seed weight and seed yield/plant, respectively. The highest values of heterosis percentage relative to the mid parent (MP) in the F_1 crosses were registered from crosses (P_2xP_4), (P_2xP_5), (P_2xP_3), (P_1xP_2), (P_1xP_3), (P_1xP_2) and (P_2xP_4) with regard to days to flowering, days to maturity, number of branches, pods and seeds per plant, 100-seed weight and seed yield per plant traits, respectively. While, the highest values of heterosis percentage relative to the better parent (BP) in the F_1 generations were registered from crosses (P_2xP_4), (P_2xP_3), (P_2xP_3), (P_2xP_4), (P_1xP_3), (P_1xP_3) and (P_1xP_3) for the same previous traits in the same order. It could be suggested that the heterotic effects for seed yield was associated with other components

Furthermore, various cross combinations exhibited different degrees of F_1 superiority in some traits based on the genes in parental combinations that may contribute directly or indirectly to the traits. Varied values of heterosis might be due to the genetic diversity of the parents with non-allelic interaction which increase or decrease the expression of heterosis (Hayman, 1958). The heterosis estimates for the majority of the traits showed that there was sufficient genetic divergence among the parents assessed, resulting in a favorable situation for breeding (Barelli *et al.*, 2000). Even in the absence of epistasis, multiple alleles at a locus lead to either positive or negative heterosis (Cress, 1966). Pronounced and favourable heterosis have been obtained by several researchers for faba bean traits which varied according to the cross combinations and traits (Duc, 1997; Stelling, 1997; Schill *et al.*, 1998; Abdulmula *et al.*, 1999; Bond and Crofton, 1999; Filippetti *et al.*, 1999; Abdalla *et al.*, 2001; Attia *et al.*, 2002; Darwish *et al.*, 2005; Attia & Salem, 2006; El-Hady *et al.*, 2006; Gasim and Link, 2007; Elghamdi, 2009; Salem, 2009; Hossam, 2010 and Farga & Afiah, 2012).

Combining ability

Mean squares of both GCA and SCA estimates were highly significant in both generations for all the studied traits except number of branches/plant in the F_2 generation (Table 2). Also, the ratio of GCA/SCA estimates exceeded the unity for all studied traits in both F_1 and F_2 generations. This indicates that most of the genetic variation among the investigated genotypes for the mentioned traits appears to be under additive gene actions. A direct selection could thus be useful for improving these traits. Comparisons between GCA effects associated with each parent (Table 5), revealed that the parent P_1, P_2 and P_3 showed significant negative effects for days to flowering and could be considered as sources for earliness in breeding program, whereas, P_4 parent showed highly significant positive effect in this respect. P_2 parent had a highly negative effect for days to maturity and could be considered as a source for earliness in breeding program. These findings are highly important for breeding early faba bean cultivars. Concerning number of pods and seeds plant traits, P_1 parent showed significant effect in this respect. On the other hand, the tow parents (P_4 and P_5) had a highly significant positive effect on 100 seed weight and also P_2 parent showed significant positive effect in this respect. P_4 parent showed a highly significant effect on seed yield plant, while P_5 parent showed significant positive effect in this respect. These results suggest that the mentioned parental genotypes were good combiners for improving most studied traits. The significant relation between combining ability results and the mean performance of parental genotypes indicates the efficiency of phenotypic performance for

Table 5: General combining ability effects in F_1 and F_2 generations for various traits.

Parents		P_1	P_2	P_3	P_4	P_5	S.E
Days to Flowering	F_1	-1.95*	-2.05*	-1.71*	6.33**	-0.62	0.82
	F_2	-1.43	-2.33	-1.67	6.24**	-0.81	1.72
Days to Maturity	F_1	-0.47	-5.40**	2.35*	1.99	1.53	1.12
	F_2	0.34	-5.38**	2.15	1.12	1.75	2.05
Number of branches plant	F_1	-0.15	-0.06	-0.12	0.28	0.05	0.24
	F_2	-0.12	-0.03	-0.14	0.23	0.06	0.50
Number of pods Plant	F_1	2.68*	-0.04	-0.45	0.46	-2.65*	1.34
	F_2	2.61	-0.05	-0.03	0.21	-2.44	3.40
Number of seed Plant	F_1	6.01*	-3.58	-1.38	3.63	-4.68	2.86
	F_2	5.35	-2.87	-1.58	3.53	-4.43	5.03
100 seed Weight	F_1	-11.18**	4.80*	-13.99**	9.04**	11.34**	1.89
	F_2	-12.78**	5.29	-10.90**	7.79*	10.61**	3.37
Seed yield plant	F_1	-6.50**	1.38	-12.56**	13.17**	4.51*	2.21
	F_2	-7.64	4.14	-11.00*	9.26*	5.24	4.35

*, ** significant at 0.05 and 0.01 level of probability, respectively

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detecting the potentiality of parents for inclusion in cross breeding programs. Three F_1's (P_1xP_3, P_3xP_5 and P_4xP_5) had significant negative effect for days to flowering (Table 6). Moreover tow F_1's (P_1xP_2 and P_2xP_4) showed highly significant positive effects for number of pods plant. With respect to number of seeds plant, four F_1's (P_1xP_3, P_1xP_5, P_2xP_4 and P_4xP_5) had significant positive effects. Five F_1's (P_1xP_2, P_1xP_3, P_2xP_4, P_2xP_5 and P_4xP_5) and only one F_2 (P_1xP_3) had significant positive effects for 100 seed weight. Five F_1's (P_1xP_3, P_1xP_4, P_2xP_4, P_2xP_5 and P_4xP_5) as well as three F_2's (P_1xP_3, P_2xP_4 and P_2xP_5) had significant positive effects for seed yield plant. Thus SCA for seed yield per plant seemed to be influenced by SCA for yield components.

The obtained results clear that some yield components are more important for yield expression than others. GCA effects seemed to provide appropriate criterion for detecting the validity of a line in hybrid combination (or synthetic variety) but SCA effects may be related to heterosis (Peng and Virmani, 1999). In a cross showing high SCA, it might include only one good combiner, such combinations would show desirable transgressive segregations, providing that the additive genetic system present in the crosses are acting in the same direction to reduce underisible plant characteristics and maximize the characters in view (Abdalla *et al*., 1999). Therefore, most of the earlier crosses may be of importance in traditional breeding programs. These results are in full agreement with Abdalla *et al*. (2001), Attia *et al*. (2002), Zeid (2003), Darwish *et al*. (2005), Attia & Salem (2006), El-Hady *et al*. (2006), El-Hady *et al*. (2007), Elghamdi (2009), Salem (2009), Hossam (2010) and Farag & Afiah (2012).

Conclusion

The obtained results are highly promising to breed faba bean cultivars, hybrids or synthetics possessing genetic factors for earliness and high yield potential.

References

Abdalla, M.M.F.; D.S. Darwish; M.M. El-Hady and E.H. El-Harty, 1999. Investigations on faba bean, (*Vicia faba* L.) 12-Diallel crossed materials grown under cages. Egypt. J. Plant Breed., 3: 213-229.

Abdalla, M.M.F., D.S. Darwish, M.M. El-Hady and E.H. El-Harty, 2001. Investigations on faba bean (*Vicia faba* L.). 16- F1 and F2 diallel hybrids with reciprocals among five parents. Egypt. J. Plant Breed., 5: 155-179

Abdulmula, A.A.; W. Link; E. Von Kittlitz and D. Stelling, 1999. Heterosis and inheritance of drought tolerance in faba bean (*Vicia faba* L.). Plant Breed., 118: 485-490.

Alghamdi, S.S., 2009. Heterosis and combining ability in a diallel cross of eight faba bean (*Vicia faba* L.) genotypes. Asian J. Crop Sci., 1 (2): 66-76.

Attia, S.M. and M.M. Salem, 2006. Analysis of yield and its components using diallel matings among five parents of faba bean. Egypt. J. Plant Breed., 10: 1-12.

Attia, S.M.; M.S.S. Zakia; M. Ezzat; A.M.A. Rizk and K.A. Aly, 2002. Heterosis, combining ability and gene action in crosses among six faba bean genotypes. Egypt. J. Plant Breed., 6: 191-210.

Barelli, M.A.A.; M.C.G. Vidigal; A.T. Junior; S.P.V. Filho and C.A. Scapim, 2000. Combining ability among six common bean cultivars adapted to the north west of Parana state, Brazil. Bragantia Campinas, 59: 159-164.

Bond, D.A. and G.R.A. Crofton, 1999. History of winter beans (*Vicia faba*) in the UK. J. R. Agric. Soc. Engl., 160: 200-209.

Cress, C.E., 1966. Heterosis of the hybrid related to gene frequency differences between two populations. Genetics, 53: 269-274.

Darwish, D.S.; M.M.F. Abdalla; M.M. El-Hady and E.A.A. El-Emam, 2005. Investigations on faba beans, (*Vicia faba* L.) 19- Diallel and Triallel mating using five parents. Egypt. J. Plant Breed., 9:197-208.

Duc, G., 1997. Faba bean (*Vicia faba* L.). Field Crops Res., 53: 99-109.

El-Hady, M.M.; A.M. Rizk; M.M. Omran and S.B. Ragheb, 2007. Genetic behaviour of some faba bean (*Vicia faba* L.) genotypes and its crosses. Annals Agric. Sci. Moshtohor, 45: 49-60.

El-Hady, M.M.; S.M. Attia Olaa; A.M. El-Galaly and M.M. Salem, 2006. Heterosis and combining ability analysis of some faba bean genotypes. J. Agric. Res. Tanta Univ., 32: 134-148.

Farag, H.I.A. and S.A. Afiah, 2012. Analysis of gene action in diallel crosses among some faba bean (*Vicia faba* L.) genotypes under Maryout conditions. Annals of Agric. Sci., El-Mataryia, Fac. of Agic., Ain Sham Univ., 57 (1): 37-46.

Filippetti, A.; G.H. Azadegano and C. De Pace, 1999. Breeding strategies for seed protein content and trypsin inhibitors inferred from combining ability and heterosis in test crosses of *Vicia faba*. Plant Breed., 118: 411-416.

Gasim, S. and W. Link, 2007. Agronomic Performance and the effect of self fertilization on German winter faba. J. Central Eur. Agric., 8: 121-127.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci., 9:463-493.

Hayman, B.I., 1958. The theory and analysis of diallel crosses 1. Genetics, 39: 789-809.

Hossam, M.I., 2010. Heterosis, combining ability and components of genetic variance in faba bean (*Vicia faba* L.). Met., Env. Arid Land Agric. Sci., 21 (1): 35-50.

Peng, J.Y. and S.S. Virmani, 1999. Combining ability for yield and four related traits in relation to breeding in rice. Oryza, 37: 1-10.

Salem,S. A.(2009). Heterosis and Combining Ability in a Diallel Cross of Eight Faba Bean (*Vicia faba* L.) Genotypes. Asian Journal of Crop Science, 1: 66-76.

Schill, B.; A.E. Melchinger; R.K. Gumber and W. Link, 1998. Comparison of intra- and inter-pool crosses in faba beans (*Vicia faba* L.). II. Genetic effects estimated from generation means in Mediterranean and German environments. Plant Breed., 117: 351-359.

Stelling, D., 1997. Heterosis and hybrid performance in topless faba beans (*Vicia faba* L.). Euphytica, 97: 73-79.

Zeid, M.M., 2003. Analysis of Genetic Diversity Based on Molecular Markers (AFLP) and of Heterosis in Faba Bean (*Vicia faba* L.). Doctoral Dissertation, Faculty of Agricultural Sciences Georg-August-University Göttingen, Germany.

قوة الهجين والقدرة علي الائتلاف في الجيل الأول والثاني في الفول البلدي

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أجري هذا البحث تحت الصوبة السلكية في محطة بحوث الوادي الجديد خلال المواسم ٢٠١٠/٢٠٠٩ و ٢٠١١/٢٠١٠ و ٢٠١٢/٢٠١١ بهدف دراسة قوة الهجين والقدرة علي الائتلاف في الجيل الأول والثاني في الفول البلدي لصفات المحصول ومكوناته وقد أستخدم لهذا الغرض خمسة تراكيب وراثية من الفول البلدي ذات أصول وراثية متباعدة وأجريت الهجن التبادلية بين الآباء. تم تقييم سلوك الآباء والهجن في الجيل الأول والثاني بالإضافة لتقدير تأثيرات قوة الهجين علي أساس متوسط الأبوين والأب الأعلى والقدرة العامة والخاصة علي الائتلاف . وكانت النتائج المتحصل عليها كالآتي:

- كان التباين الراجع للتراكيب الوراثية والآباء والهجن عالي المعنوية لكل من الجيل الأول والثاني لكل الصفات.
- سجلت بعض الهجن قيماً معنوية موجبة لقوة الهجين سواء المحسوبة علي أساس متوسط الأبوين أو الأب الأعلى محصولاً لصفات عدد القرون علي النبات ووزن الـ ١٠٠ بذرة ووزن محصول البذور للنبات وتراوحت القيم بين ٦.٣-٣٢.٤% و ٢.٨-٢٣.٥% و ٣.١-١٢.٨% و ٣.٢-٦.٦% و ٤.٢-٣٠.٤% و ١٣.٢-٢٢.٦% بالنسبة لمتوسط الأبوين أو الأب الأعلى محصولاً لكل صفة علي التوالي.
- كانت النسبة بين التباين الراجع للقدرة العامة والخاصة علي التآلف ذات قيم عالية تفوق الوحدة لكل الصفات في الجيل الأول والثاني.
- أظهرت السلالة الأبوية (1703B/87/2003) قدرة عامة علي الائتلاف معنوية لصفتي وزن الـ ١٠٠ بذرة ومحصول البذور للنبات. كما أعطت السلالة الأبوية (1706A/400/2003) أعلي القيم المعنوية الموجبة لتأثيرات القدرة العامة علي التآلف لصفة وزن الـ ١٠٠ بذرة. من ناحية ثانية أعطت ثلاثة آباء جيزه ٤٠ ووادي ١ وجيزه ٤٢٩ قدرة عامة للتبكير.
- أظهرت خمسة هجن في الجيل الأول (P_1xP_2, P_1xP_3, P_2xP_4, P_2xP_5, P_4xP_5) وهجن واحد فقط في الجيل الثاني (P_1xP_3) تأثيرات موجبة وعالية للقدرة الخاصة لصفة وزن الـ ١٠٠ بذرة . كما أعطت خمسة هجن في الجيل الأول (P_1xP_3, P_1xP_4, P_2xP_4, P_2xP_5, P_4xP_5) وثلاثة هجن في الجيل الثاني (P_1xP_3, P_2xP_4, P_2xP_5) تأثيرات موجبة وعالية للقدرة الخاصة علي التآلف لصفة محصول البذور للنبات وهذه يمكن الاستفادة منها في برامج التربية لتحسين محصول الفول البلدي.