SINAI Journal of Applied Sciences 11 (2) 2022 213-228

Available online at www.sinjas.journals.ekb.eg

SCREENED BY iThenticate Professional Plagiarism Prevention

SINAI Journal of Applied Sciences

Print ISSN 2314-6079
Online ISSN 2682-3527

ARU-EGYPT SJAS Trust Science | It Creates

EFFECT OF SOWING DATES ON *Orobanche crenata* INFECTION AND YIELD AND ITS COMPONENTS OF SOME FABA BEAN GENOTYPES

Ismail A. I. Mohammed*; Th.M. AbouSen and T.S. El-Sayed

Food Legumes Res. Section, Field Crops Res. Inst, ARC, Egypt.

2. Des. Res. Cent., Egypt

ARTICLE INFO

Article history:
Received: 11/02/2022
Revised: 07/03/2022
Accepted: 31/03/2022
Available online: 01/04/2022

Keywords:
Faba bean,
seed yield,
Orobanche,
sowing dates.

Check for updates

ABSTRACT

The present investigation was performed at Sakha Agricultural Research Station, Agriculture Research Center, Egypt, during two growing seasons 2019/2020 and 2020/2021 under *Orobanche* naturally infested soil. The main purpose of this study was to evaluate and compare the yielding of 13 faba bean (*Vicia faba* L.) genotypes under two sowing dates (October 15th and November 15th). Sowing on Oct.15th produced taller plants than sowing on Nov.15th in both seasons. The highest seed weight per plant was produced in the first sowing date (52.39 and 49.22g), compared to the second sowing date (31.04 and 26.50g), respectively in 1st and 2nd seasons. The decrease in the number of pods/plant may be due to the competitiveness of the faba bean plant and *Orobanche crenata* and the struggle for available nutrients and others in the surrounding media, which leads to a decrease in the flower growth during the flowering period. Initialization period that reduces the number of pods /plant. The results showed that Line 3 produced the highest seed yield (9.37and 8.03 ardab/fed) in 1st and 2nd seasons, compared with the other genotypes. Generally, the phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all characters. The variation exhibited by the 13 faba bean genotypes in agronomic characters indicated that selection for several of these characters might be effective. Estimates of heritability (h^2bs) for number of branches/plant and number of seeds/pod were higher in first than second sowing dates. These findings suggest that genetic effects constitute a major portion of the total phenotypic variation for these characters under the first sowing date.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important annual legume crops in Egypt. It is vital source for high quality and inexpensive protein in human diets and as a fodder for animals; also, faba bean plays an essential role in enhancing soil fertility (**Duc *et al*., 2010).** In Egypt, the total area of faba bean cultivation has steadily decreased in many countries over the last century, the average of faba bean growing area during the last five years from 2011 to 2015 was 113810 feddan with average seed yield about 9.2 ardab/feddan (one ardab = 155kg) and total production about 162.200 metric tons, which covers about 32.6% from the total national consumption* {Economic Affairs Sector, ministry of Agriculture} (1 faddan = 0.42 ha). In East Africa, the Middle East and Mediterranean region, the development of this crop is facing many biotic stresses **(Abang *et al*., 2007).** The root parasitic weeds (*Orobanche* spp.) are the most damaging pathogens on the crop. In Egypt, broomrapes *Orobanche crenata* are known to be detrimental on faba bean. *O. foetida* has been reported to damage faba bean only in Egypt **(Nassib *et al*., 1984; Darwish *et al*., 1999)**. The yield

*** Corresponding author: E-mail address:** is.abobaker@yahoo.com
https://doi.org/10.21608/SINJAS.2022.121008.1092

loss can reach more than 95% in highly infested fields **(Abbes *et al*., 2007; Kharrat *et al*., 2010)** depending on host susceptibility, level of infestation, and environmental conditions. Breeding for *Orobanche*-resistant crop plants as a long-term measure for *Orobanche* control seems to be more approporiate than costly and doubtful chemical or physical control procedures to reduce the infestation and to improve the yield of faba bean in infested fields. However, breeding for *Orobanche* resistance is difficult due to limited sources of resistance, complex nature of the resistance mechanism, and low heritability **(Nassib *et al*., 1984; Pérez-de Luque *et al.*, 2003).** Control of these parasites is difficult because broomrape produce hundreds of thousands of minute seeds that are highly persistent to the soil conditions and can easily transfer to new areas. Methods of control included agricultural practices such as hand weeding, tillage, crop rotation and sowing dates and chemical control. Sowing date is the major factor affecting development, source sink relationship and assimilation in faba bean plants. Sowing date is crucial in many farming systems to avoid frost, drought, pests or diseases, which may occur early or late in the growing season. Late sowing may result in severe insect and disease attack **(Sahile *et al*., 2008)**. **Mekky *et al*. (2003)** referred that sowing faba bean on 15 and 30 November decreased broomrape infestation by 44.8 and 92% as compared with the 1st of November in both growing seasons, in association with increasing seed yield by 6.55 and 27.7%, respectively. The present investigation was carried out to study the response of some promising locally developed faba bean genotypes to early and late sowing dates.

MATERIALS AND METHODS

The present investigation was performed at the Experimental Farm, Sakha Agricultural Research Station (SARS), Kafr EL-Sheikh, Egypt during the two growing seasons 2019/2020 and 2020/2021 under *Orobanche* naturally infested soil.

The main purpose of the study was to evaluate the yielding ability of 13 faba bean genotypes under two sowing dates (October 15th and November 15th). The genetic materials of faba bean used in this study consisted of 9 local promising lines selected from the faba bean Breeding Program of Legume Research Dept., Sakha Agricultural Research Station and four Egyptian commercial cultivars; Giza 843, Miser1, Sakha 2 and Cairo 4. The names, original source and pedigree of these genotypes are shown in Table 1. The experimental design was a randomized complete block with three replications for each sowing dates. Each plot consists of four rows, 4m length and 0.6m spacing between rows (9.60 m^2). At harvest, ten guarded plants were chosen at random for recording the following traits: plant height (cm), number of pods/plant, number of seeds/plant, number of seeds/ pod, 100- seed weight seed weight/plant (g), seed yield (ardab/feddan), number of *Orobanche* spikes/plant (total number of *Orobanche* spikes/plant was recorded at harvest time) and dry weight of emerged *orobanche* spikes per host plant *(*the dry weight of emerged *orobanche* spikes per host plant), their incidence (percentage of host plants showing emerged spikes using a 0 to 100% scale, their severity (according to a 9-point scale **(Abbes *et al.,* 2007)**.

Data collected were statistically analyzed as technique of analysis of variance (ANOVA) according to **Gomez and Gomez (1984).** The importance of genotypic components of variance in relation to phenotypic variance [(over all variance, (σ^2ph)] was assessed as broad sense heritability (h^2b.s) [**Allard, 1960**] as:

$$H^2 = [(\sigma^2 g) / (\sigma^2 ph)] \times 100$$

The coefficient of variation was estimated by using the formula suggested by **Burton (1952).**

Table 1. Pedigree and origin of the studied Faba bean genotypes

Code No.	Genotype	Pedigree	Origin
1	Line 1	Selected from Sakha4 lines (breeder seed)	Egypt
2	Line 2	Selected from Sakha4 lines (breeder seed)	Egypt
3	Line 3	Selected from Sakha4 lines (breeder seed)	Egypt
4	Line 4	Selected from Sakha4 lines (breeder seed)	Egypt
5	Line 5	Selected from Giza843 lines (breeder seed)	Egypt
6	Line 6	Selected from Giza843 lines (breeder seed)	Egypt
7	Line 7	Selected from Sakha1 lines (breeder seed)	Egypt
8	Cross 957	ILB 716 X620/283/85	Egypt
9	L73	Introduced from Japan	Japan
10	Cairo 4	Individual selection from breeding program (FACU)	Egypt
11	Miser 1	Giza 3 X 123A/45/76	Egypt
12	Giza843	561/2076 X416/854/8	Egypt
13	Sakha-2	Rena Blanka X 461/845/83	Egypt

-Genotypic coefficient of variation (G.C.V) = $((G.V)^{1/2}/ \text{grand mean})) \times 100$

-Phenotypic coefficient of variation (P.C.V.) = $((Ph .V)^{1/2} / \text{grand mean})) \times 100$

RESULTS AND DISCUSSION

Results given in Table 2 indicate that, sowing dates (S) were highly significant in both seasons for all traits, indicating that these traits were strongly affected by any change in sowing dates. Genotypes (G) were highly significant for all traits. Meaning that there is a sufficient degree of genetic variability between the genotypes under evaluation. G × S interaction was highly significant for all traits, except for number of branches per plant, indicating the great effect of sowing dates on the performance of the studied genotypes for most traits.

Mean Performance

Mean performance of the different traits of faba bean genotypes, as affected by sowing date are shown in Table 2 in both growing seasons of 2019/2020 and 2020/ 2021.

Growth Traits

Plant height (cm)

The results in Table 2 indicate that, sowing on Oct.15th produced taller plants than sowing on Nov. 15th in both seasons. The increase in plant height in early sowing may be due to the fact that longer days through October are favorable for faba bean vegetative growth. The difference among genotypes in plant height was highly significant in both seasons and ranged from (90.67 to 114.23 and 95.03 to 122.03) in 1st and 2nd seasons, respectively. Plants of Lines 1 in the first season and Line7 in the second season were significantly taller than the other genotypes. On the other hand, plants of Line 4, Cairo 4 and Sakha 2 were the shortest one in the first and second seasons, respectively. The difference in plant height among faba bean genotypes may be due to their different genetic makeup,

Table 2. Average of agronomic characters for faba bean genotypes evaluated under two sowing dates in 2019/20 and 2020/21 seasons

Trait / Treatment	Plant height (cm)		No. of branches/ plant		No. of pods/ plant		No. of seeds/ plant		No. of seeds/ pod	
	2019/ 20	2020/21	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21
Sowing date(S)										
15-Oct	114.78	118.21	3.24	3.37	19.01	17.25	69.64	66.32	3.63	3.85
15-Nov	90.68	103.55	2.40	2.61	13.50	12.92	45.03	39.53	3.31	3.03
F. Test (s)	**	**	**	**	**	**	**	**	**	**
LSD $_{0.05}$	2.36	1.37	0.12	0.13	3.47	0.83	2.62	1.65	0.11	0.14
LSD $_{0.01}$	3.31	1.92	0.17	0.18	4.86	1.17	3.68	2.32	0.16	0.15
Genotypes (G)										
Line1	114.23	110.25	2.52	2.73	17.53	16.03	68.84	56.77	3.81	3.46
Line2	106.68	112.27	2.83	3.04	19.03	16.53	64.43	58.54	3.28	3.43
Line3	101.03	112.8	2.80	3.01	21.03	19.03	76.83	67.46	3.60	3.46
Line4	96.74	95.53	2.82	3.03	16.53	14.03	64.16	52.12	3.80	3.62
Line5	106.53	112.53	2.56	2.77	18.53	14.03	65.65	59.86	3.44	4.08
Line6	111.80	111.69	2.73	2.94	19.03	17.53	65.61	67.39	3.39	3.72
Line7	107.53	122.03	2.61	2.82	14.53	13.53	54.38	47.91	3.63	3.44
Cross 957	103.37	118.93	3.26	3.47	13.60	14.67	52.78	58.17	3.39	3.87
L73	103.87	119.43	2.79	2.83	15.36	18.27	55.05	55.75	3.59	3.22
Cairo4	90.67	102.73	2.89	2.93	9.66	11.27	34.64	35.17	3.82	3.42
Miser 1	98.57	114.13	3.29	3.33	20.03	17.02	58.40	52.48	2.90	3.00
Giza843	98.47	114.03	2.64	2.83	19.16	18.43	58.90	55.95	3.03	3.20
Sakha-2	96.03	95.03	2.94	3.15	7.27	5.77	25.66	20.50	3.45	3.50
F. Test	**	**	**	**	**	**	**	**	**	**
LSD $_{0.05}$	1.73	1.74	0.14	0.16	2.35	2.49	3.85	3.38	0.12	0.15
LSD $_{0.01}$	2.28	2.29	0.18	0.21	3.10	3.27	5.06	4.44	0.17	0.24
F. Test(S x G)	**	**	NS	NS	**	**	**	**	**	*

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

Table (2). Cont.

Trait / Treatment	100-seed weight (g)		Seed weight /plant(g)		Seed yield /(ardab) feddan)		No. of *Orobanche* / plant		Dry weight of *Orobanche* / plant (g)	
	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21	2019/20	2020/21
Sowing date (S)										
15-Oct	75.22	73.96	52.39	49.22	8.90	7.45	17.25	16.56	2.79	2.28
15-Nov	68.48	66.80	31.04	26.50	6.07	6.37	11.77	9.22	1.39	0.82
F. Test (s)	**	**	**	**	**	**	**	**	**	**
LSD $_{0.05}$	0.09	0.08	1.21	0.52	0.47	0.83	2.55	1.43	0.17	0.15
LSD $_{0.01}$	0.13	0.12	1.70	0.73	0.86	1.17	3.22	2.56	0.22	0.20
Genotypes(G)										
Line1	68.15	66.13	48.42	38.74	7.74	7.77	7.25	8.35	2.04	3.67
Line2	68.30	67.80	45.26	41.01	7.80	6.98	9.88	10.35	2.34	2.87
Line3	67.63	63.80	53.21	44.18	9.37	8.03	4.35	4.98	1.67	2.13
Line4	64.17	64.74	42.48	34.59	7.45	6.91	17.32	15.38	4.11	4.88
Line5	72.41	70.30	48.71	43.51	8.94	8.13	5.28	5.11	1.85	1.46
Line6	72.28	63.24	48.45	43.78	8.04	7.30	6.15	6.21	1.75	2.01
Line7	68.80	63.80	38.58	31.65	6.98	6.68	20.29	19.34	3.03	3.10
Cross 957	76.80	78.53	41.71	47.14	8.18	7.47	7.10	7.88	2.15	2.18
L73	75.80	77.53	42.77	44.66	7.77	6.81	8.34	7.37	2.14	2.49
Cairo4	79.30	81.03	28.43	29.44	6.87	6.21	23.34	21.01	4.33	5.11
Miser 1	61.80	63.53	37.09	34.56	7.27	7.34	18.66	17.38	3.33	3.44
Giza843	72.80	70.75	44.07	40.77	7.55	6.97	14.35	12.34	3.24	3.65
Sakha-2	85.80	83.80	23.11	18.13	3.37	3.25	28.37	26.32	5.80	6.02
F. Test (g)	**	**	**	**	**	**	**	NS	**	**
LSD $_{0.05}$	0.15	0.17	1.10	1.32	0.35	0.49	3.85	2.38	0.16	0.17
LSD $_{0.01}$	0.20	0.23	1.45	1.74	1.10	1.27	4.06	3.44	0.19	0.23
F. Test (S x G)	**	**	**	**	**	NS	**	**	**	**

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

difference in number and length of internodes as well as environmental effects. These results are in general agreement with those reported **by Fayed *et al*., 2002, Mekky *et al*., 2003, Kawochar *et al*., 2011, Abd El-Hafez *et al*., 2012 and El-Metwally *et al*., 2013** where they indicated that height of faba bean plants was reduced with delayed sowing dates beyond October.

Number of branches/plant

Number of branches per plant was higher in the early sowing (3.24 and 3.37) in 1st and 2nd seasons, respectively, while, at the late sowing date, the number of branches per plant was significantly lower (2.40 and 2.61 branch). Similar results were obtained by **Badawy (2011).** Concerning the performance of genotypes, results emphasized that, Cross 957 and Miser 1 had the maximum number of branches per plant (3.26 and 3.47) and (3.29 and 3.33) in the 1st and 2nd seasons, respectively. On the other hand, the lowest number of branches per plant was recorded for Line 1 and Line 5 in both seasons, the other genotypes differed in their values from season to another. These results were in general agreement with those obtained by **Nassib *et al*. (1984), Attia (1998), Rubiales (2004), Abbes *et al*. (2007), Badawy (2011) and Kissi *et al*. (2016).**

Yield and Yield Components

Number of pods/ plant

Number of pods per plant was higher in the early sowing (19.01 and 17.25), while, the late sowing registered lower number of pods per plant (13.50 and 12.92) in 1st and 2nd seasons, respectively. Over both seasons, the highest number of pods per plant was produced by Line3, followed by Miser 1, Giza 843, Line 6 and Line 2. On the other hand, the lowest number of pods per plant was recorded by genotypes Sakha 2 and Cairo4 in the first and second seasons, respectively. The other genotypes differed in their values from season to another. Similar conclusion was reported by **Hussein *et al.* (1994), Soliman *et al.* (1994), Ashrie *et al.* (2010) and Badawy (2011).**

Number of seeds per plant

Number of seeds per plant was greater in the early sowing (69.64 and 66.32), while, the late sowing date produced fewer number of seeds per plant with values of 45.03 and 39.53 seeds in 1st and 2nd seasons, respectively. Concerning genotypes, Line3, Line1 and Line 5 possessed the greatest number of seeds per plant (76.83, 68.84 and 65.65) in the first season, respectively. On the other hand, the genotypes Line 3, Line 6 and Line 2 gave the maximum number of seeds per plant (67.46, 67.39 and 58.54) in the second season, respectively. The lowest number of seeds per plant was obtained by genotypes Sakha 2 and Cairo 4 in the first and the second seasons, respectively. The other faba bean genotypes varied in their performance from season to another.

These results are in general agreement with those obtained by **El-Harty 2005, Abbes *et al*., 2006, Badawy 2011 and Kissi *et al*., 2016.**

Number of seeds per pod

Number of seeds per pod was higher in the early sowing (3.63 and 3.85), while, the late sowing date produced fewer number of seeds per pod with values of 3.31 and 3.03 seeds in 1st and 2nd seasons, respectively. Concerning genotypes, Cairo 4 and Line1 exhibited the highest number of seeds per pod in the first season. Conversely, Line 5, Cross 957 and Line 6 gave the maximum number of seeds per pod in the second season. The lowest number of seeds per pod was obtained by both genotypes Miser1 and Giza 843 in the first and the second seasons respectively. The other genotypes differed in their values from season to another. These results are in general agreement with those attained by **Rubiales (2004), Abbes *et al*. (2007) and Kawochar *et al*. (2011)**.

Weight of 100 seeds (g)

Results presented in Table 2 show the means of 100-seed weight of genotypes as affected by sowing dates in both seasons. The results indicated that in general, plant growth of October sowing date induced highly significant increase in weight of 100 seeds (75.22 and 73.96 g) compared with late sowing date which recorded 68.48 and 66.80 g in the 1^{st} and 2^{nd} seasons, respectively. Differences in 100-seed weight due to genotypes were significant in both seasons. Genotype, Sakha 2 had the heaviest 100-seed weight (85.80 and 83.80g) followed by Cairo 4 (79.30 and 81.03 g) and Cross 957 (76.80 and 78.53g) in 1^{st} and 2^{nd} seasons, respectively. The obtained results are in agreement with those reported by **Attia 1998, Fayed *et al*. 2002, Mekky *et al*. 2003, Rubiales 2004 and Kissi *et al.* 2016.**

Seed weight / plant (g)

The highest seed weight per plant was produced in the first sowing date (52.39 and 49.22g), compared to the second sowing date (31.04 and 26.50g) in 1^{st} and 2^{nd} seasons, respectively. The increase in seed weight/plant may be attributed to the considerable increases in plant height, number of pods and seeds per plant. This fact can be attributed to the photoperiod effect as longer days prevailing in October enhance the vegetative growth. Seed weight per plant varied among the different faba bean genotypes in both seasons. Genotypes, Line 3, Line 5 and Line 6 possessed the highest seed weight per plant (53.21, 48.71 and 48.45g) in the first season respectively. On the other hand, Cross 957, L 73 and Line 3 gave the highest seed yield per plant in the second season. This increase in seed yield/plant for these genotypes may be due to the considerable increases in No. of branches/plant, No. of pods and seeds per plant and 100 seed weight. On the other hand, the lowest means of seed weight per plant was obtained by genotypes Sakha 2, Cairo 4 and Miser1 in the first and the second seasons. The other genotypes differed in seed weight per plant from season to season. These results are in agreement with those reported by **Hussein *et al*. 1994, Darwish *et al.*, 1999, Abd El-Hafez *et al.*, 2012 and El-Metwally *et al.*, 2013**.

Seed yield (ardab/fed.)

The highest seed yield (ardab/fed.) was produced in the first sowing date (8.90 and 7.45 ardab/fed.), compared to the second sowing date (6.07 and 6.37 ardab/fed) in both seasons, respectively. The results displayed that, Line 3 was promising and produced the highest seeds yield (9.37and 8.03 ardab/fed.) when compared with the other genotypes. While, the lowest values were (3.37 and 3.25 ardab/fed.) obtained by Sakha 2 cultivar in 1^{st} and 2^{nd} seasons, respectively. The superiority of Line 3 in seed yield in both seasons may be due to the considerable increase in plant height, number of branches, pods and seeds per plant which directly in turn on seed yield. These results are in agreement with those reported by **Hussein *et al.* (1994), Attia (1998), Darwish *et al.* (1999), Fayed *et al*. (2002), Kawochar *et al.* (2011), Abd El-Hafez *et al.* (2012), Behairy *et al.* (2012) and El-Metwally *et al.* (2013)**.

Orobanche crenata Effect

The aim of this study was to evaluate the behavior of some faba bean genotypes to Egyptian population of crenate broomrape in field and sowing dates experiments. There were considerable differences between faba bean genotypes in their response to *O. crenata.* Differences in infection and seed yield among the seasons can be ascribed to variations in weather conditions, which are known to influence both the extent of *Orobanche* infestation and faba bean growth (**Rubiales, 2004; Abbes *et al.*, 2010)**. Several criteria have been used by authors to quantify resistance to *Orobanche* infestation, such as: number of orobanche per host plant and dry matter of parasitic plants per host plant (**Rubiales, 2010**). According to some authors (**Cubero, 1991; Rubiales, 2004)**, the best index is the number of *Orobanche* shoots per host plant, which gives the most reliable estimation of the total level of infestation.

No. of *Orobanche* /plant

The highest number of *Orobanche*/plant was produced in the first sowing date (17.25 and 16.56/plant), compared to the second sowing date (11.77 and 9.22 /plant), respectively in 1^{st} and 2^{nd} seasons, respectively. The tolerant Line 3 had the lowest number of *Orobanche*/plant (4.35 and 4.98) followed by the parents Line 5 and Line 6 (5.28 and 5.11) and (6.15 and 6.21) in 1^{st} and 2^{nd} seasons respectively, meanwhile, Sakha2 possessed the highest level of infection with number of *Orobanche*/plant (28.37 and 26.32) followed by Cairo 4 and Line 7 (23.34 and 21.01) and (20.29 and 19.34) in 1^{st} and 2^{nd} seasons respectively. These results are in agreement with those reported by **Nassib *et al.* (1984), Fayed *et al*. (2002), Rubiales (2004), Abbes *et al.* (2006), Abbes *et al*. (2007) and Imen *et al.* (2015).**

Dry weight of emerged *Orobanche* spikes per host plant

Significant differences were observed among genotypes for dry weight of emerged *Orobanche* spikes per host plant with sowing dates in both seasons a ranged from (2.79 to 1.39 and 2.28 to 0.82) respectively. The delay in sowing time reduced the accumulation of a dry joint weight of the host and parasite (*Vicia faba and O. crenata*), which was not affected by the parasite infection. Cultivar Sakha 2 was most strongly affected by *O. crenata*, showing the highest incidence and severity (Table 2), the highest *Orobanche* number and dry weight, and the lowest seed yield. On the other hand, Line 3, Line 5 and Line 6 were less susceptible than other genotypes and may carry some genes rendering them resistant to *Orobanche*, indeed, the number and the dry weight of the *Orobanche* spikes on these genotypes were much lower than on the susceptible cv. Sakha 2, Cairo 4 and Line7. These results are in agreement with those reported **(Rubiales, 2004; Abbes *et al.*, 2010; Cubero, 1991; Imen *et al.*, 2015)**.

Effect of Sowing Date on Genotypes

Table 3 reveal the means of all genotypes as affected by sowing date over two seasons of agronomic characters. The results indicated that, October 15^{th} (S_1) sowing date produced taller plants than did in November 15^{th} (S_2). The increases in plant height may be due to the fact that longer days prevailing in October through November are favorable for faba bean vegetative growth. The tallest plants were obtained from Line 6, followed by Line1 and Line 7, while Cairo 4 had the shortest plant height followed by Sakha 2 and Line 4 genotypes in both sowing dates respectively.

Generally, in both sowing dates, the highest number of branches/plant were produced from Cross 957, followed by Misr 1 and the lowest number was produced from Line1 followed by Line 5 which could be attributed in all cases to the genetic makeup of each genotype. These results are in harmony with those obtained by **Attia (1998), Fayed *et al*. (2002), Mekky *et al*. (2003), Rubiales (2004), Abbes *et al*. (2007), Badawy (2011), Kawochar *et al*. (2011) and Kissi *et al*. (2016).**

Effect of sowing dates on No. of pods/ plant showed that, the highest values were recorded for early sowing date(S_1) fluctuated from 7.77 to 23.03 for Sakha 2 and Line 3, while, the lowest ones were recorded for the late sowing date (S_2) by genotypes Sakha 2 followed by Misr 1 ranged from

Table 3. Mean performance of faba bean genotypes as effected by two sowing dates over two years for all studied traits.

Traits	Plant height (cm)		No. of branches/ plant		No. of pods/ plant		No. of seeds /plant		No. of seeds /pod	
Genotypes	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**	**S1**	**S2**
Line1	122.91	101.57	3.01	2.25	19.53	14.03	76.79	48.82	3.86	3.41
Line2	121.73	97.22	3.32	2.56	21.03	14.53	78.79	44.18	3.72	2.99
Line3	118.53	95.30	3.29	2.53	23.03	17.03	87.6	56.69	3.77	3.29
Line4	105.85	86.42	3.31	2.55	17.53	13.03	69.21	47.07	3.88	3.53
Line5	115.03	104.03	3.045	2.29	19.03	13.53	80.22	45.29	4.21	3.31
Line6	123.69	99.80	3.22	2.46	21.03	15.53	81.99	51.01	3.88	3.23
Line7	122.03	107.53	3.10	2.34	16.53	11.53	63.18	39.11	3.75	3.32
Cross 957	121.00	101.30	3.75	2.99	15.65	12.62	68.35	42.60	3.31	2.95
L73	121.50	101.80	3.28	2.35	20.15	13.48	68.70	42.1	3.37	3.15
Cairo4	104.80	88.60	3.38	2.45	13.15	7.78	45.57	24.23	3.42	3.38
Misr 1	116.20	96.50	3.78	2.85	19.40	17.65	67.24	43.65	3.44	2.46
Giza843	116.10	96.40	3.13	2.35	21.88	15.72	66.97	47.87	3.27	2.96
Sakha-2	105.03	86.03	3.43	2.67	7.77	5.27	29.14	17.02	3.72	3.23
Grand mean	116.49	97.11	3.31	2.51	18.13	13.21	67.98	42.28	3.74	3.17

Table 3. Cont.

Traits	100-seed weight (g)		Seed yield /plant(g)		Seed yield/ feedan (ardab)		No. of *Orobanche*/plant		Dry weight of *Orobanche*/plant	
Genotypes	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Line1	71.48	62.8	55.78	31.38	8.88	6.63	13.84	10.27	2.86	1.63
Line2	71.3	64.8	56.96	29.33	8.09	6.69	15.1	13.24	2.61	1.38
Line3	68.63	62.8	61.04	36.37	10.37	7.03	6.93	4.22	1.90	0.88
Line4	67.46	61.45	47.54	29.54	8.1	6.26	18.24	13.28	4.50	2.07
Line5	74.36	68.35	60.49	31.74	9.63	7.44	7.25	5.12	1.66	0.64
Line6	69.91	65.61	57.97	34.27	9.03	6.31	8.11	6.55	1.88	0.92
Line7	69.80	62.80	44.98	25.27	7.76	5.90	28.24	15.37	3.07	1.44
Cross 957	81.67	73.67	56.78	32.08	8.85	6.80	10.21	8.32	2.17	0.94
L73	80.67	72.67	56.29	31.15	8.29	6.29	12.24	9.13	2.32	1.09
Cairo4	82.67	77.67	38.48	19.4	7.31	5.76	24.36	17.27	4.72	2.72
Misr 1	66.67	58.67	45.56	26.10	8.32	6.29	21.28	14.89	3.39	1.39
Giza843	76.30	67.25	51.93	32.92	8.16	6.36	18.26	12.82	3.45	1.27
Sakha-2	88.80	80.80	26.75	14.51	3.52	3.09	33.57	21.34	5.91	3.91
Grand mean	74.59	67.64	50.81	28.77	8.18	6.22	16.74	11.68	3.11	1.56

5.27 to 17.65 respectively. This decrease in the number of pods/plant may be due to the competitiveness of faba bean plant and *Orobanche crenata* and the struggle for available nutrients and others in the surrounding media, which leads to a decrease in the growth of flower growth during the flower, initialization period that reduces the number of pods/plant. These results are in agreement with those reported by **Nassib *et al.*, 1984, Abbes *et al*., 2007, Badawy 2011, Kawochar *et al*., 2011 and Kissi *et al.*, 2016.**

With respect to the effect of sowing dates on No. of seeds/ plant, the highest values were recorded in the early sowing date (S_1) ranged from 29.14 to 87.60 for Sakha2 and Line3, whereas, the lowest ones were verified for the late sowing date (S_2) ranged from 17.02 to 56.69 for Sakha2 and Line3 respectively. In case of sowing faba bean crop on 15^{th} October, growth period was longer and consequently more accumulate of assimilates. Similar results were obtained by **Darwish *et al.* (1999), Rubiales (2004), Badawy (2011) and Kawochar *et al.* (2011)**.

Concerning, number of seeds per pod the genotypes differed from each other under early and late sowing dates, the highest values were obtained from Line5, followed by Line 4, Line 6 and Line1 however; the lowest values were commonly obtained from Giza 843 followed by Misr 1 and Cross 957. The heaviest 100–seed weight was obtained in the early sowing date, while, the late sowing date produced the lowest 100-seed weight for all genotypes. This might be due to the high efficiency of plant to convert solar energy to chemical energy which increased seed weight with sowing on 15^{th} October than the other tested sowing date. Significant differences in 100–seed weight among faba bean genotypes under different environmental conditions were previously reported by **Fayed *et al.* (2002), Mekky *et al*. (2003), Badawy (2011) and Kissi *et al*. (2016).**

Concerning seed weight per plant, the highest values were recorded for the faba bean genotypes grown at the early sowing date ranged from 26.75 for Sakha 2 to 61.04 for Line3, with grand mean 50.81, while, the late sowing date produced lower seed weight/plant varied from14.50 for Sakha 2 to 36.36 for Line 3 with grand mean 28.77 overall all genotypes. These results are in agreement with those reported by **Darwish *et al.* (1999), Abd El-Hafez *et al.* (2012) and El-Metwally *et al.* (2013)**.

Significant variances were detected among genotypes for seed yield ardab/fed., with sowing dates. The highest values were produced from Line 3, followed by Line 5, and Line 6 in the first and second sowing dates, while, the lowest values were produced from Sakha 2, followed by Cairo 4 and Line 7. The superiority in seed yield in faba bean genotypes Line 3, Line 5, and Line 6 may be due to their strong growth and taller plants that develop more pods, number of seeds, and weight of the heaviest 100-seed. Also, they tolerate weed infection *Orobanche*, on the other hand, it was observed that the number of *Orobanche* dates decreased during the harvest. Significant differences in seed weight/plant among soybean genotypes under different environments were reported by **Hussein *et al*. (1994), Fayed *et al.* (2002), Badawy (2011), Kawochar *et al.* (2011), Behairy *et al.* (2012) and El-Metwally *et al.* (2013)**.

Significant differences were observed among genotypes for number of *Orobanche*/ plant dry weight of emerged *Orobanche* spikes per host plant with sowing dates. The tolerant Line 3 had the lowest number of *Orobanche*/plant dry weight of emerged *Orobanche* spikes per host plant followed by Line 5 and Line 6, meanwhile, Sakha 2 possessed the highest level of infection with number of *Orobanche* and dry weight of emerged *Orobanche* spikes/plant followed by Cairo 4 and Line 7 in the two sowing date. The delay in sowing time reduced the accumulation of a dry joint weight of the host and parasite (*Vicia faba and O. crenata*), which was not affected by the parasite infection. The decrease in the number of pods and seeds and the weight of the seed crop is due to the influence of climatic conditions, the history of planting and the infection of parasites. Parasitism mainly reduces host productivity by reducing the number of pods. The seed size decreased to a lesser extent, while the number of seeds per pod was not affected by the parasite attack. These results are in agreement with some exceptions with those reported by **Nassib *et al.* (1984), Abbes *et al*. (2006), Abbes *et al.* (2007) and Imen *et al.* (2015)**.

Phenotypic, Genotypic Coefficient of Variations and Heritability

Estimates of phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV) and broad sense heritability (h^2b.s), were calculated in each sowing date. Regimes for each of nine traits only which between them homogeneity of error over the two seasons according to "Barttlet test" and presented in Table 4.

The PCV values was closer than their relating genotypic one (GCV) for number of branches/plant, number of seeds /plant, 100-seed weight, seed weight/plant and seed yield ardab/fed. under both seasons, showing a few impact of environment on the advertising of these traits. Whereas, PCV values were divergence than their corresponding GCV for plant height(cm), number of pods / plant, number of seeds / pod, number of Orobanche / plant and dry weight of Orobanche / plant with a few exceptions under both seasons, revealing great influence of environment on these characters.

The variation exhibited by the 13 faba bean genotypes in agronomic characters indicated that selection for several of these characters might be effective. Selection efficiency, however, is related to the magnitude of heritability. These results are in agreement with those reported by **Attia (1998), Darwish *et al.* (1999), Soliman *et al.* (1994), El-Harty (2005), El-Sayed *et al*. (2012) and Sharifi (2015).**

Table 4. Genotypic (GCV) and phenotypic (PCV) coefficient of variation and heritability (h^2b.s) for agronomic characters (a 2- year average)

Trait	G C V		PCV		h^2b.s	
	S1	S2	S1	S2	S1	S2
Plant height(cm)	48.37	77.00	50.04	80.11	96.67	96.12
No. of branches/plant	3.19	1.70	3.64	2.61	87.46	64.95
No. of pods/ plant	106.49	119.74	108.77	122.15	97.9	98.02
No. of seeds /plant	424.66	268.12	425.30	268.35	99.85	99.91
No. of seeds /pod	2.90	3.94	3.45	4.95	84.23	79.51
100-seed weight (g)	57.88	60.81	58.27	60.93	99.34	99.81
Seed weight /plant(g)	218.72	140.08	219.13	140.20	99.81	99.91
Seed yield / (ardab/fed.)	38.18	17.04	38.79	18.30	98.42	93.13
No. of *Orobanche* /plant	2117.90	693.47	2120.60	698.60	99.87	99.27
Dry weight of *Orobanche* / plant	51.61	50.64	55.50	53.35	96.46	94.94

The heritability estimates ranged from 84.23% for number of seeds/pod to 99.87% for number of *Orbanche*/plant under the first sowing date and ranged from 64.95 for number of branches/plant to 99.91 for number of seeds/plant under the second sowing date. Estimates of heritability for number of branches/plant and number of seeds/pod were higher under first than second sowing date. These findings suggest that genetic effects constitute a major portion of the total phenotypic variation for these characters under the first sowing date. These results are in agreement with those reported by **Darwish *et al*. (1999), Soliman *et al*. (1994), Abbes *et al.* (2007) and El-Sayed *et al.* (2012).**

Conclusions

In conclusion, the five tested genotypes (Line3, Line4, Line5, Line6 and Cross957, selected for their partial resistance to *Orobanche crenata*, showed a high level of resistance under field conditions. These genotypes can be promoted as new varieties or used in breeding programs to develop new resistant lines. Also, the delay in sowing date reduced the influence of the parasite *(O. crenata)* on the yield and its components, which was not affected by the parasite's infection.

REFERENCES

Abang, M.M.; Bayaa, B.; Abu-Irmaileh, B. and Yahyaoui, A. (2007). A participatory farming system approach for sustainable broomrape (*Orobanche* spp.) management in the near East and North Africa. Crop Prot., 26: 1723–1732.

Abbes, Z.; Kharrat, M. and Chaïbi, W. (2006). Study of the interaction between Orobanche foetida and faba bean at root level. Tunisian J. Plant Protec., 1: 55-64.

Abbes, Z.; Kharrat, M.; Delavault, P.; Simier, P. and Chaıbi, W. (2007). Field evaluation of the resistance of some faba bean (*Vicia faba* L.) genotypes to the parasitic weed *Orobanche foetida* Poiret. Crop Prot., 26: 1777–1784.

Abbes, Z.; Sellami, F.; Amri, M. and Kharrat, M. (2010). Effect of sowing date on *Orobanche foetida* infection and seed yield of resistant and susceptible faba bean cultivars. Acta Phytopathologica et Entomologica Hungarica, 45: 267-275.

Abd El-Hafez, G.A.; Tohamy, T.H.; Gabra, A.M. and Ibrahim, M.A.M. (2012). Influence of sowing dates, plant densities on aphid, (*Aphis craccivora* KOCH) infestation rate, yield and yield characteristics of two faba bean cultivars in Minia region. J. Plant Prod., Mansoura Univ., 3(12): 2945- 2956.

Allard, R.W. (1960). Principle of Plant Breeding. John Wiley and Song Inc. New York, 485.

Ashrie A.M.A.; Mohamed, E.A.I.; Helal, A.A.; Abdel-Tawab, Y.M. and El-Harty, E.H. (2010). Performance of six Faba bean genotypes under free and *Orobanche* soils. Egypt. J. Plant Breed., 14 (2): 189 – 205.

Attia, S.M. (1998). Performance of some faba bean genotypes and hybrids and reaction to O*robanche*. Ph.D. Thesis, Fac. Agric., Cairo Univ., Egypt.

Badawy, R.A.W. (2011). Effect of planting date and plant density on growth and yield of some faba bean varieties. M.Sc. Thesis, Published by Cairo Univ., Fac. Agric., Egypt.

Behairy, R.T.; Ashrie, A.A.M. and El-Danasoury, M. (2012). Effect of *Orobanche* parasitism on the behavior of four faba bean cultivars (*Vicia faba* L.) Minia J. Agric. Res. and Develop., 32 (5): 833-849.

Burton, G.W. (1952). Quantitative inheritance in grasses. Proc. V1 In. Grassland Cong., 1: 222-283.

Cubero, J.I. (1991). Breeding for resistance to *Orobanche* species: a review. In: Progress in Orobanche Research, (Eds.): K. Wegmann and L.J. Musselman, 257-277.

Darwish, O.S.; Abdalla, M.M.F.; EL-Metwally, E.A.; El-Sherbiny, M.H. and Attia, S.M. (1999). Performance of some faba bean genotypes and their hybrids under *Orobanche* infestation. Egypt. J. Plant Breed, 3: 231-246.

Duc, G.; Bao, S.; Baum, M.; Redden, B.; Sadiki, M.; Suso, M.J.; Vishniakova, M. and Zong, X. (2010). Diversity maintenance and use of *Vicia faba* L. genetic resources. Field Crops Res., 115: 270 -278.

El-Harty E.H. (2005). Evaluation of some faba bean, *Vicia faba* L. Lines for Orobanche resistance, Ph.D. Thesis in Agronomy, Fac. Agric., Moshtohor, Zagazig Univ., Egypt.

El-Metwally, I.M; El-Shahawy, T.A. and Ahmed, M.A. (2013). Effect of sowing dates and some broomrape control treatments on faba bean growth and yield. J. Appl. Sci. Res., 9(1): 197-204.

El-Sayed, Azza F.; Soliman, S.S.A.; Ismail. T.A. and Attia, Sabah M. (2012). Genetic nature and heritability of *Orobanche crenata* resistance in Faba bean (*Vicia faba* L.) Zagazig J. Agric. Res., 39 (4).

Fayed, M.A.B.; Hamdi, A.; Mahmoud, S.A. and Shaaban, M. (2002). Performance of *Orobanche* control treatment in faba bean crop. Egypt J. Agric. Res., 80 (2): 753-769.

Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. 2nd Ed., John Wiley and Song, Inc.

Hussein, A.H.A.; Dossoky, R.F.; ElDeeb, M.A. and El-Morsy, M. (1994). Effect of sowing dates and plant densities on yield and yield component of new faba bean cultivars (Giza Blank) in newly reclaimed land. J. Agric. Sci. Mansoura Univ., 19(2): 447-45

Imen, T.; Zouhaier, A.; Moez, A. and Kharrat, M. (2015). Performance of faba bean genotypes with *Orobanche foetida Poir*. And *Orobanche crenata Forsk*. infestation in Tunisia. Chilean J. Agric. Res., 75 : 1.

Kawochar, M.A.; Ullah, M.J.; Salam, M.A.; Alam, K.H. and Islam, M.R. (2011). Effect of sowing time and fertilizer on growth attributes, dry matter partitioning and grain yield of faba bean. J. Expt. Biosci., 2(2): 17-24.

Kharrat, M.; Abbes, Z. and Amri, M. (2010). A new faba bean small seeded variety najeh tolerant to *Orobanche* registered in the Tunisian catalogue. Tunisian J. Plant Prot., 5: 125–130.

Kissi W.; Reta, D. and Tamiru, M. (2016). Effect of sowing date and seed rate on faba bean (*Vicia faba* L.,) growth, yield and components of yield at Sinana, Highland Conditions of Bale, Southeastern Ethiopia. Int. J. Sci. Res. gric. Sci., 3(1): 025-034.

Mekky, M.S.; Yehia, Z.R. and Nassar, A.N.M. (2003). Effect of sowing date, varieties and glyphosate application on broomrape and yield of faba bean. Bull. Fac. Agric. Cairo, Univ., 54: 55-76.

Nassib, A.; Hussein, A.H.A. and El-Rayes, F.M. (1984). Effect of variety, chemical control, sowing date and tillage on *Orobanche* spp., infestation and faba bean yield. Fabis Newsletter, 10: 11-15.

Pérez-de Luque, A.; Eizenberg, H.G.; Grenz, J.H.; Sillero, J.C.; Ávila, C.; Sauerborn, J.; Rubiales, D.; A.P De Luque; J.I. Cubero and J.C. Sillero (2003). Crenate broomrape (*Orobanche* *crenata*) infection in field pea cultivars. Crop Prot., 22: 865-872.

Rubiales (2004). Effect of sowing date and host resistance on the establishment of *Orobanche crenata* in faba bean and common vetch. Weed Res., 44: 282-288.

Rubiales, D. (2010). Broomrape management in faba bean, Field Crops Res., 115: 319-328.

Sahile, S.; Ahmed, S.; Fininsa, C.; Abang, M.M. and Sakhuja, P.K. (2008). Survey of chocolate spot (*Botryty fabae*) disease of faba bean (*Vicia faba* L.) and assessment of factors influencing disease epidemics in northern Ethiopia. Crop Prot., 27: 1457-1463.

Sharifi, P. (2015). Genetic variation for seed yield and some of agro morphological traits in faba bean (*Vicia faba* L.) genotypes. Acta. Agric. Slovenica., 105(1):73-83.

Soliman, M.M.; Abdallah, N.G.; Bakheit, M.A.; Raslan, M.A. and Zielinska, A.; Rutkowski, M. and Majchrzak, B. (1994). Effect of row spacing and sowing density on the yield of faba bean. C.F. Field Crop Abst., 47(11): 7218.

الملخص العربي

تأثير مواعيد الزراعة على الاصابة بالهالوك والمحصول ومكوناته لبعض التراكيب الوراثية للفول البلدي

إسماعيل أبوبكر الصديق إسماعيل محمد، ثروت محب أبوسن، طارق صابر السيد

قسم بحوث المحاصيل البقولية، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية، مصر.

أجريت تجربتان حقليتان خلال موسمي 2019-2020، 2020-2021 م بمحطة البحوث الزراعية بسخا – مركز البحوث الزراعية – جمهورية مصر العربية. وكان الهدف من هذه الدراسةِ هو تقييم ومقارنة القدرة المحصولية لثلاثة عشرَ تركيبا وراثيا من الفول البلدي في ميعادي زراعة هما (15 أكتوبر - 15 نوفمبر) في أرض موبوءة بشكل طبيعي بحشيشة الهالوك وذلك بغرض تحديد أفضل التراكيب الوراثية محصولا وتحملا للإصابة بعدوى الهالوك لاستعمالها في الإنتاج الزراعي. أظهرت النتائج زيادة ارتفاع النبات في ميعاد الزراعة الأول 15 أكتوبر بالمقارنة بالميعاد الثاني في 15 نوفمبر في كل من الموسمين. أعطى ميعاد الزراعة الأول قيما أعلى في وزن البذور للنبات (52.39 و49.22 جم) مقارنة بالميعاد الثاني (31.04 و26.50 جم) في كل من الموسمين. قد يرجع الانخفاض في عدد القرون/النبات إلى القدرة التنافسية بين نباتات الفول (العائل) وحشيشة الهالوك (الطفيل) على العناصر الغذائية. كما أوضحت النتائج أن السلالة 3 أنتجت أعلى محصول للبذور (9.37 و8.03 اردب/فدان) عند مقارنته بالتراكيب الوراثية الأخرى في كل من الموسمين. كان معامل الاختلاف المظهري PCV بشكل عام أعلى من معامل الاختلاف الوراثي GCV لجميع الصفات. كانت تقديرات درجة التوريث بالمعنى الواسع (h^2bs) اعلى لصفات عدد الفروع لكل نبات وعدد البذور لكل قرن في ميعاد الزراعة الأول وتشير هذه النتائج إلى أن التأثيرات الوراثية تمثل جزءًا كبيرًا من التباين الظاهري الكلي لهذه الصفات في ميعاد الزراعة الأول.

الكلمات الاسترشادية: الفول، محصول البذور، الهالوك، مواعيد الزراعة.

REVIEWERS:
Dr. Munir Abdalla Abdelaziz | munirabdalah0@gmail.com
Dept. Agron., Fac. Agric., Al-Azhar Univ., Egypt.
Dr. Hassan Oda Awaad | hassanawaad@yahoo.com
Dept. Agron., Fac. Agric., Zagazig Univ., Egypt.