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ASSESSMENT OF *Orobanche* TOLERANCE AND YIELD IN SIX NEW PROMISING LINES OF FABA BEAN

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ABSTARACT

The present investigation was conducted under Orobanche free and naturally infected soil during 2013/14 and 2014/15 seasons at Mallawy Agricultural Research Farm, El-Minia, Egypt, in a Randomized Complete Blocks Design (RCBD) with three replicates, to evaluate the tolerantce levels of six faba bean lines as compared with Giza 2 (Orobanche-susceptible) and Giza 843 (Orobanche-tolerant) cultivars. All tested lines were significantly less infected with Orobanche (number and dry weight spikes/ m^2) than both checks. Therefore, the tested lines could be considered Orobanche-tolerant. Consequently, lines 1 and 3 were the most promising lines for resistance to Orobanche with high yielding ability (7.88 and 6.40 ardab/faddan, respectively) and (8.14 and 7.87 ardab/faddan, respectively) in 1^{st} and 2^{nd} seasons, respectively. Highly significant differences were detected for infection type of Orobanche, suggesting that these lines differed in genes controlling the resistance to Orobanche. Second season had higher heritability than first season for all traits, except number of pods per plant, indicating that heritability in the second season was less influenced by the environment. In both seasons; high heritability was coupled with higher genetic advance% for no. of seeds/plant (81.00%, 54.58% and 95.80, 67.66%), and for seed yield/plant (85.00, 63.35% and 89.00, 65.22%), respectively, suggesting the involvement of epistatic interactions. Therefore, additive gene action was increased with advanced generation, and was more pronounced in the inheritance of Orobanche-resistance and yield components in both generations, confirming the potential value in reducing the losses to yield under infection condition. Tested lines, especially line 1 and line 3 can be promoted as new varieties or used in breeding programs to develop new resistant lines.

Key world**: *Vicia faba, Broomrape, Heritability, Genetic advance.***

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the main pulse crops grown for seed in Egypt. It is widely considered as a good source of protein, starch, cellulose and minerals for humans in developing countries and for animals in industrialized countries (Haciseferogullari *et al* 2003). In addition, faba bean is one of the most efficient fixers of the atmospheric nitrogen and, hence, can contribute to sustain or enhance total soil nitrogen fertility through biotical N_2-fixation (Lindemann and Glover 2003). The cultivated area across the last six years (2008 – 2013) was 146,000 feddan with an average yield of 9.28 ard/feddan (the annual Economic Reports, Agricultural Economic Sector, Ministry of Agriculture, Egypt).

Broomrape (*Orobanche crenata*, Forsk) is known to be the highly damaging parasite plant affecting faba bean production in Egypt. It causes yield loss of many important dicotyledonous crops throughout the world (Parker 1986), by removing carbohydrates and water (Schaffer *et al* 1991). When infestation levels are high, there can be complete failure of the crop.

Despite of the pressing need for greater annual production in order to meet an increasing demand of faba bean seeds, the existing cultivars has been dwindling lately mainly due to pest attacks of the most devastating pest of broomrape (*Orobanche crenata*). Being a noxious root parasite, broomrape represents a major constraint in the main production areas of Middle and Upper Egypt where it causes great losses in seed yield and sometimes a complete failure of the crop in endemic land. Moreover, seeds of this parasitic weed remain viable for years in the infested soil thus posing a constant threat to the annual acreage since more land is being rendered uncultivable with faba bean every year (Nassib *et al* 1992). Various control methods have been proposed, ranging from cultural practices such as hand weeding, solarization, trap and catch crops, delayed sowing dates and crop rotation, to use of chemical and biological control methods. However, no single method has provided satisfactory control (Parker 1994 and Rubiales *et al* 2002). Little success has been achieved in breeding legumes for broomrape resistance due to the scarcity of sources of resistance and the complex inheritance of those available so far (Cubero *et al* 1994 and Rubiales 2003). Thus, there is a great need for development of resistant cultivars and for better understanding of inheritance of resistance (Sillero *et al* 2005). Breeding efforts have been employed for combining genes for adaptability and high yield from elite faba bean genotypes with those for tolerance to *Orobanche* (Cubero 1973, Nassib *et al* 1979, El-Deeb *et al* 1999). However, information on the genetics of resistance to *Orobanche* is scant and the nature of the genetic system involved is far from clear which might account for the rather limited number of resistant cultivars released through breeding. The limited success of the breeding efforts for selecting faba bean cultivars with enhanced resistance to the devastating parasitic weed *Orobanche crenata* could be attributed to the ambiguity in defining resistance / tolerance, hence the inappropriate choice of the selection criterion. Number of broomrape spikes per host plant was adopted as the most stable index for resistance (Cubero and Moreno 1979, Abdalla *et al* 1981, Gil *et al* 1987, Cubero *et al* 1994). However, responses to selection for the population of plants without *Orobanche* shoots (zero-broomrape plants) was found to be slow with very little advance being achieved (Cubero and Moreno 1979). Soliman *et al* (2011) recorded that there was a negative correlation between weight of broomrape spikes per host plant and both of seed yield per host plant and number of seeds per host plant but no such associations were found with number broomrape spikes per host plant.

In a systematic breeding program, the components of genetic variance analysis in terms of type of gene action, heritability and breeding potentials of genetic entries involved in the program are obviously essential. Heritability estimates provide a measure of relative importance of the genotypic to the phenotypic variation and the latter being the sum of genotypic and environmental variations (Abdalla *et al* 2001, Attia *et al* 2001, Attia *et al* 2002, Attia and Salem 2006, El-Hady *et al* 2006 and 2007).

The genetic nature of broomrape resistance is not clear at present and requires more studies on Egyptian faba bean genotypes. Therefore, the objective of this work was to evaluate the newly developed faba bean genotypes (lines) as a new source for *Orobanche* resistance, which may be considered useful genetic stock in food legume breeding programs under natural infestation.

MATERIALS AND METHODS

A diallel mating design was performed among five faba bean genotypes (2006/07). F_2 populations were established and evaluated under naturally infested soils heavy infested with *Orobanche* at Mallawy Research Station, ARC, Egypt from 2007/08 to 2011/12 seasons and all plants that have tolerance and low dry weight of *Orobanche* were selected and bulked (mass selection under naturally infested soils). F_3 families were used as base populations to select high-yielding faba bean lines with greater resistance to *Orobanche*.

In 2013/14 and 2014/15 seasons, the six selected tolerant lines were evaluated and compared with Giza 843 (tolerant), and the highly susceptible cultivar Giza 2 (Table 1) under free and heavy naturally infested field with *O. crenata*. A randomized complete block design with three replications was used. Each genotype was represented by 5 ridges, 3m long and 60 cm apart (plot area = 9.0 m^2) with single seeded hills at one side of the ridge and 20cm between hills.

Table 1. Pedigree and reaction to *Orobanche* of the studied faba bean genotypes.

Genotype	Pedigree	Reaction to *Orobanche*
Line 1	Giza 843 x Giza 429	Unknown
Line 2	Giza 429 x Promising 3	Unknown
Line 3	Giza 843 x Promising 3	Unknown
Line 4	Giza 429 x Promising 4	Unknown
Line 5	Giza 843 x Giza 2	Unknown
Line 6	Promising 3 x Promising 4	Unknown
Giza 843	Cross 461 x Cross 561	Tolerant
Giza 2	Developed by selected single plant from local landraces	Highly susceptible

All materials were obtained from Field Crops Research Institute (FCRI).

The agricultural practices were maintained as recommended for faba bean in Mallawy location. At harvest, 10 guarded plants were chosen to collect data on the following characters: *Orobanche* number and dry weight (kg /plot) and faba bean seed yield components as number of pods, number of seeds per plant, 100-seed weight, seed yield (g/plant, kg/plot and ard/fed) of faba bean genotypes evaluated under both free and *Orobanche* infested soils.

Seed yield **(SY)** was determined from the yield of the central three ridges (to discard the border effect), then transformed to ardab/feddan. It is noted that exaggerate values of seed yield may be resulted under the previous transformation due to the yield of large area (feddan) is computed from a small area (plot).

The reduction due to *Orobanche* infestation was calculated according to the formula:

$$\textbf{Reduction\%} = \frac{\textbf{Seed yield of free field - Seed yield of infested field}}{\textbf{Seed yield of free field}} \quad \%$$

Statistical analysis

Analyses of variance of randomized complete block design were carried out for each trait in each season under both free and *Orobanche* infested soils. Collected data under both free and infested soils was tested for homogeneity using Bartlett's (1937) test and when it were found homogeneous, the data were combined.

Analysis of variance of randomized complete block design for each trait in each year (the two consecutive advanced generations F_7 and F_8) was separately performed according to Snedecor and Cochran (1989). Analysis of variance was performed for each trait under both free and infested soils following a split plot design (Gomez and Gomez, 1984). Least significant difference test was used to detect the significant differences among genotype means. Estimates of broad-sense heritability for the six lines were calculated by partitioning variance components of family mean squares to pooled environmental variance (σ^2_E) and genotypic variance (σ^2_G), and then broad-sense heritability estimates (h^2_b) were calculated as follows according to Holland *et al* 2003.

$$\sigma^2_P = \sigma^2_G + \sigma^2_{GE}/e + \sigma^2_E/re.$$

$$h^2_b = \sigma^2_G / \sigma^2_P$$

where, h^2_b = broad-sense heritability, σ^2_G = genotypic variance, σ^2_P = phenotypic variance, r = number of replications, and e = number of infestation treatments. In accordance to the methods reported by Johnson *et al* (1955) and Kumar *et al* (1985), the phenotypic (PCV) and genotypic (GCV) coefficients of variation were estimated as a percentage of their corresponding phenotypic (σ_P) and genotypic (σ_G) standard deviations to the trait grand mean. Expected genetic advance (GA) and GA% as percent of the mean assuming selection of the superior 5% of the genotypes were estimated in accordance with the methods illustrated by Fehr (1987):

$$GA = K\,\sigma_P\,h^2 \text{ and } GA \text{ (as \% of the mean)} = (GA/\bar{x})*100\%.$$

RESULTS AND DISCUSSION

Performance of genotypes under free and *Orobanche* infested soils

Mean performance of eight tested lines and varieties under free and *Orobanche* infested soils in 2013/14 and 2014/15 seasons for studied traits which included seed yield and its components attributes (number of pods, number of seeds per plant, 100-seed weight, seed yield (g/plant, kg/plot and ard/fed), as well as *Orobanche* characters (number and *Orobanche* spikes dry weight/m^2) are presented in Tables (2, 3 and 4). The results exhibited significant differences among the tested genotypes, for all studied characters, indicating genetic variation among them.

Table 2. Mean performance of some seed yield components of faba bean genotypes (Gen.) evaluated under both free and *Orobanche*-infested (Inf.) soils in 2013/14 season.

Genotype		No. of pods		No. of seeds		100-seed weight(g)		Yield/plant (g)		Yield/plot (kg)	
		Free	Inf.	Free	Inf.	Free	Inf.	Free	Inf.	Free	Inf.
Line 1		52.33	36.53	204.00	142.67	74.70	71.73	146.33	106.67	5.96	3.05
Line 2		40.33	20.33	177.67	78.67	65.03	73.37	126.33	51.33	5.44	2.22
Line 3		46.33	32.00	180.67	116.00	71.20	75.07	135.67	82.67	5.54	2.45
Line 4		37.67	20.00	151.00	77.67	74.20	73.07	110.33	57.67	5.01	2.15
Line 5		29.33	26.67	113.00	114.00	72.77	75.47	85.33	83.00	4.19	2.42
Line 6		32.00	20.67	125.00	103.67	74.23	73.83	92.33	77.00	4.51	2.35
Giza843		27.67	13.00	103.67	48.67	63.07	68.20	69.00	30.67	4.08	1.97
Giza 2		25.33	3.00	97.00	10.00	57.50	61.57	59.67	5.73	3.68	0.54
LSD 5%	Gen.	4.67	4.23	1.94	8.78	4.82	4.86	6.82	8.68	0.45	0.42
	Gen.* Inf.	4.25		6.07		4.62		7.45		-	

Table 3. Mean performance of some seed yield components of faba bean genotypes (Gen.) evaluated under both free and *Orobanche*-infested (Inf.) soils in 2014/15 season.

Genotype		No. of pods		No. of seeds		100-seed weight(g)		Yield/plant (g)		Yield/plot (kg)	
		Free	Inf.	Free	Inf.	Free	Inf.	Free	Inf.	Free	Inf.
Line 1		62.33	34.67	209.00	146.67	62.67	72.00	131.23	103.71	6.42	3.15
Line 2		48.67	14.67	165.67	61.33	72.67	71.33	119.77	43.65	4.91	2.41
Line 3		50.33	30.33	191.33	126.00	67.33	64.00	129.60	80.61	5.06	3.05
Line 4		42.00	16.67	157.33	69.33	71.00	71.00	111.89	49.01	4.29	2.78
Line 5		43.33	26.67	168.00	111.00	62.33	64.00	89.96	70.31	4.33	2.93
Line 6		36.33	20.33	144.67	84.67	72.33	72.67	104.83	61.41	4.17	2.87
Giza 843		30.67	10.33	105.67	43.67	64.67	62.67	68.39	28.12	4.50	1.79
Giza 2		22.67	5.33	87.67	22.67	56.33	57.33	49.33	12.90	4.06	0.80
LSD 5%	Gen.	7.43	3.31	43.74	15.80	3.97	3.43	31.66	11.66	0.56	0.57
	Gen.* Inf.	12.24		NS		3.54		22.78		-	

Table 4. Mean *Orobanche* number and dry weight (kg /plot), seed yield (ard/fed) and seed yield reduction% of faba bean genotypes evaluated under both free and infested soils in both seasons.

Genotype	2013/14					2014/15				
	Orobanche/plot		Yield (ard/fed)		Yield Reduction%	*Orobanche*/plot		Yield (ard/fed)		Yield Reduction%
	Number	Weight (kg)	Free	Inf.		Number	Weight (kg)	Free	Inf.	
Line 1	99.00	0.70	15.39	7.88	48.77	76.33	0.61	16.57	8.14	50.88
Line 2	124.67	1.20	13.47	5.72	57.54	176.00	0.89	12.67	6.23	50.83
Line 3	101.33	0.80	14.30	6.40	55.24	83.00	0.88	13.06	7.87	39.74
Line 4	146.00	1.10	12.94	5.55	57.11	197.67	2.08	11.07	7.18	35.14
Line 5	119.67	0.90	10.80	6.25	42.13	238.00	1.83	11.17	7.57	32.23
Line 6	129.00	0.90	11.65	6.00	48.50	247.00	1.64	10.76	7.41	31.13
Giza843	190.67	1.67	10.30	4.46	56.40	269.67	2.45	9.04	3.77	58.30
Giza 2	306.67	2.60	9.45	1.40	85.20	426.67	3.49	7.89	1.54	80.50
LSD5%	62.31	0.64	1.08	0.92	8.80	59.32	0.58	1.54	1.47	11.30

***Orobanche* spikes of spikes parasitized faba bean genotypes were collected just when its plants started to death and their data were recorded immediately.**

The performance of selected populations and checks in 2013/14 presented in Table (2), showed significant differences among faba bean genotypes for all studied traits. The six lines revealed highest value for all yield components *vs*. Giza 843 (tolerant check). Line 1 and line 3 gave the maximum number of pods (52.33, 46.33 and 36.53, 32.00 pods plant^{-1}), number of seeds per plant (204.00, 180.67 and 142.67, 116.00 seeds plant^{-1}) and seed yield per plant (146.33, 135.67 and 106.67, 82.67g plant^{-1}) and per plot (5.96, 5.54 and 3.05, 2.45 kg plot^{-1}) under free and infested conditions, respectively. However, the heaviest weights of 100 seeds (74.70 and 74.23 g) under free were recorded by line 1 and line 6. These finding were in agreement with those reported by Saber *et al* 1999 and El-Sayed *et al* 2003.

Results of 2014/15 season presented in Table (3) showed that line 1 and line 3 produced the highest number of pods, seeds per plant and seed yield being (62.33, 50.33 and 34.67, 30.33 pods), (209.00, 191.33 and 146.67, 126.00 seeds), (131.23, 129.60 and 103.71, 80.61 g plant^{-1}) and (6.42, 5.06 and 3.15, 3.05 kg plot^{-1}) under free and infested conditions, respectively. However, the heaviest weights of 100 seeds (72.67 and 72.33 g) under free conditions were recorded by line 2 and line 6. These finding were in agreement with those reported by Saber *et al* 1999 and El-Sayed *et al* 2003.

Data presented in Tables (2 and 3) indicated that all tested lines and the tolerant check cultivar; Giza 843 exceeded the susceptible check Giza 2 in seed yield. In addition, these tested lines exceeded the tolerant check cultivar; Giza 843 itself. These findings indicated clearly that tested lines could be considered tolerant to *Orobanche*. Consequently, line 1 also produced the highest seed yield components for both generations under free and infested conditions followed by line 3 with significant differences compared to the check cultivar (Giza 2). Similar conclusion was also reported by Saber *et al* 1999 and El-Sayed *et al* 2003.

Effect of *Orobanche* infestation on faba bean yield

Data presented in Table (4) showed the effect of *Orobanche* infestation on faba bean yield. Results showed that *Orobanche* number and dry weight seed yield (ard/fed) and seed yield reduction% of faba bean genotypes evaluated under both free and infested soils in both seasons. All genotypes revealed significantly seed yield reduction under *Orobanche* infestation conditions. Results showed that *Orobanche* number and dry weight were significantly affected by genotype. The highest values of *Orobanche* number and dry weight were recorded on Giza 2 (306.67 and 2.61 kg/plot, respectively) in 1st season and (426.67 and 3.49 kg/plot, respectively) as susceptible one. Regarding the tested lines data revealed that the line 1 and line 3 had the lowest values of *Orobanche* number and dry weight (76.33 and 0.61 kg/plot, respectively) and (83.00 and 0.88 kg/plot, respectively) in both seasons, respectively. These finding were in agreement with those reported by Saber *et al* (1999), El-Sayed *et al* (2003) and Abdalla *et al* (2014).

In 2013/14 season, seed yield of line 5, line 6, line 1 and line 3 was the least affected genotypes. Line 5 recorded the least reduction value due to *Orobanche* infestation (42.13%), followed by line 6 (48.50%), line 1 (48.77%) and line 3 (55.24%) compared with the check cultivar Giza 843 (56.40%). However, Giza 2 recorded the highest reduction value (85.20%). Most lines were superior in seed yield with least reduction value (Table 4). Regarding to 2nd season, all lines were superior to in seed yield ard fed^{-1} under both free and infested condition. Line 1 also produced the highest seed yield ard fed^{-1} under infested conditions recording (8.14 ardab fed^{-1}) followed by line 3 (7.87 ardab fed^{-1}) and line 5 (7.57 ardab fed^{-1}). Line 6 recorded the least reduction value due to *Orobanche* infestation (31.13%), followed by line 5 (32.23%). Therefore, in 2014/15, seed yield of line 6 and line 5 were the least affected genotypes. However, Giza 2 recorded the highest reduction value (80.50%). All lines were superior in seed yield and showed the lowest reduction values compared with the check cultivar Giza 843 (Table 4).

All genotypes revealed significant reduction in seed yield components reduction under *Orobanche* infestation in both seasons (Fig. 1). All lines revealed superior values *vs*. Giza 843 (tolerant check) under free and infested conditions, the seed yield under *Orobanche* infestation and yield reduction percent of both seasons was fairly constant. These results indicated that the degree of terminal *Orobanche* infestation was reasonably controlled at the predetermined levels. These findings indicated clearly that tested lines could be considered *Orobanche* tolerant.

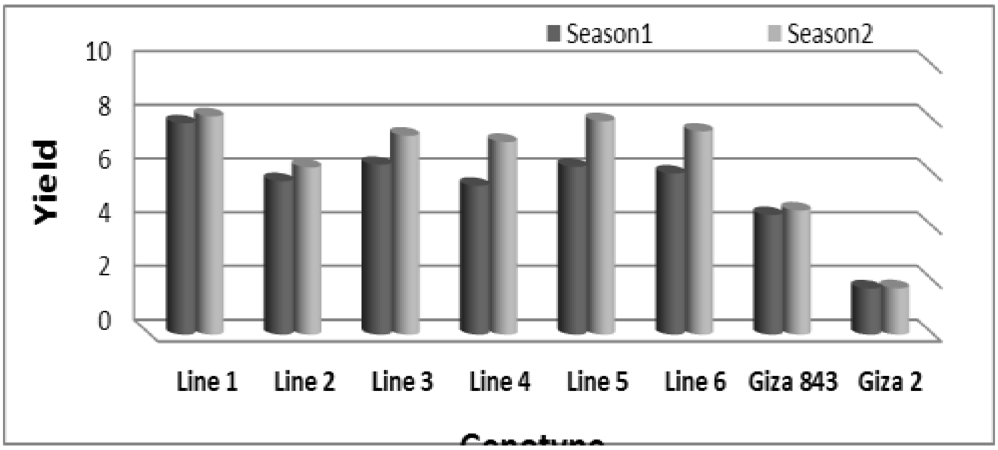

Figure 1. Effect of infestation applied on faba bean genotypes yield in both seasons.

These results are in agreement with Saber *et al* (1999), El-Sayed *et al* (2003) and Abdalla *et al* (2014), who found that high infestation levels led to a significant loss and reductions in total seed yield.

Combined analysis

The results of combined analysis of variance in both seasons for seed yield components (Table 5) showed significant differences among the two different conditions (infested/free) for all traits ($P \leq 0.01$) except 100-seed weight in 2nd season, therefore, infection affected the yield and productivity (El-Sayed *et al* 2003 and Ashrie *et al* 2010).

Table 5. Mean squares of combined analysis of variance for both seasons for yield traits of studied genotypes under free and infested conditions.

SOV	df	2013/14				2014/15			
		No. of pods	No. of seeds	100-s weight	Yield/ plant	No. of pods	No. of seeds	100-seed weight	Yield/ plant
Replication	2	7.46	232.89 **	1.93	132.39 **	31.58	425.15	1.90	214.19
Infection (I)	1	2646.27 **	39790.08 **	72.03 *	20451.76 **	4941.02 **	59643.00 **	6.02	23666.09 **
Error	2	5.51	6.27	2.64	10.57	35.08	410.81	0.90	228.63
Genotype (G)	7	554.22 **	8554.56 **	167.19 **	5352.00 **	526.09 **	9920.24 **	171.83 **	4650.26 **
I * G	7	54.10 **	1638.37 **	20.74 *	806.89 **	133.26 *	415.57	22.26 **	502.97 *
Error	28	6.47	13.18	7.64	19.86	53.52	352.57	4.49	185.58
Total	48								

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

In respect to genotypes in both seasons, significant differences were detected for yield traits, which indicate the presence of sufficient genetic variability among genotypes, which can be exploited in faba bean breeding program for improving yield and other traits El-Sayed *et al* 2003 and Ashrie *et al* 2010). In terms of the interaction between infection and genotypes, there were significant differences for yield traits except number of seeds per plant in 2nd season, meaning infection range affected on genotypes yield.

Genetic variability of yield traits

Genetic variability of traits can be used to predict the genetic gain form selection in breeding programmes. Ranges of yield component traits of tested faba bean lines and checks under different *Orobanche* infestation conditions of both seasons were presented in Table (6).

Table 6. Genetic parameters for some yield components in all studied faba bean genotypes under infestation conditions in both seasons.

Parameter	2013/14				2014/15			
	No. of pods	No. of seeds	100-seed weight	Yield/ plant	No. of pods	No. of seeds	100-seed weight	Yield/ plant
σ^2_g	83.35	1152.7	24.40	3.09	65.47	1584.11	24.93	4.79
σ^2_{ph}	92.37	1425.76	27.87	892.00	87.68	1653.37	28.64	775.04
PCV%	33.20	32.77	7.51	36.21	29.35	34.34	8.04	35.50
GCV%	31.54	29.47	7.03	33.37	25.37	33.61	7.51	33.53
h^2	90.00	81.00	87.50	85.00	75.00	95.80	87.00	89.00
GA	17.87	62.89	9.53	52.25	14.40	80.25	9.60	51.15
GA%	61.71	54.58	13.55	63.35	45.15	67.77	14.43	65.22

In general, phenotypic variance (σ^2_{ph}) and coefficient of variability (PCV %) were higher than corresponding genotypic variance (σ^2_g) and coefficient of variability (GCV %) for all the traits which demonstrated the effect of environment upon the traits in both generations. Across the studied traits, the PCV% values ranged from 7.51 and 8.04% for 100-seed weight to 36.21 and 35.50% for seed yield plant^{-1} in both seasons, meanwhile GCV % values ranged from 7.03 and 7.51% for 100-seed weight to 33.47 and 33.61% for seed yield plant^{-1} and number of seeds plant^{-1}, respectively in both generations. The relatively high estimates (>30%) of genotypic coefficient of variation (GCV %) were obtained by number of pods plant^{-1} (31.54%) and seed yield plant^{-1} (33.37%) in 1st season, and number of seeds plant^{-1} (33.61%) and seed yield plant^{-1} (33.53%) in 2nd season. While intermediate (GCV %) estimates (16 - 30%) were noted with the number of seeds plant^{-1} (29.47%) in 1st season, and (25.37 %) for number of pods plant^{-1}. Hundred seed weight recorded low (GCV %) estimates (less than 15) in both generations, respectively. These results were in agreement with those reported by Toker (2004).

Heritability is a function of a breeding population and the conditions under which a study is conducted (Falconer and Mackay, 1996). Broad-sense heritability repaints personage of both additive as well as non-additive gene effects. 1st season had higher heritability than 2nd one for number of pods plant^{-1} (90.00 > 75.00%), indicating that the F_7 generation had less influence by the environment. In contrast, 2nd season had higher heritability than 1st one for number of seeds plant^{-1} (95.80 > 81.00%) and seed yield plant^{-1} (89.00 > 85.00%), indicating that the F_8 had less influence by the environment. Hundred seed weight recorded the same heritability value approximately (87.5 and 87.00%) in both generations, indicating that the both generations had the same environmental effect.

In both generations; high heritability was coupled with higher genetic advance% from selection for no. of seeds/plant (81.00%, 54.58% and 95.80, 67.66%), respectively and for seed yield/plant (85.00, 63.35% and 89.00, 65.22%), suggesting the involvement of epistatic interactions. In 2nd season; high heritability was coupled with highest genetic advance for no. of seeds/plant (95.80%, 67.66%), suggesting also the involvement of epistatic interactions. Whereas, 100-seed weight recorded the lowest genetic advance values in both generations (13.55%, 14.43%), respectively.

Soliman *et al* (2012) reported that six faba bean genotypes exhibited resistance to *Orobanche* in comparison with the check susceptible cultivar (Giza 2). These results are in agreement with those of Darwish *et al* (1999) and Kumar and Dubey (2001). These results confirmed the potential value of selected lines in reducing the losses to yield (Saber *et al* 1999).

CONCLUSION

In conclusion, the six-tested lines in advanced generations, selected for their partial tolerance to *O. crenata*, showed tolerance under field conditions. These lines can be promoted as new varieties or used in breeding programs to develop new tolerant lines.

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تقدير المحصول وتحمل الهالوك فى ستة سلالات مبشرة من الفول البلدى

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أجريت هذه الدراسة بهدف تقييم مستويات مقاومة الهالوك لستة سلالات خلال الجيلين السابع والثامن من الفول البلدى مقارنة بالصنف الحساس– جيزة ٢ والصنف المقاوم– جيزة ٨٤٣ ، بالإضافة لدراسة توارث بعض صفات المحصول باستخدام تصميم القطاعات الكاملة العشوائية فى ثلاثة مكررات. وقد تم التقييم تحت ظروف أرض موبؤة وأخرى خالية من الهالوك خلال موسمى ٢٠١٣/١٤ – ٢٠١٤/١٥ بمحطة بحوث ملوى – مركز البحوث الزراعية. اظهرت كل السلالات نقصا معنويا للاصابة بالهالوك (لكلا من عدد ووزن شماريخ الهالوك الجاف/م^{2}) مقارنة بصنفى المقارنة. لذا تعد هذه السلالات متحملة للهالوك. وتعد سلالة ١ وسلالة ٣ أكثر السلالات تحملاً للهالوك وذات محصول عالى حيث سجلتا (٧,٨٨ و٦,٤٠ على التوالى) و (٨,١٤ و٧,٨٧على التوالى) فى كلا الجيلين على التوالى. وقد أظهرت النتائج وجود اختلافات معنوية لشكلى الاصابة بالهالوك (التربة الخالية والموبوءة) مما يدل على أن التراكيب الوراثية تختلف فى جينات مقاومة الهالوك. نلاحظ أن كفاءة توريث سلالات الجيل الثامن سجلت قيماً أعلى من الجيل السابع لكل الصفات عدا صفة عدد القرون/النبات، مما يدل على أن نباتات الجيل الثامن أقل تأثراً بالبيئة. سجلت النتائج كفاءة توريث مرتفعة ومصحوبة بتحسين وراثى متوقع (% المتوسط) عالى ايضا لصفة عدد بذور النبات (٨١,٠٠ – ٥٤,٥٨ و٩٥,٨٠–٦٧,٦٦) لكلا الجيلين على التوالى، وكذلك لصفة محصول بذور النبات(٨٥,٠٠%– ٦٣,٣٥% و٨٩,٠٠ –٦٥,٢٢) على التوالى . وعليه فان الفعل الجينى المضيف يزداد بتقد م الاجيال ، وكان اكثر وضوحاً فى توارث صفة المقاومة للهالوك ومكونات المحصول خلال الجيلين؛ مما يؤكد احتمالية تقليل الفقد المحصولى تحت ظروف العدوى. ويمكن أن ترقى السلالات المدروسة خاصة السلالة ١ والسلالة ٣ لكى تصبح أصناف جديدة أو تستخدم فى برامج التربية لتحسين صفة المقاومة فى السلالات الجديدة .

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