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GENETICAL ANALYSIS OF SOME FABA BEAN GENOTYPES AND THEIR CROSSES UNDER NORMAL AND *Orobanche* INFESTATION

B. R. Bakheit[1], T.A. Ahmed[1], S.H. Mohamed[2] and M.H. Haridy[2]

1- Agronomy Department, Faculty of Agriculture, Assiut University, Assiut
2- Agronomy Department, Faculty of Agriculture, El-Azhar University, Assiut

ABSTRACT

The present investigation was carried out during three seasons 2005/06 to 2007/08 to study the performance, combining ability and genetic components of variation for number of *Orobanche* and seed yield in some faba bean crosses by using diallel analysis between seven parents under free and *Orobanche* infestation. The obtained data revealed highly significant differences were found between genotypes for number of *Orobanche* spike/row and seed yield/plant for both locations.

Mean square due to both general and specific combining ability was highly significant for number of *Orobanche* spike/row and seed yield/ plant for both experiments. The ratio of $\sum g_i^2 / \sum S_{ij}^2$ exceeded the unity for two traits except F_1 hybrid for number of *Orobanche* spike/row under field infestation, suggesting that additive type of gene action was more important. While under field free infestation this ratio decreased from unity suggesting non-additive type of gene action. Estimates of GCA for seven parents revealed the variety Misr 1 and Giza 429 had significant and negative effect for number of *Orobanche* and could be considered good combiners for tolerance to broomrape. While the parents Giza 3, Giza 2 and Giza 40 showed positive effect due to susceptibility to *Orobanche*. Additive "D" and dominance component "H_1" were highly significant for traits under both generations, indicating additive gene action was most important for two traits under field infestation, while, dominance gene effects played the major role for seed yield/plant under free infestation. The dominant and recessive genes were unequally distributed among the parents for two traits.

Key words: ***Faba bean, Orobanche*, GCA, SCA, Genetic parameters.**

INTRODUCTION

Faba bean (*Vicia faba* L.) is considered one of the most important sources of protein in Egypt. Also, it is an essential source for livestock feed in the world.

In Egypt, faba bean fields are often infested with *Orobanche spp*. In Middle and Upper Egypt, the level of infestation is so high that there has been complete crop failure (Darwish, 1987 and Zaitoun, 1990). The extent of the damage caused by *Orobanche* is often substantial therefore many farmers abundant growing faba bean in *Orobanche* infested fields. Many factors limited faba bean production throughout the Mediterranean region because of broomrape (Abdalla and Darwish, 1996 and 1999). Unfortunately the majority of known control methods do not offer satisfactory results to control this parasite. However, breeding resistant or tolerant genotype may provide a reliable measure of control against *Orobanche* as reviewed by Abdalla and Darwish (2002).

Regarding the genetic backgrounds conditioning reactions of faba bean to *Orobanche* several arguments were suggested. Cubero and Martinez (1980) found strong additive effects of faba bean resistance to broomrape, with insignificant dominance effects. The results suggested that the genetic system controlling the number of broomrape/plant gave a rather low partial dominance, with resistance being recessive. Darwish *et al* (2007) pointed out that the inheritance of parasitism was not simple and recessive quantitative genes conferring resistance/tolerance may be present in both tolerant and susceptible combinations. Abd El-Maksoud and Hamada (2007) reported that additive genetic variance played an important role in the inheritance of seed yield/plant.

The objectives of this investigation were to elucidate the value of some faba bean varieties in breeding program using diallel cross analyses and the exploring of genetic components of variation for the genetic nature conditioning faba bean reaction to *Orobanche*.

MATERIALS AND METHODS

The experimental work was carried out during 2005/06, 2006/07 and 2007/08 seasons. The first and second seasons, experiments were performed in the Agricultural Experimental Farm at Assiut of Al-Azhar University. The third season (2007/08) was carried out at two locations, the first one was at Al-Azhar University farm (free *Orobanche*), while, the second was at Assiut University farm (naturally infested with *Orobanche*).

Seven genetically diverse genotypes of faba bean wildly different in their agronomic characters were used as parental genotypes. The common names, origin and reaction to *Orobanche* of these genotypes are presented in Table (1).

Table 1. Name and origin of the parental varieties.

Parent No.	Variety	Origin	*Orobanche* reaction
1	Giza 3	Egypt, through hybridization, ARC	Susceptible
2	Giza 2	Egypt, through hybridization, ARC	Susceptible
3	Assiut 215	From program of Waly Assiut Univ.	Resistant
4	Giza 40	Egypt, selection from Rebaya 40, ARC	Susceptible
5	Triple White	Introduction from Sudan	Susceptible
6	Giza 429	Egyptian selection from Giza 402, ARC	Resistant
7	Misr 1	Egypt, through hybridization, ARC	Resistant

In the (2005/2006) season, diallel crosses among the parents, excluding reciprocals, more made. These parents were crossed again in (2006/07) season to obtain were hybrid seeds (F_1's) for all combinations. Also, the (F_1's) plants were grown to obtain F_2 seeds.

In (2007/08) season the obtained fourty nine genotypes included seven parents and twenty one F_1 crosses and 21 F_2 generations, were evaluated in the experimental sites (free and infested plots). In each field, a randomized complete block design with three replications was conducted. Planting was carried out on 28th and 29th October, 2007 in both fields. Seeds were sown in rows, 3 m long and 45 cm apart, in single seeded hills spaced at 20 cm. Each parent was represented by two rows, while each F_1 hybrid was represented by one row and each F_2 population was represented by four rows. The recommended cultural practices for faba bean production were adopted throughout the growing season. At harvest all plants/plot were harvested individually and the traits were recorded.

At harvest, the number of *Orobanche* spikes/row and seed yield/plant were recorded.

Statistical analysis for parents and F_1 hybrids and parents and F_2 generations were made on an entry mean basis according to Gomez and Gomez (1984). Combining ability analysis were conducted according to Griffing (1956) method (2) Model (1). The genetic parameters were estimated using Hayman (1954).

RESULTS AND DISCUSSION

Analysis of combining ability:

Analysis of variance for number of *Orobanche* spikes/row and seed yield/plant for infested experiment as well as seed yield/plant in free *Orobanche* experiment of the half diallel cross 7x7 are listed in Table (2). The mean squares of genotypes parents, 21 F_1's and F_2's and parents vs. crosses were highly significant for all studied traits under both experiments. Mean squares due to general and specific combining ability were also highly significant, suggesting that both additive and non-additive gene actions were important in the inheritance of all studied traits under two experiments. The ratio of $\sum g_i^2 / \sum S_{ij}^2$ for seed yield/plant under free condition was less than one (0.15 and 0.13) in both F_1 and F_2's generations, respectively, indicating that the non-additive gene actions is responsible for most of the genetic variation for seed yield/plant under this environment. While these ratios for seed yield/plant under *Orobanche* infested, exceeded the unity in both generations (3.3 and 1.8, respectively). Thus, additive gene effects appeared to be more important than the non-additive gene effects of genes that conferring faba bean seed yield under *Orobanche* infested plots. These results are in line with those reported by Abdallah (2003) and Darwish *et al.*

(2007). The ratio of $\sum g_i^2$ to $\sum S_{ij}^2$ for the number of *Orobanche* spikes/row was 0.76 and 1.26 for F_1 and F_2 generations, respectively, indicating that additive and non-additive gene action are responsible for most of the genetic variation. Our results were in agreement with those obtained by Abd El-Maksoud and Hamada (2007) and Massoud (2008) who reported that additive gene action were involved in the inheritance of number of *Orobanche* spike/row, while, Darwish *et al* (2007) reported that the dominance gene action was involved in the inheritance of number of *Orobanche* spikes/row.

Number of *Orobanche* of spikes/row:

The average number of *Orobanche* spikes/row for the seven parents and their F_1 and F_2 generations are presented in Table (3). The average number of *Orobanche* spikes/row for parent ranged from 5.3 for the parent Misr 1 to 27.8 for the parent Giza 2 with an average of 17.7 spikes. With respect to F_1 hybrids, the results showed that the average number of *Orobanche* spikes/row ranged from 4.7 for the crosses Misr 1 x Assiut 215 and Misr 1 x Giza 429 to 17.8 for the cross Giza 2 x Giza 3 with an average of 13.2 spikes. While for the F_2 generation the average ranged from 6.1 to 19 spikes for the same crosses with an average of 14.4 spikes. In both generations, the cross Misr 1 x Giza 429 was the tolerant to *Orobanche* and the cross Giza 2 x Giza 3 was the susceptible to *Orobanche* assuming number of spikes/row as indication of tolerance which may be questioned by some authors.

The estimate of GCA effects of parent and SCA of cross for F_1 and F_2 are presented in Table (4). Results revealed that four parents namely: Giza 3, Giza 2, Giza 40 and Triple White, showed highly significantly and positive GCA effects. While, the rest three parents (Misr 1, Giza 429 and Assiut 215) recorded highly significantly and negative GCA effects in both generations for number of *Orobanche* heads. The parental group, which recommended as resistant varieties exhibited negative effects for *Orobanche* formers. Thus, such genotype may possess favorable genes which could be utilized in breeding programs as source of tolerance to improve. Similar results were reported by Hassanin *et al* (1998) and Abdallah (2003).

Estimates of SCA effects (Table 4) for F_1 and F_2 generations, showed that twelve and fifteen crosses exhibited significant SCA effects in the F_1 and F_2 generations, respectively. The cross Misr 1 x Assiut 215 could be considered as the best combinations for tolerance to *Orobanche* in both generations.

The genetic components analysis for number of *Orobanche* spikes/ row in F_1 and F_2 generations using Hayman's diallel cross biometrical approach are shown in Table (9). Results revealed that the additive "D" component was found to be highly significant in both generations, indicating the presence of additive gene action effect. The dominance component "H_1" was highly significant and smaller in magnitude than additive component in F_1 generation. This indicates the importance of the additive gene action in the inheritance of this trait. Abd El-Halim (1994) and El-Sayed *et al* (2003) observed the presence of additive genetic variance in the expression of number of *Orobanche* spikes/row. While Darwish *et al* (2007) reported the importance of genetic components due to dominance effects for number of *Orobanche* spikes plant.

The component of variation due to the dominant effects associated with gene distribution "H_2" was highly significant in both generations. The values of "H_2" were lower than those of "H_1" in both generations. The covariance of additive and dominance gene effects as estimated by "F" value was found to be positive and significant in both generations indicating an excess of dominant over recessive alleles. This result was confirmed by the ratio of KD/KR which was more than one. The average degree of dominance was less than unity in both generations. These results indicated that additive gene action was the most important in controlling this character. Similar results were reported by Darwish *et al* (2007). Broad and narrow sense heritability values (Table 9) were high in both generations, indicating that the major proportion of the total phenotypic variation was genetic.

Seed yield/plant

The mean seed yield/plant of the seven parents, their F_1 and F_2 generations under free and infestation with *Orobanche* are presented in Tables (5 and 6). The average seed yield/plant under free infestation (Table 5) ranged from 74.3 g for the cross Misr 1 x Giza 3 to 90.8 g for cross Giza 429 x Assiut 215 with an average of 83.1 g in the F_2 generation. The average of the F_1 was higher than the average of the parents, indicating positive heterotic effect. In both generations, the cross Giza 429 x Misr 1 approximately had the highest seed yield/plant. While, the average seed yield/plant under *Orobanche* infestation (Table 6) for parents ranged from 6.7 g for Giza 2 variety to 22.0 g for Misr 1 variety. But for F_1 hybrids ranged from 10.3 g for cross Giza 2 x Giza 3 to 25.0 g for cross Giza 429 x Misr 1, with an average of 16.0 g. In both generations, the cross Giza 429 x Misr 1 had the highest seed yield/plant but the cross Giza 2 x Giza 3 and Giza 40 x Giza 3 had the lowest value (Table 6). These results are in line with those reported by Attia (1992 and 1998).

In general, crosses included variety Misr 1 as a common parent showed the highest seed yield/plant, while the crosses having Giza 2 or Giza 3 and Giza 40 gave the lowest yield for both generations under *Orobanche* infestation. The studied genotypes could be classified into three categories.

Table 2. Mean squares for number of *Orobanche* spikes/row and seed yield/plant of F_1 and F_2 generations of the seven parents diallel cross under each of *Orobanche* free and infested fields.

Source of variation	d.f	Mean squares					
		Number of *Orobanche* spikes/row		Seed yield/plant			
		Infested		Infested		free	
		F_1	F_2	F_1	F_2	F_1	F_2
Genotypes	27	118.260**	117.687**	78.89**	80.93**	58.07**	29.44**
Parents	6	337.103**	337.103**	611.30**	611.30**	66.17**	66.18
Crosses	20	42.020**	49.178**	526.23**	322.60**	58.03**	59.41**
Parents vs crosses	1	329.986**	171.389**	329.22**	171.39**	10.35**	19.72**
g.c.a.	6	350.367**	404.215**	311.39**	294.74**	23.97**	22.14**
s.c.a	21	51.943**	35.822 **	12.46*	19.07**	18.04**	19.15**
$\sum g_i^2 / \sum S_{ii}^2$		0.759	1.261	3.31	1.82	0.15	0.13

* and ** significant at 5% and 1% levels of probability, respectively.

Table 3. Mean number of *Orobanche* spikes/row of parents (diagonal), F_1 hybrids (above) and F_2 populations (below) of the seven parents diallel cross under *Orobanche* infested.

Parents	Giza 3	Giza 2	Assiut 215	Giza 40	Triple white	Giza 429	Misr 1
Giza 3	<u>26.57</u>	17.75	11.78	14.21	11.78	10.33	10.07
Giza 2	18.98	<u>27.83</u>	14.65	15.52	16.60	13.55	13.07
Assiut 215	12.62	14.93	<u>7.50</u>	16.42	17.17	8.56	4.68
Giza 40	16.92	12.20	11.18	<u>24.30</u>	15.37	16.68	15.63
Triple white	15.85	17.92	18.10	13.49	<u>25.97</u>	14.32	13.29
Giza 429	13.78	17.88	16.62	7.65	5.82	<u>6.60</u>	4.67
Misr 1	18.38	19.14	17.13	14.67	13.61	6.05	<u>5.30</u>

Parents Mean ± S.E	17.72	±0.306	**L.S.D. 0.05**	**Parent**	0.60
F_1 mean ± SE	13.15	±1.485		**F_1**	2.91
F_2 mean ± SE	14.43	±1.999		**F_2**	1.63

Table 4. **Estimates of general (g_i) and specific (S_{ij}) combining ability effects of number of *Orobanche* spikes/row for the F_1 (above) and F_2 (below) generations of the seven parents diallel cross under *Orobanche* infested field.**

Parents	S.C.A.							G.C.A.	
	Giza 3	Giza 2	Assiut 215	Giza 40	Triple white	Giza 429	Misr 1	F_1	F_2
Giza 3	---	-1.786*	-1.246	-4.843**	-7.048**	-1.926*	-1.155	1.637**	1.997**
Giza 2	1.795**	---	-0.350	-5.504**	-4.203**	-0.680	-0.129	3.608**	3.532**
Assiut 215	-1.234**	0.463	---	1.903*	2.871**	0.833	-2.022**	-2.899**	-3.395**
Giza 40	-5.867**	-4.420**	2.475**	---	-4.950**	2.940**	2.924**	3.122**	3.554**
Triple white	-3.467**	-3.819**	1.632**	-3.558**	---	0.791	0.802	2.902**	3.137**
Giza 429	-1.090*	-1.336**	-0.248	4.289**	0.236	---	-1.252*	-3.669**	-3.956**
Misr 1	-1.194**	-0.130	-1.169**	3.198**	0.092	-0.375	---	-4.703**	-4.869**

*** and ** Significant at 5% and 1% levels of probability, respectively.**

		F_1	F_2			F_1	F_2
S.E. (g_i)	=	0.2733	0.1556	L.S.D.$_{0.05}$ ($g_i - g_j$)	=	0.313	0.237
S.E. (S_{ij})	=	0.7951	0.4521	L.S.D.$_{0.05}$ ($S_{ij} - S_{ik}$)	=	0.655	0.672
				L.S.D.$_{0.05}$ ($S_{ij} - S_{kl}$)	=	0.644	0.628

Table 5. Mean seed yield/plant (gm) of the parents (diagonal), F_1 hybrids (above) and F_2 populations (below) of the seven parents diallel cross under *Orobanche* free infestation.

Parents	Giza 3	Giza 2	Assiut 215	Giza 40	Triple white	Giza 429	Misr 1
Giza 3	90.01	86.98	88.00	92.49	89.43	91.95	83.16
Giza 2	83.54	85.04	80.28	85.64	83.95	83.61	89.16
Assiut 215	83.39	81.62	83.45	85.03	91.09	81.18	91.09
Giza 40	88.47	81.25	82.95	90.23	76.61	88.47	89.17
Triple white	78.57	84.77	82.29	82.56	77.27	75.69	83.20
Giza 429	87.05	83.03	90.75	79.89	89.90	81.07	88.92
Misr 1	74.33	85.47	85.15	72.86	80.96	86.32	82.47

Parents Mean ± S.E	84.22 ±0.264	L.S.D. 0.05	Parent	0.52
F_1 mean ± SE	85.03 ±0.470		F_1	0.92
F_2 mean ± SE	83.10 ±1.070		F_2	2.09

Table 6. Mean seed yield/plant of the parents (diagonal), F_1 hybrids (above) and F_2 populations (below) of the seven parents diallel cross under *Orobanche* infestation.

Parents	Giza 3	Giza 2	Assiut 215	Giza 40	Triple white	Giza 429	Misr 1
Giza 3	<u>11.00</u>	10.33	11.33	11.00	7.67	13.33	16.33
Giza 2	12.00	<u>6.67</u>	13.67	12.00	9.33	11.33	16.33
Assiut 215	12.00	14.67	<u>18.33</u>	17.33	16.67	18.67	25.33
Giza 40	10.67	14.33	17.67	<u>12.00</u>	16.33	18.67	22.00
Triple white	11.33	10.67	17.67	18.00	<u>13.33</u>	20.00	22.67
Giza 429	12.67	11.00	23.67	18.67	21.67	<u>21.33</u>	25.00
Misr 1	18.00	19.00	25.67	21.67	21.33	26.00	<u>22.00</u>

Parents Mean ± S.E	16.11	±0.474	**L.S.D. 0.05**	**Parent**	3.65
F_1 mean ± SE	15.94	±0.227		**F_1**	3.61
F_2 mean ± SE	16.54	±1.540		**F_2**	3.76

Table 7. Estimates of general and specific combining ability effects for seed yield/plant (gm) for F1 crosses (upper right) and then F_2 populations (lower left) under *Orobanche* free infestation.

Parents	S.C.A.							G.C.A.	
	Giza 3	Giza 2	Assiut 215	Giza 40	Triple white	Giza 429	Misr 1	F_1	F_2
Giza 3	---	0.492	1.078**	-4.912**	5.742**	-2.570**	-4.031**	1.544**	1.578**
Giza 2	-1.620**	---	-5.217**	-0.337	1.680**	0.512	2.935**	0.122	0.201
Assiut 215	-2.165**	-5.607**	---	-1.374	8.389**	-2.346**	4.437**	0.553**	0.599**
Giza 40	-4.205**	0.322	-1.813**	---	-6.571**	4.460**	2.037**	1.030**	0.866**
Triple white	6.046**	1.250*	9.308**	-7.375**	---	-4.606**	-0.226	-2.677**	-2.539**
Giza 429	-1.869**	0.815	-2.246**	3.060**	-6.139**	---	4.665**	-1.848**	-1.840**
Misr 1	-3.142**	2.332**	4.787**	-0.230	-1.015	3.640**	---	1.275**	1.136**

* and ** Significant at 5% and 1% levels of probability, respectively.

		F_1	F_2			F_1	F_2
S.E. (g_i)	=	0.093	0.203	L.S.D.$_{0.05}$ ($g_i - g_j$)	=	0.143	0.299
S.E. (S_{ij})	=	0.271	0.597	L.S.D.$_{0.05}$ ($S_{ij} - S_{ik}$)	=	0.402	0.886
				L.S.D.$_{0.05}$ ($S_{ij} - S_{kl}$)	=	0.376	0.829

Table 8. Estimates of general (g_i) and specific (S_{ij}) combining ability effects of seed yield/plant for the F_1 (above) and F_2 (below) generations of the seven parents diallel cross under *Orobanche* infestation.

Parents	S.C.A.							G.C.A.	
	Giza 3	Giza 2	Assiut 215	Giza 40	Triple white	Giza 429	Misr 1	F_1	F_2
Giza 3	---	2.546**	-2.713**	-0.676	-0.824	-1.824	-0.935	-3.577**	-3.735**
Giza 2	3.343**	---	0.620	1.324	-1.491	-2.824**	0.065	-4.577**	-4.143**
Assiut 215	-2.546**	0.528	---	0.398	-0.417	1.250	2.806**	1.683**	1.746**
Giza 40	-1.324	2.750**	0.194	---	1.620	0.620	1.843	-0.688	-0.810*
Triple white	-0.917	-1.176*	-0.065	2.824**	---	1.806*	2.361**	-0.540	-0.550
Giza 429	-2.806**	-4.056**	2.713**	0.269	3.009**	---	1.361	2.792**	2.672**
Misr 1	0.380	1.787	2.565**	1.120	0.528	1.972*	---	4.905**	4.820**

*** and ** Significant at 5% and 1% levels of probability, respectively.**

		F_1	F_2			F_1	F_2
S.E. (g_i)	=	0.393	0.399	L.S.D.$_{0.05}$ ($g_i - g_j$)	=	0.601	0.616
S.E. (S_{ij})	=	0.954	0.960	L.S.D.$_{0.05}$ ($S_{ij} - S_{ik}$)	=	1.700	1.811
				L.S.D.$_{0.05}$ ($S_{ij} - S_{kl}$)	=	1.590	1.612

Table 9. Genetic parameters for number of *Orobanche* spikes/row and seed yield/plant for F_1 and F_2 generations under each of *Orobanche* free and infested fields.

Source of variation	Mean squares					
	Number of *Orobanche* spikes/row		Seed yield/plant			
	Infested		Infested		free	
	F_1	F_2	F_1	F_2	F_1	F_2
D	109.77** ± 6.55	111.54** ± 1.89	27.72**±2.26	29.33**±2.92	21.77**±1.06	20.63**±2.93
H_1	66.76** ± 15.78	211.68**± 4.55	5.17±5.43	102.14**±7.02	78.48**±2.56	332.20**±7.06
H_2	44.35 ± 13.90	133.43** ± 4.00	3.02±4.78	55.14**±6.19	65.42**±2.25	268.89**±6.22
F	92.97** ± 15.72	101.98** ± 4.53	-19.69**±5.43	-28.36**±7.00	24.58**±2.55	48.50**±7.04
$F_1(H_1/D)^{½}$, $F_2(H_1/4D)^{½}$	0.78	0.69	0.43	0.93	1.90	2.01
$H_2/4H_1$(UV)	0.17	0.16	0.15	0.14	0.21	0.20
KD/KR	3.38	4.95	0.10	0.32	1.35	3.83
Broad sense heritability	0.93	0.98	0.84	0.94	0.96	0.95
Narrow sense heritability	0.60	0.81	0.81	0.84	0.23	0.25

* and ** significant at 5% and 1% levels of probability, respectively.

The first included the parent Misr 1 and Giza 429 which may be described as greatly favorable for inclusion in program for improving performance under *Orobanche* infestation. The second group included the parent Assiut 215 which seemed to be tolerant to *Orobanche*. The third group included the three susceptible parents Giza 2, Giza 3 and Giza 40 which seemed to be unfavorable for inclusion in cross programs for improving varietal performance under broomrape conditions. These results are in line with those reported by Zaitoun *et al* (1991), Khalil *et al* (1991), Darwish *et al* (2007) and Massoud (2008).

The estimates of general combining ability effect for individual parents and specific combining ability of their crosses for F_1 and F_2 generations under free and *Orobanche* infestation are presented in Tables (7 and 8). Results revealed that three parents namely, Giza 3, Assiut 215, Giza 40 and the parent Misr 1 in both generations showed highly significant and positive effect of GCA and it could be considered good combiners for seed yield/plant under free *Orobanche* infestation (Table 7). While, under *Orobanche* infestation in general, the parents Misr 1, Giza 429 and Assiut 215 showed the highest positive general combining ability (while the parents Giza 2 and Giza 3 showed the highest negative GCA values in both generations) and it may be considered good combiner for tolerance or resistance to broomrape (Table 8). Thus such genotype may posses favorable gene which could be utilized in breeding programs designed to improve seed yield under *Orobanche* infestation. Needles to report that variety Misr 1 may be considered good combiner under both conditions (free and *Orobanche* infestation).

Estimates of SCA effects (Table 7) in F_1 and F_2 generations for free infestation showed ten and eleven crosses exhibited significant SCA effect in F_1 and F_2 generations, respectively. The cross Assiut 215 x Triple White showed the highest significant and positive SCA in both generations, thus it could be considered the best combinations for seed yield under free infestation. While, under *Orobanche* infestation (Table 8) results showed that five and seven crosses showed significant and positive SCA values for F_1 and F_2 generations, respectively. The cross Misr 1 x Assiut 215 showed approximately the highest positive SCA values, thus it could be considered the best combination for seed yield under *Orobanche* infestation.

Estimates of the genetic components of variation and their corresponding standard error in the F_1 and F_2 generations under each of *Orobanche* free and infested fields are presented in Table (9). The results indicated that the additive component "D" was highly significant in the two generations for both fields indicating the presence of additive gene action effect. Also, the estimates of "H_1" and "H_2" were highly significant and more than "D" in both generations and fields except for F_1 under infested field that was insignificant. The values of "H_2" were lower than those of

"H_1" which complies with theoretical assumption of Hayman (1954) and could be considered of further proof for unequal proportions of positive (U) and negative (V) alleles at all loci for this trait. The symmetry versus asymmetry in gene frequency was examined by computing the "F" component. The covariance of additive and dominance "F" was positive and highly significant in both sites, indicating an excess of dominant over recessive alleles, under free field. This result was confirmed by the ratio of KD/KR which was more than one. The relative size of "D" and "H" estimates as $(H_1/D)^{1/2}$ could be used as weighted measure of the average degree of dominance. This average value was more than one in both generations indicating over dominance. While, for infested field the ratio of KD/KR was less than one. Also, the average degree of dominance values was less than one, indicating partial dominance.

The $(H_2/4H_1)$ values in both generations and fields were less than 0.25, revealing asymmetric distribution of positive and negative alleles among the parents. These results are in agreement with those obtained by Cubero and Fernandez (1991), Darwish *et al* (2007) and Massoud (2008). Heritability estimates in the broad and narrow sense for F_1 and F_2 generations in both fields are presented in Table (9). High broad and narrow sense heritability was found in both generations under *Orobanche* infestation. These results confirm that additive gene effects as the main source of genetic variation under *Orobanche* infestation and that selection applied in the early segregating generations could be very effective. Similar results were reported by Abdallah (2003) and Abd El-Maksoud and Hamada (2007).

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التحليل الوراثى لبعض التراكيب الوراثية وهجنها للفول البلدى تحت الظروف العادية والإصابة بالهالوك

باهى راغب بخيت[1]، طلعت عبدالفتاح أحمد[1]، سعيد حراجى محمد[2]، مختار حسن هريدى[2]

١- قسم المحاصيل – كلية الزراعة – جامعة أسيوط – أسيوط
٢- قسم المحاصيل – كلية الزراعة – جامعة الأزهر بأسيوط

أجريت هذه الدراسة خلال ثلاثة مواسم هى ٢٠٠٥/٢٠٠٦ ، ٢٠٠٦/٢٠٠٧ ، ٢٠٠٧/٢٠٠٨ لدراسة الأداء والقدرة على الإئتلاف وكذلك مكونات التباين الوراثى لسبعة آباء من الفول البلدى وهجنها عن طريق تحليل الهجن التبادلية للمحصول البذرى النبات وعدد نباتات الهالوك للخط وذلك فى حقلين أحدهما به إصابة طبيعية بالهالوك والآخر خال من الإصابة . ويمكن تلخيص أهم النتائج المتحصل عليها :

١- أظهرت النتائج معنوية عالية جداً بين الآباء المستخدمة لصفة عدد نباتات الهالوك للخط وكذلك المحصول البذرى للنبات فى كلا التجربتين .

٢- أظهرت النتائج أن القدرة العامة والخاصة على الائتلاف كانت عالية المعنوية لكل من صفة عدد نباتات الهالوك للخط وصفة المحصول البذرى للنبات فى كلا التجربتين .

٣- كانت نسبة التباين للقدرة العامة على الائتلاف إلى تباين القدرة الخاصة على الائتلاف أكبر من الوحدة فى الجيلين مما يوضح أهمية الجزء المضيف فى توريث كلا الصفتين وذلك فى الحقل المصاب بالهالوك . بينما كانت هذه النسبة أقل من الواحد لمحصول النبات الفردى فى الحقل الخالى من الإصابة بالهالوك مما يوضح أهمية الجزء الغير مضيف فى توريث هذه الصفة .

٤- أظهرت النتائج أن أحسن الآباء من حيث التحمل للهالوك هو مصر ١ ، جيزه ٤٢٩ وذلك لأن القدرة العامة على الائتلاف كانت سالبة المعنوية بينما كان الصنف جيزه٢ ، جيزه ٣ ، جيزه ٤٠ أقل الأصناف تحملاً للهالوك لأن المعنوية كانت موجبة .

٥- كان المكون الوراثى المضيف والسيادى معنوياً جداً لكل من الصفتين فى الجيلين الأول والثانى مما يوضح أهمية الجزء المضيف والجزء الغير مضيف فى توريث تلك الصفات .

٦- الأليلات السالبة والموجبة كانت غير منتظمة التوزيع فى الآباء مما يدل على أهمية الأليلات السائدة على المنتخبة فى تلك الصفتين