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GENETICAL ANALYSIS OF SOME *Vicia faba* GENOTYPES FOR TOLERANCE TO *Orobanche* INFESTATION

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ABSTRACT

Eleven faba bean genotypes and their 28 F_1 hybrids produced according to 4x7 factorial mating design were evaluated under natural infested soil with Orobanche crenata seeds. The results revealed that mean squares of genotypes were significant for all studied traits, indicated the existence of genetic variability among studied genotypes particularly for reaction to Orobanche. The mean performances of the studied parents could be arranged into three groups, the first group included resistant genotypes, second group, included the partial tolerant to Orobanche and the third group includes susceptible parents. In addition, the best heterosis value for earliness was detected in the crosses; Misr 1 x Sakha 1 and Misr 1 x Sakha 2 relative to their mid-parents. Moreover, 20 out of 28 crosses exhibited highly significant positive heterosis relative to mid-parents value for seed yield/plant. The resistant genotypes Misr 1, C.1657 and Misr 2 and also the early genotypes Sakha 1, T.W and C. 1543 have greater combining ability effects for seed yield/plant than the other genotypes. The most desirable crosses which had desirable values of SCA effects were C. 1657 x C. 1534 and T.W. x BPL710 for number of pods/plant and seed yield/plant. Furthermore, the best combination for reaction to Orobanche was C.1657 x C.1543. The additive genetic variance appeared to be larger than non-additive genetic variance for studied traits except for plant height and number of seeds/plant. This indicated that additive genetic variance played an important role in the inheritance of these traits. Concerning the other studied trait as plant height and number of seeds/plant, non-additive genetic variance was more important than additive genetic variance. The estimation of dominance degree ratio was confirmed that the importance of non-additive genetic variance for plant height and number of seeds/plant. Heritability in the broad sense estimates were close to the corresponding values of narrow sense heritability for most studied traits, indicating that a major part of the total genotypic variance is additive. Reaction to Orobanche appeared to be genetically and phenotypically negative correlated with yield and its components. It could be concluded that the recurrent selection is the proper method for developing desirable lines in advanced generations for their tolerance to Orobanche infestation.

Key words: ***Vicia faba, Orobanche crenata, Heterosis, Combining ability, Genetic parameters***

INTRODUCTION

Faba bean (*Vicia faba* L.) is the most important source of puls protein for both man and animals in the Mediterranean area (Scarasia and

Marzie, 1970). In the Mediterranean region, the most important biotic stress on faba bean is broomrape (*Orobanche crenata* Forsk). This is an obligate parasitic weed which severely stresses faba bean plants, often leading to complete crop loss. The extent of the damage caused by *Orobanche* is often hidden because many farmers who have lost their crop in the past simply stop growing faba bean in *Orobanche* infested fields. Therefore, the most important factor limiting faba bean production throughout the Mediterranean region is broomrape (Grenz *et al* 2005). Different parameters have been used by different authors to evaluate the susceptibility/resistance of *Vicia faba* and other crop plants to *Orobanche* spp. (Radwan *et al* 1988 and Perez-de-Luque *et al* 2005). On the other hand, knowledges about nature of gene action are needed to determine the desirable breeding programe for improvement of different traits. Additive and non-additive genetic variance could be derived from the combining ability analysis. In this respect, Abaas (2001) and El-Hifny *et al* (2001) reported that both additive and non-additive gene action contribute in the inheritance of most studied traits in faba bean, while additive gene effiicts played the major role in the genetic expression of days to flowering, plant height, number of branches/plant, number of seed/pod, 100-seed weight and seed yield/plant. Therefore, this investigation was carried out to partition the genetic variance to its components for some faba bean traits, which may play a role in the resistance mechanism to *Orobanche crenata*.

MATERIALS AND METHODS

Eleven faba bean genotypes with different background were obtained from the Field Crops Research Institute. Agricultural Research Center, Sakha Station. These cultivars were; Misr 1, Cross 1657, Determinant (6), Triple White, Sakha 1, Sakha 2, C. 1534, Misr 2, Luz de Otona, Rena Mora and BPL 710. During 2003/2004 season, the parental genotypes were sown under the insect free cage. The first four genotypes were crossed as male parents to each of the remaining seven genotypes as females in a factorial mating design. In 2004/2005 growing season, the obtained 39 genotypes which included eleven parental genotypes and 28 F1 hybrids were evaluated under naturally heavily infested soil with *Orobanche crenata* seeds. In the experiment, data were recorded on the following traits; no. of branches/plant, no. of pods/plant, no. of seeds/plant, no. of seeds/pod, seed yield/plant,100-seed weight and reaction to *Orobanche* (number of *Orobanche* spikes and *Orobanche* spikes dry weight). Analysis of variance was done according to Steel and Torrie (1960). Heterosis was estimated as the percentage of increase in the mean of the F_1 hybrids over mid-parents (M.P) or better parent (B.P) values. General and specific combining ability were estimated according to Kempthorne (1957) procedure as outlined by Singh and Chaudhary (1985).

Subsequently, genetic variance was partitioned to its components as additive and non-additive (including dominance) genetic variances, according to Comstock and Robinson (1952). The coefficient of inbreeding for maternal and paternal varieties was considered to be equal to one. Subsequently, heritability and dominance degree were estimated.

RESULTS AND DISCUSSION

The significance mean squares of 4 x 7 factorial F_1 mating and for studied traits are presented in Table (1). The results cleared the presence of

Table 1. Analysis of variance and mean squares of 4 x 7 factorial mating design for all studied traits under *Orobanche*-infestation

S.O.V	d.f	Branches/ Plant	Pods/ plant	Seeds/ plant	S.yield/ Plant (g)	100-Seed Weight (g)	seeds /pod	Reaction to *Orobanche*: No. of *Orobanche* spikes	Reaction to *Orobanche*: Spikes dry Weight
Reps	2	0.17	1.14	5.79	9.44	1.78	0.35	1.14	15.03
Gens.	38	7.36**	123.3**	1126.7	928.4**	489.5**	1.73**	665.3**	1953**
Crosses	27	4.61**	82.8**	906.9**	745.6**	503.1**	1.38**	339.7**	614.5**
Males	3	23.5**	187.8**	1062**	1057.9**	1491.7**	5.02**	973.8**	1683**
Females	6	4.7**	153.7*	1509.7	2002.4**	723.9	1.30	57.6*	1410.5*
M. X F.	18	1.4**	41.7**	679.9**	274.6**	264.7**	0.80**	155.9**	171.1**
Error	76	0.15	1.32	3.62	3.17	1.85	0.10	5.30	19.05

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

highly significant differences were recorded among all genotypes (eleven parents and their 28 F_1 hybrids) for studied traits except no. of seeds/plant. This finding indicated the existence of genetic variability among studied genotypes, particularly for reaction to *Orobanche*. In addition, partitioning the mean squares to crosses male parents and females interaction were highly significant for studied traits except the male x female interaction was highly significant for all studied traits, this indicating that female parents differed in the order of performance in crosses with each of the male parents. female parents for seeds/seed index and seeds/pod mean squares were significant. Similar results were obtained by Darwish *et al* (1999) and Toker (2004).

Mean performance of parents and crosses for the studied traits are presented in Table (2). Significant differences were observed among most genotypes for measured traits. Judging by the level of yield and its components, the studied parental cultivars could be arranged into three groups. The first group contains the genotypes of Misr 1, C. 1657 and Misr 2, which considered being the most tolerant group to *Orobanche*. These genotypes accompanied with high yielding (51.10, 50.65 and 59.92, respectively.), and least number of *Orobanche* (10.33, 11.33 and 12.33, respectively). The second group of parents, includes Sakha 1 and C.1534 is partial tolerant to *Orobanche* which parasitized by moderate levels of *Orobanche* and accompanied with medium seed yield/plant (30.52 and

Table 2. The mean performances of parents and their F1 hybrids for studied characters under *Orobanche*-infested soil

Genotypes	Branches/ Plant	Pods/ plant	Seeds/ plant	seeds /pod	Seed. yield/ Plant (g)	100-Seed Weight (g)	Reaction to *Orob.* No. of *Orobanche* spikes	Reaction to *Orob.* Spikes dry Weight
Misr 1	4.34	20.34	61.34	3.02	51.10	83.31	10.33	25.00
C.1657	2.42	18.91	59.65	3.15	50.65	84.92	11.33	30.00
D 6	6.58	3.95	12.43	3.14	11.88	95.58	60.00	65.00
T.W	1.10	4.13	9.64	2.33	6.10	63.32	55.00	77.67
Sakha 1	2.52	11.99	42.26	3.52	30.52	72.24	17.67	70.00
Sakha 2	5.28	3.72	16.14	4.34	14.29	88.58	51.00	102.33
C. 1534	2.25	9.25	27.70	3.00	22.12	79.85	22.67	82.33
Misr 2	4.24	25.50	76.01	2.98	59.92	78.84	12.33	21.67
Rena Mora	7.37	4.68	23.46	5.02	25.61	109.13	40.67	90.00
Luz de Otona	5.63	3.26	16.91	5.19	18.53	109.63	38.00	93.00
PBL710	6.23	3.97	8.15	2.05	6.67	81.87	52.67	121.67
Misr 1 x Sakha 1	5.34	22.80	57.39	2.52	55.89	97.38	7.67	30.00
Misr 1 x Sakha 2	5.68	13.39	33.35	2.49	27.11	81.30	19.00	40.00
Misr 1 x C. 1534	3.58	17.64	52.98	3.00	46.94	88.59	9.33	36.67
Misr 1 x Misr 2	5.39	35.11	125.99	3.58	116.67	92.89	6.00	13.33
Misr 1 x Rena Mora	6.45	8.60	35.76	4.16	38.81	108.54	17.00	45.00
Misr 1 x Luz de otona	6.48	6.12	30.34	4.96	29.42	96.95	19.67	44.67
Misr 1 x BPL710	5.40	6.79	26.25	3.87	22.20	84.58	17.00	40.67
C. 1657 x Sakha 1	4.06	14.77	50.57	3.42	40.37	79.82	9.00	29.00
C. 1657 x Sakha 2	4.63	16.11	44.16	2.74	39.62	89.73	16.67	34.33
C. 1657 x C. 1534	3.47	22.82	72.44	3.17	68.03	93.91	12.33	38.33
C. 1657 x Misr 2	4.55	25.03	80.99	3.24	77.81	96.08	11.00	25.00
C. 1657 x Rena Mora	5.25	13.98	58.93	4.21	56.75	96.30	19.00	54.00
C. 1657 x Luz de Otona	5.81	9.16	42.44	4.63	39.32	92.64	19.00	46.33
C. 1657 x BPL710	5.60	9.36	29.24	3.12	26.24	89.75	18.67	55.00
D. (6) x Sakha 1	5.10	14.35	55.04	3.84	47.54	86.38	22.67	45.00
D. (6) x Sakha 2	5.60	6.76	26.83	3.97	22.95	89.48	40.00	45.67
D. (6) x C. 1534	6.58	10.27	38.65	3.76	32.21	83.34	23.67	45.00
D. (6) x Misr 2	6.53	16.18	54.11	3.35	51.43	95.05	22.33	35.00
D. (6) x Rena Mora	7.95	7.49	39.64	5.29	42.08	84.78	28.00	52.33
D. (6) x Luz de otona	7.46	6.12	28.09	4.59	35.04	93.65	26.33	48.00
D. (6) x BPL710	7.47	5.18	17.79	3.43	14.53	81.65	29.00	56.00
T.W x Sakha 1	3.77	14.38	37.10	2.58	31.70	85.43	21.67	42.33
T.W x Sakha 2	4.64	5.03	15.46	3.07	12.58	81.39	28.33	49.67
T.W x C. 1534	3.53	10.26	27.98	2.73	21.97	78.52	30.33	46.67
T.W x Misr 2	3.86	20.70	62.44	3.02	56.80	90.96	20.00	40.33
T.W x Rena Mora	4.52	7.54	33.32	4.42	28.83	86.52	36.00	57.67
T.W x Luz de otona	4.39	6.72	29.51	4.39	32.72	82.83	38.67	64.33
T.W x BPL710	4.13	6.38	16.06	2.52	12.95	85.84	38.33	86.67
LSD 0.05	0.62	1.87	3.09	2.89	2.21	0.51	3.74	7.09
0.01	0.83	2.48	4.10	3.83	2.93	0.68	4.96	9.40

22.12, respectively.) and small seeds size. These two groups of genotypes exhibited high percentage of podded plants accompanied by reliable characters of the individuals in addition to lower rate of *Orobanche* infestation (as number of spikes per plant) reflected in a better seed yield per plant compared to the stocks of the rest group. Third group includes D6, T.W., Sakha 2, Rena Mora, Otona and BPL710 which may be considered as susceptible parents. This group is parasitized by highest number of *Orobanche* accompanied with low yielding stocks (11.88, 6.11, 14.29, 25.61, 18.53 and 6.6, respectively.), and large seeds size. The low parasitism is generally accompanied by relatively better host growth, a higher percentage of fruiting plants and higher seed yield as reported by Abdalla and Darwish (1996).

Out of 28 crosses 20 exhibited highly significant positive heterosis % over mid-parent for seed yield/plant which ranged from 13.67 to 110.16% (Table 3). For better parent heterosis, highly significant heterotic effect (3.85 to 94.69%) were observed in 12 crosses for this traits. In addition to, the record negative heterosis % for *Orobanche*. In this respect, nine hybrids showed significant negative heterotic values over their respective tolerant parent (-15.38 to -38.46%). Generally, the results of this study revealed the presence of heterosis over mid-parents value for most traits either concerning *Orobanche* infestaion or those of yield and its components. Therefore, the expected selection program in these materials in the advanced segregating populations would not be limited to the superior specific hybrids, and the expected improvement would be fruitful. These results are in harmony with those reported by EL-Galaly (1997), EL-Hifny (2001) and Zeid (2003).

Estimates of general combining ability (GCA) effects of parents for studied traits are given in (Table 4). Generally, wide variation could be observed among genotypes for their combining ability effects for the traits under study. Results showed that irrespective of the statistical differences, the resistant genotypes Misr 1, C.1657 and Misr 2 and also the early genotypes Sakha 1, T.W and C. 1543 have greater combining ability effects for seed yield/plant than the other genotypes. While, the susceptible genotypes and also the late ones; D6, Rena Mora, Otona and BPL 710 were inferior combiner for most important traits as yield and yield components. The most interesting aspect that facing plant breeders is to know whether GCA for a given parent agrees with its own performance or not. The results obtained here showed an excellent agreement between the parental performance and its GCA effects for most studied traits. Similar results were previously reported by Khalil *et al* (1994), Helal (1997) and Abaas (2001).

Table 3. Precentages of heterosis over mid-parents M.P and better parent B.P for all studied traits

Genotypes	No. of branches/plant		No. of pods/plant		No. of seed/plant		Seed yield/plant (g)		100-seed weight		No. of seeds/pod		Reaction to *Orobanche*: No. of *Orobanche* spikes		Reaction to *Orobanche*: Spikes dry weight	
	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.	M.P.	B.P.
Mis 1 x Sk1	55.68**	23.0**	41.1**	12.1**	10.80**	-6.43*	36.94**	9.37**	25.21**	16.9**	-23.**	-28.**	-45.**	-25.8	-36.8**	20.0
Mis1 x Sk 2	18.10**	7.61**	11.31	-34.1**	-13.9**	-45.6**	-17.1**	-46.9**	-5.40	12.55	-32.**	-42.**	-38.**	83.**	-37.2**	60*
Mis1x 1534	8.68	-17.5**	19.22**	-13.3**	19.00**	-13.6**	28.20**	-8.2**	8.60	6.34	-0.06	-0.38	-43.**	-9.**	-31.7**	46.7**
Mis1xMis 2	25.54**	24.2**	53.19**	72.60**	82.88**	65.23**	110.2**	94.69**	14.58*	11.5**	19.31*	18.6**	-47.**	-41**	-42.86	-38.4**
Mis1x R.M	10.11*	-12.5**	-31.23**	-57.7**	-15.7**	-41.7**	1.19	-24.1**	12.80*	-0.5**	3.49	-17.**	-33.**	64.5	-21.7**	80.0**
Mis1x L de	30.00**	15.1**	-48.11**	-69.90*	-22.4**	-50.5**	-15.5**	-42.4**	0.50	-11.56	20.8**	-4.46	-18.**	90.**	-24.3**	78.7**
Mis1 x 710	2.10	-13.4**	-44.15**	-66.6**	-24.5**	-57.21	-23.2**	-56.56	2.41	1.52	52.6**	28.2**	-46.**	64.5*	-44.6**	62.7**
1657 x Sk 1	64.24**	85.50	-4.40	-21.8**	-0.75	-15.2**	-0.55	-20.3**	1.58	-6.01	2.53	-2.8**	-37.**	-20.5	-42.0**	-3.33
1657 x Sk 2	20.33**	-12.2**	42.33**	-14.8**	16.54**	-25.9**	22.02**	-21.7**	3.44	1.30**	-26.**	-36.8	-46.**	47.**	-48.1**	14.4**
1657x1534	48.55**	43.3**	62.11**	20.68**	65.86**	21.45**	86.96**	34.30**	13.99*	10.5**	3.22	0.64	-27.5*	8.8**	-31.7**	27.8**
1657xMis 2	36.63**	7.30**	12.74**	32.37**	19.40**	6.55**	40.74**	29.85**	17.35*	13.1**	5.46	2.58	-7.04	-2.**	-3.23	15.4**
1657xR.M	7.16	-28.81	18.57**	-26.0**	41.82**	-1.19	48.85**	12.05	-0.75	-11.75	3.15	-16.01	-26.**	67.**	-10.0	80.0**
1657 x L de	44.3**	3.16	-17.33*	-51.5**	10.89**	-28.8**	13.67**	-22.3**	-4.76	-15.5*	11.06	-10.71	-22.9*	67.6	-24.7**	54.44
1657 x710	29.53**	-10.1**	-18.21*	-50.5**	-13.7**	-50.9**	-8.45	-48.2**	7.61	5.68	20.02*	-0.9**	-41.**	64.**	-27.5**	83.3**
D.(6) x Sk 1	12.00*	-22.58	79.99**	19.67**	81.29**	30.24**	64.23	55.7**	2.95	-9.62	15.05	8.84	-41.**	28.**	-33.3**	-30.8**
D. (6) xSk 2	-5.98	-14.9**	76.07**	70.89	87.84**	66.25**	75.39**	60.57**	-7.09	-10.**	6.17	-8.5**	-27.**	-21**	-45.4**	-29.74
D.(6) x1534	48.98**	-0.05	55.59**	11.06**	92.64**	39.52**	89.50**	45.62	-4.99	-12.**	22.6**	25.6**	-42.**	4.41	-38.9**	-30.77
D.(6) xMis2	20.67**	-0.76**	9.85	-36.5**	22.37**	-28.8**	43.27**	-14.2**	8.99	-0.55*	9.24	12.22	-38.**	81.0*	-19.23	61.54
D.(6) xR.M	13.88**	7.79**	73.60**	60.18**	90.87**	68.92**	64.54**	64.34	3.73	-2.7**	29.7**	5.5**	-44.**	-31**	-32.5**	-19.5**
D.(6) x Lde	22.06**	13.3**	69.79**	54.89**	91.52**	66.15**	60.42**	89.03**	21.57**	13.8**	10.14	-11.55	-46.**	-30**	-39.2**	-26.2**
D. (6) x710	16.56**	13.4**	30.86	31.11**	72.94**	43.17**	56.64**	22.31**	-7.97	-14.5*	32.1**	9.20	-48.**	-44**	-41.1**	-15.4**
T.W x Sk1	78.36**	49.84*	78.39**	19.92**	43.01**	-12.2**	73.09**	3.85**	26.04**	18.27*	-11.89	-26.**	-40.**	22.**	-42.7**	-39.5**
T.W xSk 2	45.39**	-12.1*	28.09	21.74**	19.96*	-4.20**	23.38	-11.9**	7.17	-8.1**	-7.81	-29.**	-46.**	-44**	-44.8**	-36.05
T.W x1534	75.51**	56.9**	53.37**	10.94	49.88**	1.01**	55.71**	-0.67**	9.69	-1.7**	2.38	-8.9**	-21.**	33**	-41.7**	-39.91
T.W xMis2	44.48**	-8.98**	39.76**	-18.8**	45.81**	-17.8**	72.04**	-5.22**	27.9**	15.38	13.51	1.17	-40.**	62.	-18.79*	86.2**
T.W x R.M	6.54	-38.75	71.30**	61.29**	91.33**	42.00**	81.83**	12.58**	0.34	-20.72	20.2**	-11.**	-24.**	-11**	-31.2**	-25.75*
T.W x L de	30.33**	-22.0**	81.89**	62.72	92.33**	74.52	65.65**	76.55**	28.25**	1.16**	16.77*	-15.35	-16.**	1.75	-24.6**	-17.2**
T.W x710	12.72	-33.7**	57.65**	60.86**	80.58**	66.65**	85.82**	94.16**	11.11	-1.47	14.70	7.82**	-28.**	-27**	-13.0**	11.6**

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

Table 4. Estimates of general combining ability (g_i) effects of faba bean parental genotypes for all studied traits

	No. of branches/ plant	No. of pods/ plant	No. of seed/ plant	Seed yield/ plant (g)	100-seed weight	No. of seeds/ pod	Reaction to *Orobanche*	
							No. of *Orobanche* spikes	Spikes dry weight
Males								
Misr 1	0.14	3.20**	-2.06**	2.84**	7.52**	0.240**	-3.82**	-7.95**
C.1657	-0.27**	1.88**	10.09**	6.85**	6.80**	0.57**	-7.25**	-6.28**
D 6	1.33**	-2.52**	-1.42**	0.09	-5.23**	-0.39**	3.22**	2.85**
T.W	-1.20**	-2.57**	-6.60**	-9.79**	-9.09**	-0.41**	7.84**	11.38**
LSD (g-i) 0.05	0.16	0.50	0.82	0.77	0.59	0.13	0.99	1.89
0.01	0.22	0.66	1.09	1.02	0.78	0.18	1.32	2.51
LSD (g-g) 0.05	0.23	0.70	1.16	1.09	0.83	0.19	1.41	2.67
0.01	0.31	0.94	1.55	1.44	1.10	0.25	1.87	3.55
Females								
Sakha 1	-0.26*	1.82**	7.43**	2.10**	3.59**	0.52**	-7.09**	-7.13**
Sakha 2	-0.19	-4.18**	-10.14**	-11.95**	-9.26**	-0.21*	3.15**	-1.79
C. 1534	-1.03**	1.49**	6.67**	2.26**	-7.13**	-0.14	-5.92**	-7.04**
Misr 2	-0.24*	5.25**	17.69**	24.90**	-6.71**	0.43**	-7.51**	-15.29**
Rena Mora	0.71**	1.40**	-6.42**	1.60**	10.34**	-0.18*	3.40**	8.53**
Luz de Otona	0.70**	-0.96**	-1.24*	-4.64**	7.60**	-0.25**	10.51**	7.11**
PBL710	0.70**	-0.96**	-1.24*	-4.64**	7.60**	-0.25**	10.57**	7.11**
LSD (g-i) 0.05	0.22	0.66	1.09	1.02	0.78	0.18	1.32	2.50
0.01	0.29	0.87	1.45	1.35	1.03	0.23	1.75	3.32
LSD (g-g) 0.05	0.31	0.93	1.54	1.44	1.10	0.25	1.86	3.54
0.01	0.41	1.24	2.05	1.91	1.46	0.33	2.47	4.70

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

Specific combining ability SCA effects of the crosses for the studied traits are presented in (Table 5). In general, the most desirable crosses which had desirable values of SCA effects was Misr1 x Sakha 2 for number of branches. While, in yield and yield components crosses; C. 1657 x C. 1534 and T.W. x BPL710 for number of pods/plant and seed yield/plant. In addition, for number of seeds/plant crosses; C. 1657 x Otona and T.W. x BPL710. Furthermore, the best combination for reaction to *Orobanche* was C.1657 x C.1543, Misr 2 x T.W, T.W. x Sakha 2 followed by C.1657 x Sakha 1 with SCA effects value of -12.04, -10.71, -9.81 and -7.01 respectively. These findings explain the presence of heterosis over better parent with respect to these crosses and indicating high frequency of

Table 5: Estimates of specific combining ability effects (S_{ij}) for all studied traits on F_1 hybrids

Genotypes	Branches /plant	Pods/ plant	Seeds / plant	Seed yield /plant(g)	100-seed weight(g)	No. of seeds/ pod	Reaction to *Orobanche*	
							No. of *Orobanch* spikes	Spikes dry weight
Misr 1 x Sakha 1			9.43**	3.92**	2.56**	-0.35*	-3.76**	
Misr 1 x Sakha 2	1.26**	-	-9.54**	-8.68**	-14.31**	-0.47**		
Misr 1 x C. 1534	-1.30**	3.047	6.43**	5.32**	4.50**	0.64**	4.19**	5.55*
Misr 1 x Misr 2			-6.31**		7.24**			-5.63*
Misr 1 x Rena			2.96**	-3.79**	-11.77**		-2.67*	6.03*
Misr 1 x Luz de		3.39*		4.69**	4.38**			
Misr 1 x BPL710	-0.87**		5.80**	4.79**	8.28**		11.27**	
C. 1657 x Sakha 1	0.70**	-	-10.38**	-5.68**			-7.01**	-5.63*
C. 1657 x Sakha 2	-0.85**	-	5.78**	1.85	3.35**	0.63**	-3.21*	7.95**
C. 1657 x C. 1534	-0.54*	4.43*	13.08**	18.88**	10.76**	-0.63**	3.16*	-12.04**
C. 1657 x Misr 2	0.95**		-4.18**	-10.18**	-3.54**		-5.97**	5.47*
C. 1657 x Rena	0.48*	-	-14.67**	-10.51**	-10.57**		6.07**	
C. 1657 x Luz de		1.68*	17.37**		9.39**		-5.01**	-7.13**
C. 1657 x BPL710		2.88*		-3.97**	11.84**	-0.52**	3.41*	
D. (6) x Sakha 1		-	-26.74**	9.41**	-14.02**		4.27**	
D. (6) x Sakha 2		3.01*	8.76**	-4.33**	-7.20**		-2.67*	
D. (6) x C. 1534			-31.34**	8.37**	6.96**			
D. (6) x Misr 2	-0.56*		12.67**		-4.48**	0.40*		8.03**
D. (6) x Rena	0.57*		14.89**	-3.62**	-4.06**		-3.97**	
D. (6) x Luz de			3.76**	-2.99**	1.57*	-0.46*		-5.96*
D. (6) x BPL710		3.88*	-8.98**	-9.80**	-2.18**	-0.77**	18.57**	
T.W x Sakha 1		-	-8.95**	-2.91**	-5.53**	1.14**	-6.66**	
T.W x Sakha 2			13.16**	5.56**	7.35**		-9.80**	-5.69*
T.W x C. 1534	-0.40*		4.76**	7.14**			-2.09**	2.11
T.W x Misr 2		-	4.72**		-8.32**		-4.92**	-10.71**
T.W x Rena Mora		-	-9.43**	-6.34**	-2.57**			
T.W x Luz de		1.52*	-9.36**	-11.29**				-7.19**
T.W x BPL710		4.77*	14.07**	17.01**	9.48**		4.73**	15.95**
LSD ($S_{i,j}$) 0.05	0.44	1.32	2.18	2.04	1.56	0.36	2.64	5.01
0.01	0.58	1.75	2.89	2.70	2.07	0.47	3.50	6.64
LSD (S_{ij}-S_{kl}) 0.05	0.622	1.875	3.09	2.88	2.21	0.51	3.73	7.08
0.01	0.825	2.487	4.10	3.83	2.93	0.67	4.95	9.40

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

dominance genes involved in these combinations. The highest SAC effects were obtained from crosses between parents of high x high or high x low GCA effects. Similar results were obtained by Attia *et al* (2002) and Toker (2004).

Estimates of genetic parameters Table 6 showed that the additive genetic variance (σ^2A) appeared to be large than non-additive genetic variance (σ^2D) for studied traits except for number of seeds/plant. This indicated that additive genetic variance played an important role in the inheritance of these traits. The number of seeds/plant, non-additive

Table 6: Estimates of genetic parameters for studied traits

	Branches / plant	Pods /plant	Seeds /plant	Seeds /plant	100-seed weight	Seeds / pod	Reaction to *Orobanche*	
							N. of *Oro.* Sp	Sp. Dry W.
σ^2_A	3.06	31.27	146.96	0.57	304.38	204.39	149.76	333.50
σ^2_D	0.43	13.47	225.45	0.24	90.48	87.61	50.23	50.69
H_b%	95.97	97.13	99.04	89.14	99.20	99.37	97.42	95.28
H_n%	84.14	67.88	39.08	63.02	76.47	69.56	72.95	82.71
D.d	0.38	0.66	1.24	0.64	0.55	0.65	0.58	0.39

genetic variance was more important than additive genetic variance. This finding could be confirmed by dominance degree ratio which exceeded unity for number of seeds/plant, while it was less than unity in other traits. This finding might explain the absence of heterosis in most crosses with respect this trait. Results indicated that broad sense heritability (h^2_b) estimates were larger or close to the corresponding values of narrow sense heritability (h^2_n) for studied traits. Heritability in broad sense ranged from 89.14% for seed yield/plant to 99.37% for number of seeds/pod. Whereas, narrow sense heritability values ranged from 39.08% for number of seeds/plant to 84.14% for number of branches/plant, indicating that a major part of the total genotypic variance is additive. Accordingly, it is expected that an effective phenotypic selection in these traits could be achieved with a satisfactory degree of accuracy. These results were in agreement with those reported by Helal (1997), El-Rodeny (2002) and Toker (2004).

The covariances analysis between pairs of the studied traits was made, subsequently, phenotypic (rph) and genotypic (rg) correlations were determined and are presented in Table (7). The results showed that the magnitudes of phenotypic correlations were close to the corresponding values of genotypic correlations in most of cases. These results were expected, since the values of covariance error relatively were small than the respective values of genotypic covariance in these cases. The reaction to Orobanche which represented by Orobanche spikes and spikes dry weight appeared to be genetically and phenotypically negative correlated with yield and its components. These results in agreement with the results obtained by many investigator, among them Abdalla *et al* (1994), Ahmad *et al* (2001) and Belen *et al* (2002).

In conclusion, from the previous results which mentioned that the importance of additive and non-additive genetic variance in the genetic expression of studied traits of yield components under Orobanche infestation. It could be concluded that the recurrent selection is the proper way for selecting resistant faba bean types to Orobanche, infestation.

Table 7: Phenotypic (r_{ph}) and genotypic (r_g) correlation coefficient between pairs of all studied traits

	Branches / plant	Bods /plant	Seeds /plant	Seeds /pod	Seed yield /plant	100-seed weight	Reaction to *Orobanche*	
							No. of *Orobanche* spikes	Spikes dry weight
No. of branches/plant		-0.28	-0.16	0.52**	-0.05	0.55**	0.15	0.06
No. of pods/plant	-0.15		0.95**	-0.33	0.92**	0.04	-0.75**	-0.73**
No. of seeds/plant	-0.19	0.82**		-0.07	0.98**	0.14	-0.75**	-0.73**
No. of seeds/pod	-0.30	0.59**	0.53**		0.02	0.50**	0.09	0.12
Seed yield/plant	-0.06	0.82**	0.78**	0.58**		0.26	-0.72**	-0.70**
100-seed weight	0.25	0.17	0.04	0.06	0.08		-0.09	-0.02
No. of *Orobanche* spikes	0.15	-0.70**	-0.72**	-0.76**	-0.70**	0.03		0.79**
Spikes dry weight	0.08	-0.78**	-0.70**	-0.58**	-0.74**	0.00	0.76**	

Note: Upper diagonal denote to the phenotypic correlations values and lower diagonal denote to the genotypic correlations values.
* and ** significant at 0.05 and 0.01 levels of probability, respectively.

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التحليل الوراثى لبعض التراكيب الوراثية للفول البلدى لتحملها الإصابة بالهالوك

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أجريت الدراسة فى محطة البحوث الزراعية بسخا داخل صوبه سلكيه وذلك خلال مواسم الزراعة من 2003 /2004 و حتى 2005/2004 أجريت كافة الهجن الممكنة بين احدى عشر تركيبا وراثيا من الفول البلـدى طبقا لنظام التزاوج العاملى منها اربعة كآباء (مصر 1، هـ1657،محدود 6 ، .T.W) و سبعة أمهات (سخا 1 ، سخا 2 ، هـ 1534 ، مصر 2 ، رينا مورا، اتونا، BPL 710) للحصول علـى 28 هجـين . تهـدف هـذة الدراسة الى تقدير قوة الهجين والفعل الجينى بالإضافة لمعامل التوريث لبعض الصفات الاقتـصادية فـى الفـول البلدي. تم تقييم كل الهجن الناتجة والأباء الداخلة فى التهجين تحت ظروف الإصابة الشديدة الهالوك وذلك فـى موسم 2005/2004 فى تجربة ذات تصميم قطاعات كاملة العشوائية فى ثلاث مكررات لدراسة الـصفات التاليـة :- عدد الفروع للنبات ، عدد القرون للنبات ، عدد البذور للنبات ، عدد البذور فى القرن ، محصول بذور النبات ، وزن 100بذره للنبات عدد شماريخ الهالوك ، الوزن الجاف لشماريخ الهالوك. و اشارت النتائج الـى وجـود إختلافات معنوية عالية جدا بين الأباء الداخله فى التهجين وكذلك الهجن الناتجة منها وهذا يدل على وجود مدى واسع من الاختلافات بين التراكيب الوراثية فى سلوكها الوراثى للمقاومة للهالوك ، كذلك كان متوسـط الـسلوك الوراثى للتراكيب الوراثية للصفات المدروسة معنوى وعلى أساس مكونات المحصول تم تقسيم التراكيب الوراثـة المختلفة إلى ثلاث مجموعات أساسيه الأولى - متحملة للإصابة بالهالوك وذات محصول عـالى كانـت أفـضل التراكيب الوراثية الأبوية (مصر 1، هـ 1657و مصر 2. الثانية ، متحمله للأصابه بالهـالوك وذات محـصول متوسط كانت أفضل التراكيب الوراثية الأبوية T.W سخا 1 ، هـ 1534. الثالثة ، حساسة للأصابه بالهـالوك وذات محصول منخفض جدا كانت التراكيب الوراثية الأبوية هى D. 6 ، رينا مورا، اتونا و BPL710. اظهـرت النتائج انة بمقارنة متوسط الهجن بمتوسط الاباء ان هناك قوة هجين معنوية للمحصول و مكوناتة وتراوحت بين 12.74 الى 81.89% لصفة عدد القرون. و بالنسبة لصفة المقاومة لهالوك اشارت النتائج ايضا ان قوة الهجين كانت معنوية وتراوحت بين -15.38 الى -38.46. كانت تأثيرات القدرة على الائتلاف لمختلـف الـصفات ذو تباين كبير بين التراكيب الوراثية المختلفة . كان الأباء مصر1،T.W سخا 1 ، هـ 1534 ، مصر 2 ذو قدره عالية على الائتلاف لصفة محصول البذور / نبات. بينما أظهرت التراكيب الأخرى قدره منخفضة على الائـتلاف لنفس الصفة. ونشير أن الاختلافات فى القدرة العامة على الإئتلاف لصفة محصول البذور للنبـات تعتمـد فـى إختلافها على كلا الصفتين وهما عدد القرون /النبات ، عدد البذور /النبات وهذا يشير إلى أن الإنتخـاب للقـدره العامه العاليه لصفة عدد القرون أو عدد البذور تنعكس بطبيعتها على إنتاج محصول البذور/النبات . كما أظهرت صفة عدد شماريخ الهالوك بالنسبه للهجن هـ 1657 x هـ 1534 ، مصر 2 × .T.W و T.W x سـخا 2 قيما سالبه مما يشير إلى إمكانية تحمل هذا الهجين للهالوك. فى حين أن الإشاره الموجبه بالنسبة للقدرة الخاصة لأى من الهجن تدل على تفوق هذه الهجن فى المحصول عن الأباء الداخلة فيها . ومن خلال دراسة الفعل الجينى للصفات إتضح أن كل من الفعل الجينى المضيف والغير المضيف يلعب دوراً فى التغيير الوراثى لكافة الـصفات المدروسة ويرجع الجزء الأكبر من هذا التباين إلى تأثير الفعل الجينى المضيف مما يجعل الانتخاب المتكرر أفضل وسيلة لتحسين هذه الصفات تحت الدراسة بما فيها صفة المقاومة للهالوك خلال الأجيال الإنعزاليه.

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