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### Effect of some Broomrape Control Treatments and Plant Densities on Productivity of Two Faba Bean Varieties (*Vicia faba* L.)

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#### ABSTRACT

Experimental field was carried out in naturally infested field with broomrape at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt, during two growing seasons 2015/2016 and 2016/2017 in order to study the effect of broomrape control treatments and planting density on faba bean productivity. In this study, we used two faba bean varieties (Misr 3 and Sakha 4), two plant densities (one side and two sides) and some broomrape control treatments (rhizobium at 20 g kg<sup>-1</sup> seeds, glyphosate twice at 36 g fed<sup>-1</sup>, rhizobium + glyphosate, hand pulling twice and untreated check). A split split plot design with four replicates was used. The results showed that the highest reduction in number of broomrape spikes plant<sup>-1</sup>, number of broomrape m<sup>-2</sup> and dry weight of broomrape was recorded for Misr 3 variety with planting on one side and spraying glyphosate twice by (96.6, 97.9 and 98.0 %) in the first season, and by (96.2, 97.2 and 97.5 %) in the second season, respectively as compared to untreated Sakha 4 variety and planting on two sides. The highest yield of seeds (ardab fed<sup>-1</sup>) was obtained from Misr 3 variety with planting on two sides and spraying glyphosate twice + rhizobium treatment which surpassed by (84.8 and 88.5 %) in both sowing seasons, respectively as compared to untreated Sakha 4 variety and planting on one side. Thus, from the aforementioned results, could be recommended that the best control package for growing faba bean in soil infested with broomrape by planting Misr 3 variety with two sprays of glyphosate + rhizobium with planting on one side in kafr El-Sheikh area.

**Keywords:** Broomrape, planting densities, faba bean, glyphosate.



#### INTRODUCTION

Faba bean (*Vicia faba* L.) is main winter leguminous crop and highly demanded crop as main popular diets for the majority of Egyptian population.

Broomrape (*Orobanche crenata*, Forsk.) infection is a major constraint to legume cultivation in the Mediterranean region, affecting 1.12 million ha of the faba bean area (Manschadi et al. 1997). Total cultivated area was estimated by 120.000 fed. (E. A. Sector; 2017) during 2015/16 and 2016/17 growing seasons with average yield production of 9.2 ardab /fed. In 2015 season (one ardab =155 kg) which covers about 40% (E. A. Sector; 2017) our essential need human consumption. The productivity of the crop decreased dramatically due to broomrape infestation.

The reduction of faba bean yield due to broomrape infestation varied from 0.0 to 50% depending on broomrape infestation levels (Mesa-Garcia and Garcia-Torres, 1984). Hassanein et al. (1998) reported that one *Orobanche* spike/plant able to decrease seed yield of faba bean by 15% and 55% by four spikes faba<sup>-1</sup> bean plant. Ismail and Fakkar (2008) showed that the existence of one and four *Orobanche* spike faba<sup>-1</sup> bean plant decreased seed yield by 19.9 and 46.6% in the first season and by 14.3 and 50.0%, in the second season, respectively.

For faba bean varieties recommended cultivars vary in their ability for response to infestation of broomrape. In Egypt, Nassib (1982) illustrated that percentage and number of *Orobanche* infested faba bean plants as well as

the total dry weight were lower in Giza 402 than those of other varieties as Rebaya 40, Giza 2 and Giza 4 which were showing resistant to broomrape infestation. Khalil (1983) found that Giza 402 plants were tolerant to infestation of *Orobanche* and get more than one metric ton of seed/ha. Gadalla et al. (2010) reported that Giza3 was susceptible cultivar and on the other hand, Giza 843 was tolerant to infection, which had the lowest *Orobanche* tubercles plant<sup>-1</sup>. Amer et al. (2012) illustrated that the differences among the varieties were affect significantly on growth, plant height, number branches plant<sup>-1</sup>, pod length and number of seed pod<sup>-1</sup>. Ismail (2013) revealed that faba bean variety Misr1 decreased number and dry weight of *Orobanche* spikes by 17.3 and 17.0%, respectively, comparing with variety Giza 40. Ghalwach et al. (2008) indicated that faba bean Misr1 variety decreased number of broomrape spikes/m<sup>2</sup> by 42.89 and 27.38%; weight of broomrape spikes/ m<sup>2</sup> by 20.43 and 20.17%; spikes length by 19.94 and 19.68% and number of capsules/spikes by 28.5 and 42.65%, respectively during both growing seasons. Also, faba bean

Variety, Misr 1 recorded the highest values of yield and its components followed by Giza 843 variety comparing with Sakha 2 variety. Eid et al. (2017) revealed that both faba bean varieties Misr 3 and Giza 843 exhibited significant decrease in numbers and weight of broomrape spikes m<sup>-2</sup> (87.0 %, 91.0% and 53.3%0, respectively comparing with the susceptible variety Giza 3. Also, faba

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bean varieties Misr 3 and Giza 843 significantly increased faba bean yield and its components as compared to variety Giza 3.

Density influences plant establishment, growth, seed yield and the profitability of crop. Caballero (1987) found that increasing plant population from 10-50 plant m<sup>2</sup> increased seed from 4.59 to 5.23 tons ha<sup>-1</sup>. Ismail and Fakkar (2008) showed that the increase of plant density from 13 to 27 plants m<sup>-2</sup> due to decrease number and dry weight of *Orobanche* spikes m<sup>-2</sup> 3.2 and 10.8%, respectively, and increased seed yield of faba bean by 60.7 %. Eid et al (2017) revealed that seed rate of 30 kg/fed significantly decreased the number and weight of broomrape spikes/ m<sup>2</sup> by 16.8 % as compared to seed rate of 60 kg /fed. Also, seed rate of 30 kg/fed significantly increased faba bean yield components except plant height and seed yield (ardab fed<sup>-1</sup>) which significantly decreased with seed rate of 30 kg fed<sup>-1</sup> as compared to seed rate of 60 kg/fed.

Many researches stated that glyphosate application twice at rate of 178.1 cc ha<sup>-1</sup> gave broomrape control by 96% and increasing faba bean seed yield fed<sup>-1</sup>. 100 % than untreated infested check (Hassanein and Kholosy 1997), Al-Marsafy et al. (2001), El-Metwally et al., (2013) and Ismail (2013). The foliar application of glyphosate at rate of 36 g a.i. fed<sup>-1</sup> twice or three times with hand pulling once produced the highest number of pods and seeds yield plant<sup>-1</sup>; 100-seed weight, straw and seed yield fed<sup>-1</sup> Ghalwash et al. (2008) and (kenapar, 2009) revealed that broomrape control treatments (imazapic 1 % EC, at rate 20 g a.i. fed<sup>-1</sup> and glyphosate 48% WSC, at rate 36 g a.i. fed<sup>-1</sup>) significantly decreased broomrape infestation parameters and increased crop yield and its components, in both sowing seasons. Eid et al. (2017) showed that Round up applied twice significantly decreased the number and dry weight of broomrape spikes m<sup>-2</sup> by 75.2%. Also, significantly increased of faba bean yield and its components in both two seasons. The increase in seed yield (ardab fed-1) was 89.1% as compared with untreated check.

Hand pulling of broomrape shoots is one of the most techniques practiced by farmers to control *Orobanche*, this method is inefficient, particularly in highly infested faba bean fields. Indeed, continuous hand pulling of broomrape had slightly increased faba bean yield but not significantly, compared to the control in infested fields that were sown with a susceptible variety at Beja and Shakha 3. (Kharrat and Halila 1996) and (kenapar, 2009).

**Table 2. Particale size distribution and some chemical properties of the experimental soil and number of *Orobanche* seeds/kg soil in 2015/2016 and 2016/2017 seasons.**

Seasons	Particale size distribution			Soil texture	EC (dsm <sup>-1</sup> ) (1:5)	Chemical analyses					No. broomrape seeds kg <sup>-1</sup>
	Sand %	Silt %	Clay %			pH (1:1)	Organic matter %	Available (mg kg <sup>-1</sup> )			
						Total N (%)	P (ppm)	K (ppm)			
2015/16	19.7	32.5	47.8	Clay	2.22	7.85	1.62	37	8.64	239	38
2016/17	18.4	25.6	56.0	Clay	2.27	8.05	1.35	34	6.43	246	86

The treatments were arranged in both seasons in split split plot design in four replications; the main plots were randomly devoted two varieties, the sub plots were randomly devoted two Plant densities and sub sub plot were randomly devoted five broomrape control treatments.

Rhizobia inoculation combined with glyphosate application significantly increased dry weight of nodules, nitrogen activity of root nodules, dry weight of shoots and total plant N-content. Glyphosate application significantly decreased dry weight and number of *Orobanche* spikes/m<sup>2</sup> Hussein et al. (1993). Nitrogen fertilization of faba bean (*Vicia faba* L.) has long been practiced in various Parts of the Sudan. In the Middle East where faba bean is widely grown, the crop is usually fertilized and sometimes it is inoculated for nitrogen fixation. Inoculation of faba bean with *Rhizobium leguminosarum* can improve plant growth, nodulation, nitrogen Fixation and yield, Mahdi (1993).

For the above previous reasons, the aim of this investigation was to determine the best packages of planting densities and broomrape control treatments on the performance of the two faba bean varieties under Kafr El-Sheikh governorate conditions.

## MATERIALS AND METHODS

The present investigation was carried out at Sakha Agricultural Research Station, Agricultural Research Center, Egypt, during two successive growing seasons 2015/2016 and 2016/2017, to study the effective of varieties, planting densities and broomrape control treatments on faba bean productivity under naturally infested soils with (*Orobanche crenata*) during 5 and 8 November in both two seasons, respectively. The origin and pedigree of these varieties are presented in Table (1).

**Table 1. The pedigree and *Orobanche* reaction of the varieties used in the study.**

Varieties	Pedigree	<i>Orobanche</i> reaction
Misr 3	Misr1 X (Cairo 241 X Giza461)	Tolerant
Sakha 4	Sakha 1 X Giza 3	Susceptible

Data of particale size distribution and some chemical soil analyses, according to Jackson (1973). The types of soils and seed bank of *Orobanche* in both sowing seasons were presented in (Table 2). Before sowing a random sample of soils (1.0 kg soil) at three depths (0 – 5cm, 5 – 15cm and 15 – 25cm) was taken from each plot to count seeds of *Orobanche* in both seasons. Seed extraction was done by sieving of the samples through copper sieves with 5 mm in diameter. This process was followed by their rinsing by water and sieving of the samples through sieves of 0.5 mm in diameter. Seeds were then dried at the room temperature and separated manually. Estimation of the separated *Orobanche* seeds was performed visually by microscope (Dvorak and Krejcir 1974).

### A. Main plots: (Faba bean varieties):

- 1- Misr 3, varieties of Egyptian faba bean is tolerant *Orobanche* reaction.
- 2- Sakha 4, varieties of Egyptian faba bean is Susceptible *Orobanche* reaction.

**B. Sup plots: (Plant densities):**

- 1- One side, the seed of faba bean were sown in one side of the ridge in two seeds /hill distanced 25 cm at sole system(13.33 plant m<sup>-2</sup>).
- 2- Two sides, the seed of faba bean were sown in two sides of the ridge in two seeds /hill distanced 25 cm at duple system (26.66 plant m<sup>-2</sup>).

**C. Sub sub plots: (broomrape control treatments):**

1. *Rhizobium leguminosarum* inoculation. Mixing with seeds of faba bean at rate of 20 g kg<sup>-1</sup> seeds from the commercial equipment with 20% honey solution.
2. Glyphosate (Round up 48% WSC) at 36 g a.i. fed<sup>-1</sup> (twice) with three weeks interval, the first one applied at the beginning of faba bean flowering.
- 3- *Rhizobium leguminosarum* inoculation + glyphosate (Round up 48% WSC) at 36 g a.i. fed<sup>-1</sup> (twice)
- 4- Hand pulling twice with three weeks interval, the first one was carried out after starting broomrape emergence.
- 5- Untreated weedy check.

The experimental plot consisted of five ridges 60 cm apart and 4 m long (3 x 4 m = 12 m<sup>2</sup>). All the recommended agricultural practices for production of faba bean were applied on proper time. Fertilizer was used at the rate of 15.0 kg P<sub>2</sub>O<sub>5</sub>/fad during land preparation. Hoeing was applied before the first and second irrigation.

**Data recorded:**

**• On broomrape:**

- 1- Broomrape spike length (cm).
- 2-Number of broomrape spikes plant<sup>-1</sup>,
- 3-Number of broomrape spikes m<sup>-2</sup>,
- 4- Dry weight broomrape spikes gm<sup>-2</sup>.

**• On nodulation:**

The samples of Faba bean roots were collected and washed from soil particles on 1 mm sieve holes. Number of nodules/plant at 45 and 66 days after planting were recorded.

**• On Yield and its components:**

At harvest, the following traits were measured in a sample of 10 random guarded plants from each sub plot:

- 1- Plant height (cm).
- 2- Number of branches plant<sup>-1</sup>.

3- Number of pods plant<sup>-1</sup>.

4- 100 seed weight (g).

5- Straw yield (ton fed<sup>-1</sup>) and seed yield (ardab fed<sup>-1</sup>), were estimated from whole plot.

**• Statistical analysis:**

All the collected data were statistically analyzed, according to the technique of analysis of variance (ANOVA) for the design, as published Gomez and Gomez (1984). Least significant difference (LSD) at the (5 %) level was used to test the differences between treatment means at (5 %) of probability as described by Snedecor and Cochran (1981).

**RESULTS AND DISCUSSION**

**Effect of faba bean varieties:**

**On broomrape:**

Data in Table (3) showed the differences between the two faba bean varieties in *Orobanche* infection which reached the level of significant at 5% level. Variety Misr 3 recorded the highest reduction percentages on spikes length, number and dry weight of broomrape spikes plant<sup>-1</sup> or per m<sup>2</sup> in both sowing seasons by 6.1, 63.4, 70.3 and 68.1 %, in the first season and by 14.6, 57.3, 66.5 and 66.3 %, in the second season, respectively comparing with the susceptible variety Sakha 4. This decrease may be due to the delay of broomrape attachment to faba bean plants and its delay emergence above soil surface and consequently partially escaped from the injury of broomrape.

**On nodulation:**

Data record in Table (4) illustrated that faba bean Misr 3 variety significantly exceeded in number of nodules plant<sup>-1</sup>. Faba bean Sakha 4 variety recorded highest values of number of nodules plant<sup>-1</sup> at 45 days after planting by 66.1 and 70.3, in the two seasons, and; by 54.3 and 57.3 at 66 days after planting in the two seasons, respectively, as compared to the smallest number of nodules plant<sup>-1</sup> by the planting on one side at 45 and 66 days after sowing, with values 54.8 and 47.2, in the first season and; 59.3 and 50.1, in second season, respectively. These results are similar to those reported by Hussein *et al.* (1993), Ghalwash (2008) and Ismail (2013).

**Table 3. Effect of varieties on broomrape characters in 2015/2016 and 2016/2017 seasons.**

Varieties	broomrape spikes length (cm)		No. of broomrape spikes plant <sup>-1</sup>		No. of broomrape spikes m <sup>-2</sup>		Broomrape dry weight (g) m <sup>-2</sup>	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
Misr 3	30.9	31.1	3.0	3.8	11.0	14.3	66.4	91.7
Sakha 4	32.9	36.4	8.2	8.9	37.0	42.7	208.3	272.3
L.S.D 0.05	0.91	2.82	1.64	1.31	5.71	2.30	32.13	9.61

**Table 4. Effect of varieties on number of nodules/plant at 45 and 66 days after planting in 2015/2016 and 2016/2017 seasons.**

varieties	No. nodules plant <sup>-1</sup> 45 DAS		No. nodules plant <sup>-1</sup> 66 DAS	
	2015/16	2016/17	2015/16	2016/17
Misr 3	54.8	59.3	47.2	50.1
Sakha 4	66.1	70.3	54.3	57.3
L.S.D 0.05	1.11	2.81	1.57	1.85

**On yield and its components:**

Data presented in Table (5) showed that two varieties differed significantly in faba bean growth

characters in two planting seasons. Faba bean Misr 3 variety recorded highest values of plant height and number of branches plant<sup>-1</sup> by 126.4 cm and 3.4 respectively in the first season, and by 123.8 cm and 3.1 in the second season, respectively. The highest number of pods plant<sup>-1</sup> of faba bean belonged to the variety Misr 3 which recorded increase in number of pods plant<sup>-1</sup> by 45.5 and 47.1 %, in first and second seasons, respectively as compared to variety Sakha 4. For 100-seed weigh (g) varieties of faba bean exhibited different values and ranged to the variety Misr 3 which gives decrease in weight of 100-seed by 6.8 % and 6.4 %, in both two sowing seasons, respectively

comparing to variety Sakha 4. Related to weight of straw yield, Misr 3 gave increases by 41.7 and 42.9 % in 2015/2016 and 2016/2017 seasons, respectively compared to variety Sakha 4. Variety Misr 3 gave the highest seed yield (tolerant variety) which gave increases in seed yield (ardab fed<sup>-1</sup>) by 57.3 % in first season, and by 59.9 % in second season comparing to susceptible variety Sakha 4. In this text, the results were similar with those obtained by Gadalla et al. (2010) and Ismail (2013). From the previous

results depending on *Orobanche* severity scale, Misr 3 was considered as tolerant cultivar to *Orobanche* infection. For *Orobanche* severity scale, Hassanein et al. (1998) suggested that the scale as follows: High than 10 spikes broomrape is highly susceptible, 7-9 spikes broomrape is moderately susceptible; 4-7 is moderately tolerant; 2-3 is tolerant and less than two spike faba<sup>-1</sup> bean plant is resistant. These results proved that Misr 3 considered tolerant and Sakha 4 was highly susceptible.

**Table 5. Effect of varieties on yield and its components in 2015/2016 and 2016/2017 seasons.**

Varieties	Plant Height (cm)		No. Branches Plant <sup>-1</sup>		No. pods plant <sup>-1</sup>		100-Seed weight (g)		Straw yield (ton fed. <sup>-1</sup> )		Seed Yield (ardab fed. <sup>-1</sup> )	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
	Misr 3	126.4	123.8	3.4	3.1	14.3	13.6	69.06	68.59	2.16	2.10	8.11
Sakha 4	92.1	88.73	2.0	1.7	7.8	7.2	74.12	73.29	1.26	1.20	3.46	3.07
L.S.D <sub>0.05</sub>	4.94	3.38	0.42	0.38	0.52	0.69	0.99	1.06	0.04	0.03	0.94	0.71

**Effect of faba bean plant densities:**

**On broomrape:**

Data in Table (6) indicated that faba bean plant densities of two sides recorded the highest length of broomrape spikes, number of broomrape spikes plant<sup>-1</sup>, number of broomrape spikes m<sup>2</sup> and dry weight of broomrape spikes (g m<sup>-2</sup>) owing to the increase in number of faba bean plants unit area in both seasons, respectively as compared to planting on one side. Planting on one side

decreased the broomrape characters by 32.8, 32.3, 33.9 and 32.4 % in 2015/2016 season and by 27.8, 32.9, 30.9 and 32.7 %, in 2016/2017 season, respectively as compared to planting of two sides. This may be due to increase in biomass of root system of faba bean plants which increase the accesses of root exudates and consequently increase exudates stimulation for broomrape seed germination. These results are in harmony with those of Ismail and Fakkar (2008) and Eid et al., (2017).

**Table 6. Effect of plant densities on broomrape characters in 2015/2016 and 2016/2017 seasons.**

Plant Densities	Broomrape spikes length (cm)		No. broomrape spikes plant <sup>-1</sup>		No. broomrape spikes m <sup>2</sup>		Broomrape dry weight (g m <sup>-2</sup> )	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
One side	29.3	32.5	4.4	5.1	19.1	23.3	110.6	146.1
Two sides	43.6	45.0	6.8	7.6	28.9	33.7	163.7	217.5
L.S.D <sub>0.05</sub>	6.83	2.43	1.83	1.51	8.35	6.40	44.15	38.80

**On nodulation:**

Results showed in Table (7) reported that the two-plant densities of faba bean were slightly differed significantly. The highest number of nodules at 45 and 66 days after sowing of faba bean belonged to the plant densities two sides with the values 61.80 and 51.73 in the first season; 65.47 and 54.77 in the second season, respectively, comparing to planting on one side.

**Table 7. Effect of planting densities on number of nodules / plants in 2015/2016 and 2016/2017 seasons.**

Planting density	No. nodules plant <sup>-1</sup> 45 DAS		No. nodules plant <sup>-1</sup> 66 DAS	
	2015/16	2016/17	2015/16	2016/17
One side	59.7	64.0	49.77	52.63
Two sides	61.8	65.5	51.73	54.77
L.S.D <sub>0.05</sub>	1.17	0.82	1.08	1.23

**On Yield and its components:**

Results in Table (8) showed that the two planting densities of faba bean differed significantly. Concerning of faba bean plant height tended to increase with planting on two sides by 2.1 and 2.3 %, respectively in both sowing seasons as compared with planting on one side. This may be due to competition among faba bean plants under higher planting density. The highest number of branches plant<sup>-1</sup> of faba bean were obtained from planting on one side, with values of 3.0 and 2.7 branches plant<sup>-1</sup> compared to the smallest number of branches plant<sup>-1</sup> from the planting on two sides, with values of 2.4 and 2.0 branches plant<sup>-1</sup> in

both sowing seasons, respectively. Faba bean seed yield and its components namely; number of pods plant<sup>-1</sup>, weigh of 100 seeds, straw yield (ton fed<sup>-1</sup>) and seed yield (ardap fed<sup>-1</sup>), in both sowing seasons. The highest number of pods plant<sup>-1</sup> of faba bean belonged to the planting on one side, with the values of 11.6 and 11.0 pods plant<sup>-1</sup> compared to the smallest number of pods plant<sup>-1</sup> which belonged to the planting on two sides, with values of 10.5 and 9.8 pods plant<sup>-1</sup>, in both seasons, respectively. The heaviest 100-seed weight (g) of faba bean was the planting on one side, with values of 73.86 and 73.28 (g) in both seasons as compared to the lowest weight of 100 seeds which belonged to the planting on two sides, with values of 69.16 and 68.59 (g) in both sowing seasons, respectively. The heaviest straw yield (ton fed<sup>-1</sup>) of faba bean belonged to the planting on one side, with values of 1.35 and 1.31 (ton fed<sup>-1</sup>) in first and second seasons, compared to the lowest weight of straw yield which belonged to the planting on two sides, with values of 2.06 and 1.99 (ton fed<sup>-1</sup>) in both seasons, respectively. The highest seed yield (ardap fed<sup>-1</sup>) of faba bean resulted from the planting on two sides with values 6.43 and 5.88 (ardab fed<sup>-1</sup>) comparing to the lowest yield of seeds which belonged to the planting on one side, with values of 5.15 and 4.85 (ardab fed<sup>-1</sup>) in first and second seasons, respectively. These results are in agreement with those obtained by Ismail (2013) and Eid et al. (2017).

**Table 8. Effect of planting densities on yield and its components in 2015/2016 and 2016/2017 seasons.**

Planting densities	Plant height (cm)		No branches Plant <sup>-1</sup>		No. of pods plant <sup>-1</sup>		100-Seed weight (g)		Straw yield (ton fed. <sup>-1</sup> )		Seed yield (ardab fed. <sup>-1</sup> )	
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
One side	108.13	104.97	3.82	3.67	11.6	11.0	73.9	73.28	1.35	1.31	5.15	4.85
Two sides	110.37	107.53	2.55	2.53	10.5	9.8	69.2	68.59	2.06	1.99	6.43	5.88
L.S.D <sub>0.05</sub>	1.42	2.01	0.45	0.57	0.63	0.57	3.23	1.45	0.05	0.12	0.19	0.16

**Effect of broomrape control treatments:**

**On broomrape:**

Data recorded in Table (9) showed that all broomrape control treatments decrease significantly spike length (cm), number of spikes plants<sup>-1</sup> number of spikes m<sup>-2</sup> and dry weight of spikes (g m<sup>-2</sup>) of broomrape weed in both sowing seasons, except for *Rhizobium* treatment which increased the previous characters of broomrape, in both seasons. Glyphosate applied twice at the rate 75 cc fed<sup>-1</sup>. at the beginning of the flowering stage and after 21 days from first application decreased both spike length, number of spikes plant<sup>-1</sup>, number of spike m<sup>-2</sup> and dry weight of spike (g m<sup>-2</sup>) of broomrape by 89.5, 87.3, 90.1 and 91.0 % in the first season and by 88.6, 87.9, 89.8 and 90.5 %, in the second season, respectively, followed by

glyphosate + *Rhizobium* and hand pulling twice, as compared with untreated control. This effect is due to that glyphosate translocate to tubercles of broomrape during underground stage, so it makes early effects. On the other hand, *Rhizobium* treatment increased the broomrape characters by 6.4, 11.9, 11.2 and 8.8 %, in first season, and, by 5.5, 1.0, 11.5 and 6.8 %, in second season, respectively, as compared to glyphosate treatment. These results are in harmony with those obtained by Hassanein and Kholosy (1997) they reported that the action of glyphosate on (*Orobanche crenata*) is attributable to its selective accumulation in the young parasite plant up to a level four times as high as that in faba bean host root three days after spraying.

**Table 9. Effect of broomrape control treatments on broomrape characters in 2015/2016 and 2016/2017 seasons.**

Broomrape control treatments	Rate	Broomrape spikes length (cm)		No. broomrape spikes plant <sup>-1</sup>		No. broomrape spikes m <sup>-2</sup>		Broomrape dry weight (g/m <sup>2</sup> )	
		2015/16	2015/16	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
<i>Rhizobium</i> seeds <sup>-1</sup>	20 g kg <sup>-1</sup>	59.0	61.5	10.4	12.0	46.4	53.8	269.9	358.9
Glyphosate twice	36 g fed <sup>-1</sup>	6.6	7.4	1.5	1.6	5.2	6.2	26.5	36.4
*R + Gly	20g + 36 g	10.8	12.4	1.9	2.1	6.9	9.7	39.9	56.1
Hand pulling	twice	20.2	22.2	2.5	2.9	9.3	12.1	56.8	73.7
Untreated		63.0	65.1	11.8	13.3	52.3	60.8	295.2	384.9
L.S.D <sub>0.05</sub>		3.85	2.15	0.95	0.86	3.50	2.17	20.64	14.31

\*R + Gly = *Rhizobium leguminosarum* + Glyphosate

**On nodulation:**

Data in Table (10) revealed that rhizobium treatment increased number of nodules plant<sup>-1</sup> at 45 and 66 days after sowing by (26.3 and 31.4 %) and, (27.8 and 31.2 %) in the first and second seasons, respectively, comparing to untreated control. While, found that glyphosate twice decreased the number of nodules plant<sup>-1</sup> at 45 and 66 days after sowing by (9.6 and 4.0 %) and, (4.3 and 3.1 %) in both sowing seasons, respectively as compared to untreated control. These results agreed with those obtained by Hussein *et al.* (1993).

**Table 10. Effect of broomrape control treatments on number of nodules/plant in 2015/2016 and 2016/2017 seasons.**

Broomrape control treatments	Rate	No. nodules plant <sup>-1</sup> 45 DAS		No. nodules plant <sup>-1</sup> 66 DAS	
		2015/16	2016/17	2015/16	2016/17
<i>Rhizobium</i> seeds <sup>-1</sup>	20 g kg <sup>-1</sup>	87.4	91.9	79.2	97.6
Glyphosate twice	36 g fed <sup>-1</sup>	45.9	51.3	38.4	41.4
*R + Gly	20g + 36 g	68.9	74.2	58.3	62.1
Hand pulling	Twice	49.2	52.7	39.9	42.8
Untreated		50.8	53.6	40.0	42.7
L.S.D <sub>0.05</sub>		2.49	3.37	2.39	2.19

\*R + Gly = *Rhizobium leguminosarum* + Glyphosate

**On yield and its components:**

Results presented in Table (11) indicated that glyphosate + rhizobium in both sowing methods increased the Plant height of faba by 24.7 and 24.3 %, as compared to untreated control in the first and second seasons,

respectively, followed by glyphosate twice and rhizobium treatments. Similar results were obtained for number of branches plant<sup>-1</sup> of faba bean which increased from glyphosate + rhizobium treatment by 54.1 and 58.8 % as compared to untreated control in 2015/2016 and 2016/2017 seasons, respectively. Number of pods plant<sup>-1</sup> of faba bean by (49.0 and 50.4 %) in both seasons, respectively, as compared with untreated control, followed by glyphosate twice and rhizobium only treatments. Also, glyphosate + rhizobium increased weight of 100-seed and straw yield (ton/fed) by (7.9 and 7.3 %) and (51.38 and 54.0 %) in the first and second seasons, respectively, comparing to untreated control.

Glyphosate twice + rhizobium significantly increased seed yield (ardab fed<sup>-1</sup>) by (42.1 and 46.5 %) in the first and second seasons, respectively, as compared with untreated control. This increased of seed yield/fed may be due to the increase of faba bean growth and yield components traits namely; number of branches plant<sup>-1</sup>, number of pods plant<sup>-1</sup>, and 100-seed weight. The above results are in agreement with those by Al-Marsafy *et al.* (2001) and Ismail (2013).

**Effect of interaction:**

**Effect of interaction between faba bean varieties and planting densities:**

The effect of interaction among the faba bean varieties under two planting densities on *Orobanche*, growth characters: seed yield and its components was not statistically significant. Thus, the data were not discussed.

**Effect of interaction between faba bean varieties and broomrape control treatments:**

**On broomrape:**

The effect of interaction between faba bean varieties and broomrape control treatments was statistically significant on number of broomrape spikes plant<sup>-1</sup>, number of broomrape spikes m<sup>-2</sup>, broomrape spikes length and dry weight of broomrape (g m<sup>-2</sup>) in both seasons. Table (12) showed that planting Misr 3 variety with glyphosate twice gave the highest reduction percentage in broomrape spikes length, number of broomrape spikes plant<sup>-1</sup>, number of broomrape spikes m<sup>-2</sup> and broomrape dry weight(g m<sup>-2</sup>) which were estimated by 92.0, 95.4, 96.7 and 96.9

%, respectively, in first season, and by 91.9, 94.8, 96.1 and 96.3 %, in second season, respectively as compared with untreated control with Sakha 4 cultivar treatment, flowed by Misr 3 variety with glyphosate twice + rhizobium treatment and Misr 3 variety with hand pulling twice treatment as compared with Sakha 4 with untreated control in both sowing seasons. These results according to the scale suggest by Hassanein *et al.* (1998) suggest that Misr 3 can be considered as tolerant cultivar to broomrape infestation and the use of glyphosate raised broomrape control package to almost 90% reduction. The obtained results were in agreement with those obtained by Ismail and Fakkar (2008) and. Eid *et al.* (2017).

**Table 11. Effect of broomrape control treatments on yield and its components in 2015/2016 and 2016/2017 seasons.**

Broomrape control treatments	Rate	Plant height (cm)		No. branches plant <sup>-1</sup>		No. of pods plant <sup>-1</sup>		100 Seed weight (g)		Straw yield (ton fed. <sup>-1</sup> )		Seed yield (ardab fed. <sup>-1</sup> )	
		2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
Rhizobium seeds <sup>-1</sup>	20 g kg <sup>-1</sup>	102.9	100.2	2.7	2.3	10.7	10.0	70.83	70.25	1.92	1.80	5.12	4.90
Glyphosate twice	36 g fed <sup>-1</sup>	123.3	119.6	3.3	3.0	13.8	12.8	73.72	72.89	2.18	2.04	6.80	6.39
*R + Gly	20g+36g	126.3	122.8	3.7	3.4	14.3	13.7	74.83	73.81	2.53	2.37	7.75	7.31
Hand pulling	twice	98.6	95.8	2.2	1.8	9.2	8.7	69.67	69.32	1.46	1.33	4.78	4.30
Untreated		95.1	93.0	1.7	1.4	7.3	6.8	68.91	68.41	1.23	1.09	4.49	3.91
L.S.D <sub>0.05</sub>		2.67	3.02	0.36	0.39	0.52	0.82	1.24	1.17	0.12	0.13	0.57	0.43

\*R + Gly = *Rhizobium leguminosarum* + Glyphosate

**Table 12. Effect of interaction between varieties and broomrape control treatments on broomrape characters in 2015/2016 and 2016/2017 seasons.**

Treatments	Broomrape spikes length (cm)		No. of broomrape spikes plant <sup>-1</sup>		No. of broomrape spikes m <sup>-2</sup>		Broomrape dry weight (g m <sup>-2</sup> )		
	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	
Misr 3	<i>Rhizobium</i>	53.7	56.5	5.3	7.2	20.0	25.8	123.3	173.9
	Glyphosate	5.5	5.7	0.8	1.0	2.7	3.5	14.1	21.0
	*Rhiz + Gly	10.2	11.4	1.0	1.2	3.5	5.0	20.4	28.6
	Hand pulling	19.6	21.7	1.3	1.5	4.7	6.3	32.2	38.2
	Untreated	57.6	60.0	6.1	8.3	24.0	31.0	141.8	196.5
Sakha 4	<i>Rhizobium</i>	64.3	66.5	15.5	16.8	72.8	81.7	415.3	543.8
	Glyphosate	7.7	9.1	1.9	2.2	7.7	8.8	38.8	51.7
	*Rhiz + Gly	11.4	13.3	2.5	2.9	10.3	14.3	57.7	83.5
	Hand pulling	20.9	22.8	3.5	4.3	13.8	17.8	81.4	109.1
	Untreated	68.4	70.1	17.3	18.3	80.7	90.5	448.6	573.3
L.S.D <sub>0.05</sub>	13.34	7.45	3.29	2.98	12.12	7.51	71.48	49.56	

\*R + Gly = *Rhizobium leguminosarum* + Glyphosate

**On nodulation:**

Data indicated that the effect of interaction between faba bean varieties and broomrape control treatments on number of nodules plant<sup>-1</sup> at 45 and 66 days after sowing was not statistically significant. Thus, the data were not discussed.

**On yield and its components:**

Results in Table (13) showed that Misr 3 variety with glyphosate + rhizobium gave the highest values of plant height (cm) and number of branches plant<sup>-1</sup> (46.6 and 94.0 %) in the first season and (47.6 and 100 %), in second season, respectively as compared to Sakha 4 variety with untreated control treatment, followed by Misr 3 variety with rhizobium treatment and Misr 3 variety with glyphosate twice treatment, in both sowing seasons.

Also, growing Misr 3 variety with glyphosate + rhizobium treatment gave the highest values of number of pods plant<sup>-1</sup>, straw yield (ton fed<sup>-1</sup>) and seed yield (ardab fed<sup>-1</sup>). Which estimated by (76.1, 70.3 and 79.7 %) in the first season and by (77.2, 71.7 and 82.2 %) in the second season, respectively, as compared to Saka 4 variety with untreated control treatment, which gave the lowest values (64.3, 57.2 and 69.6 %) in the first season and (64.5, 58.8 and 72.1 %) in the second season, respectively, followed

by Misr 3 variety with glyphosate twice treatment, and Misr 3 variety with rhizobium treatment as compared to Sakha 4 with untreated control treatment, in both sowing seasons. The obtained results were in agreement with those obtained by Eid *et al.* (2017).

**Effect of interaction between plant densities and broomrape control treatments:**

**On broomrape:**

Data in table (14) revealed that the effect of interaction between planting densities and broomrape control treatments were statistically significantly on broomrape spikes length (cm), number of broomrape spikes plant<sup>-1</sup>, number of broomrape spikes m<sup>-2</sup> and broomrape dry weight (g m<sup>-2</sup>) in both sowing seasons. Planting on one side with glyphosate twice treatment gave the highest reduction percentage in all broomrape characters, which were estimated by (89.3, 93.0, 93.4 and 93.6 %) in the first season and (89.5, 89.0, 92.6 and 93.2 %) in the second season, respectively as compared to planting on two side with untreated control treatment. Followed by planting on one side with glyphosate twice + rhizobium treatment and planting density with hand pulling twice treatment, as compared to planting on two sides with untreated control treatment, in both sowing seasons.

**Table 13. Effect of interaction between varieties and broomrape control treatments on yield and its components in 2015/2016 and 2016/2017 seasons.**

Varieties	broomrape control treatments	Plant Height (cm)		No. of branches Plant <sup>-1</sup>		No. of pods plant <sup>-1</sup>		100-Seed weight (g)		Straw yield (ton fed. <sup>-1</sup> )		Seed yield (ardab fed. <sup>-1</sup> )	
		2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
		Misir 3	<i>Rhizobium</i>	130.3	127.5	2.5	2.3	14.5	13.7	69.30	68.91	2.58	2.55
	Glyphosate	127.8	124.2	2.2	2.0	16.8	15.8	69.73	69.40	2.50	2.43	8.36	8.13
	*R + Gly	133.2	130.8	2.8	2.8	17.17	16.8	70.85	70.24	2.79	2.72	9.30	8.93
	Hand pulling	121.5	119.2	1.8	1.8	12.7	12.2	68.01	67.63	1.59	1.52	7.57	6.93
	Untreated	119.0	117.5	1.8	1.8	10.3	9.8	67.39	66.78	1.33	1.28	7.09	6.23
Sakha 4	<i>Rhizobium</i>	72.7	69.5	0.8	0.5	6.8	6.3	72.36	71.60	0.91	0.90	1.97	1.73
	Glyphosate	118.7	115.0	2.0	2.0	10.7	9.8	77.71	76.39	1.56	1.50	5.24	4.66
	*R + Gly	122.2	118.2	2.2	2.2	11.5	10.7	78.77	77.39	1.94	1.87	6.21	5.70
	Hand pulling	75.7	72.5	0.5	0.5	5.7	5.2	71.33	71.01	1.03	0.99	1.99	1.68
	Untreated	71.2	68.5	0.2	0.00	4.1	3.8	70.44	70.06	0.83	0.77	1.89	1.59
L.S.D	0.05		9.26	10.45	1.23	1.27	1.77	5.16	4.99	0.43	0.46	2.17	1.48

\*R + Gly = *Rhizobium leguminosarum* + Glyphosate

**Table 14. Effect of interaction between planting densities and broomrape control treatments on broomrape characters in 2015/2016 and 2016/2017 seasons.**

Planting densities	Broomrape control treatments	Broomrape spikes length plant <sup>-1</sup> (cm)		No. of broomrape spikes plant <sup>-1</sup>		No. of broomrape spikes m <sup>-2</sup>		Broomrape dry weight (g m <sup>-2</sup> )	
		2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
		One side	<i>Rhizobium</i>	55.95	59.02	8.00	9.50	36.83	43.67
	Glyphosate	6.97	7.02	1.0	1.75	5.33	5.33	22.63	31.31
	*R + Gly	10.59	11.33	1.0	1.25	4.17	8.17	29.65	46.54
	Hand pulling	20.47	21.53	2.00	2.46	7.33	9.83	46.96	60.99
	Untreated	60.72	63.06	9.10	10.67	41.67	49.33	239.37	309.94
Two side	<i>Rhizobium</i>	61.98	64.00	12.83	14.50	56.00	63.83	323.25	434.48
	Glyphosate	6.23	7.77	1.54	1.88	6.17	7.00	30.29	41.39
	*R + Gly	11.03	13.38	2.04	2.33	8.50	11.17	48.44	65.55
	Hand pulling	19.98	22.95	2.79	3.29	11.17	14.33	66.58	86.36
	Untreated	65.27	67.02	14.29	15.92	63.00	72.17	350.97	459.87
L.S.D	0.05	13.33	7.45	3.29	2.98	12.11	7.51	81.97	69.81

\*R + Gly = *Rhizobium leguminosarum* + Glyphosate

**On nodulation:**

The effect of interaction between the plant densities and broomrape control treatments on number of nodules plant<sup>-1</sup> at 45 and 66 days after sowing, were not statistically significant, in both seasons. Thus, the data were not discussed.

**On yield and its components:**

The results in Table (15) showed that the effect of interaction between planting densities and broomrape control treatments were not significant on plant height (cm) and number of branches plant<sup>-1</sup>, number of pods plant<sup>-1</sup> and 100-seed weigh in both sowing seasons. But the same interaction was statistically significantly on straw yield (ton fed<sup>-1</sup>) and seed yield (ardap fed<sup>-1</sup>) in both sowing seasons.

Planting on two sides with application of glyphosate twice + rhizobium treatment gave highest values of straw yield (ton fed<sup>-1</sup>) and seed yield (ardab fed<sup>-1</sup>) which were (70.7 and 54.2%), in the first season, and (71.5 and 56.9%) in the second season, respectively as compared to planting on one side with untreated control treatment which gave the lowest values (56.3 and 45.2%) in the first season and (57.6 and 46.2%) in the second season, respectively, followed by planting on one side with glyphosate twice + rhizobium treatment and planting on two sides with glyphosate twice treatment, in both sowing seasons, which mean that increasing seed rate can be integrated with glyphosate twice + rhizobium or glyphosate twice treatment partially for improving faba bean seed yield.

**Table 15. Effect of interaction between plant densities and broomrape control treatments on yield and its components in 2015/2016 and 2016/2017 seasons.**

Plant densities	Broomrape control treatments	No. of pods plant <sup>-1</sup>		100-Seed weight (g)		Straw yield (ton fed. <sup>-1</sup> )		Seed yield (ardab fed. <sup>-1</sup> )	
		2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
		One side	<i>Rhizobium</i>	12.0	11.0	72.87	72.03	1.39	1.40
	Glyphosate	14.0	13.3	76.01	75.28	1.59	1.57	6.04	5.83
	*R + Gly	14.7	14.0	77.24	76.22	1.90	1.84	7.06	6.51
	Hand pulling	9.7	9.3	72.23	71.83	1.03	0.99	4.34	3.87
	Untreated	7.7	7.2	71.35	71.06	0.83	0.78	3.87	3.50
Two side	<i>Rhizobium</i>	9.3	9.0	68.80	68.48	2.11	2.06	5.80	5.26
	Glyphosate	13.5	12.3	71.43	70.51	2.47	2.37	7.55	6.96
	*R + Gly	14.0	13.3	72.39	71.41	2.83	2.74	8.45	8.12
	Hand pulling	8.7	8.0	67.12	66.81	1.59	1.51	5.22	4.73
	Untreated	6.8	6.5	66.48	65.78	1.32	1.27	5.10	4.33
L.S.D	0.05	NS	NS	NS	NS	0.62	0.74	1.97	1.51

\*R + Gly = *Rhizobium leguminosarum* + Glyphosate

**Effect of interaction among faba bean varieties, plant densities and broomrape control treatment:**

**On broomrape:**

Data in table (16) showed that the effect of interaction faba bean varieties , plant densities and broomrape control treatments were not significantly for

broom rape spikes length (cm) in both sowing seasons, meanwhile it was significant on number of broomrape spikes plant<sup>-1</sup>, number of broomrape spikes m<sup>-2</sup> and dry weight of broomrape (g m<sup>-2</sup>) in the first and second seasons.

**Table 16. Effect of interaction among plant densities, varieties and broomrape control treatments on broomrape characters in 2015/2016 and 2016/2017 seasons.**

varieties	Plant densities	Broomrape control treatments	Broomrape spikes length (cm)		No. of broomrape spikes plant <sup>-1</sup>		No. of broomrape spikes m <sup>-2</sup>		Broomrape dry weight (g m <sup>-2</sup> )	
			2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
Misr 3	One side	<i>Rhizobium</i>	50.0	53.6	3.3	5.0	12.3	19.7	77.8	124.7
		Glyphosate	6.3	5.3	0.7	0.8	2.0	3.0	10.3	17.0
		*R + Gly	9.9	10.1	0.8	1.0	2.3	4.0	13.2	23.0
		Hand pulling	19.7	21.1	1.0	1.3	3.0	5.0	28.5	29.8
		Untreated	54.4	57.4	3.9	6.0	15.3	24.0	96.6	150.6
	Two sides	<i>Rhizobium</i>	57.3	59.4	7.3	9.3	27.7	32.0	168.7	223.2
		Glyphosate	4.7	6.1	0.9	1.2	3.3	4.0	17.9	24.9
		*R + Gly	10.6	12.7	1.1	1.4	4.7	6.0	27.6	34.2
Hand pulling		19.4	22.3	1.6	1.8	6.3	7.7	35.9	46.6	
	Untreated	60.8	62.5	8.3	10.5	32.7	38.0	187.0	242.4	
Sakha 4	One side	<i>Rhizobium</i>	61.9	64.4	12.7	14.0	61.3	67.7	352.7	441.8
		Glyphosate	7.7	8.8	1.6	1.8	6.3	7.7	34.9	45.6
		*R + Gly	11.3	12.6	1.9	2.5	8.3	12.3	46.1	70.1
		Hand pulling	21.2	22.0	3.0	3.7	11.7	14.7	65.4	92.2
		Untreated	67.1	68.7	14.3	15.3	68.0	74.7	382.1	469.3
	Two sides	<i>Rhizobium</i>	66.6	68.6	18.3	19.7	84.3	95.7	477.8	126.1
		Glyphosate	7.7	9.4	2.2	2.6	9.0	10.0	42.7	57.8
		*R + Gly	11.5	14.0	3.0	3.3	12.3	16.3	69.3	96.9
Hand pulling		20.5	23.6	4.0	4.8	16.0	21.0	97.3	126.1	
	Untreated	69.7	71.5	20.3	21.3	93.3	106.3	515.0	677.3	
L.S.D	0.05		NS	NS	3.62	2.86	7.65	11.76	86.92	91.79

\*R + Gly = *Rhizobium leguminosarum* + Glyphosate

The results showed that the highest reduction in number of broomrape spikes plant<sup>-1</sup>, number of broomrape m<sup>-2</sup> and dry weight of broomrape was recorded for Misr 3 variety with planting on one side and spraying glyphosate twice by (96.6, 97.9 and 98.0 %) in the first season, and by (96.2, 97.2 and 97.5 %) in the second season, respectively as compared to untreated Sakha 4 variety and planting on two sides. The results obtained were in agreement with those obtained by Gadalla *et al.* (2010), followed by Misr 3 variety with planting on one side and glyphosate + rhizobium treatment and Misr 3 variety with planting on one side and hand pulling twice treatment in the first and second seasons.

**On nodulation:**

The effect of interaction among faba bean varieties, plant densities and broomrape control treatments on number of nodules plant<sup>-1</sup> at 45 and 66 days after sowing, was not statistically significantly in the first and second seasons. Thus, the data were not discussed.

**On yield and its components:**

Data in Table (17) showed that the effect of interaction faba bean varieties, plant densities and broomrape control was not significant for plant height (cm) and number of branches plant<sup>-1</sup>. Meanwhile it was significant for number of pods plant<sup>-1</sup>, weight of 100-seed (g), straw yield (ton fed<sup>-1</sup>) and seed yield (ardab fed<sup>-1</sup>) in the first and second seasons. The package which consists of planting Misr 3 variety with planting on two sides and glyphosate spraying twice + rhizobium gave the highest

values of straw yield (ton fed<sup>-1</sup>) which (81.02 and 83.03 %) in the first and second seasons, respectively as compared to untreated Sakha 4 variety and planting on one side treatment which gave the lowest values of 0.63 and 0.55 (ton fed<sup>-1</sup>) in both sowing seasons, respectively. The highest yield of seeds (ardab fed<sup>-1</sup>) was obtained from Misr 3 variety with planting on two sides and spraying glyphosate twice + rhizobium treatment which surpassed by (84.8 and 88.5 %) in both sowing seasons, respectively as compared to untreated Sakha 4 variety and planting on one side. The results obtained were in agreement with those obtained by Hassanein and Kholosy (1997) and Eid *et al.* (2017). From this study there was a possibility for growing faba bean in soil infested with broomrape by planting Misr 3 variety through November with two sprays of glyphosate at one side.

**Correlation among all the studied characters:**

Data presented in Table (18) indicated clearly that simple correlation coefficients between each of, broomrape spikes length, number of broomrape spikes plant<sup>-1</sup>, number of broom rape spikes/m<sup>2</sup> and dry weigh of broomrape (g m<sup>-2</sup>) and faba bean seed yield was statistically significant and strongly negative at 5% level. This means that the pervious broomrape characters were more aggressive in their parasitition to seed yield (ardab fed<sup>-1</sup>) of faba bean. Also, correlation analysis revealed that the yield increases were positively contributed to the increases in growth characters and yield components.

**Table 17. Effect of interaction among plant densities, varieties and broomrape control treatments on yield and its components in 2015/2016 and 2016/2017.**

varieties	Plant densities	Broomrape control treatments	No. of pods plant <sup>-1</sup>		100-Seed weight (g)		Straw yield (ton fed. <sup>-1</sup> )		Seed yield (ardab fed. <sup>-1</sup> )	
			2015/16	2016/17	2015/16	2016/17	2015/16	2016/17	2015/16	2016/17
Misr 3	One side	<i>Rhizobium</i>	16.7	15.3	71.8	71.2	2.00	2.08	7.27	7.77
		Glyphosate	17.3	16.3	71.3	71.1	1.97	1.94	7.33	7.79
		*R + Gly	17.7	17.0	72.4	72.2	2.25	2.20	8.51	8.09
		Hand pulling	13.3	13.0	70.5	70.1	1.25	1.18	7.04	6.54
		Untreated	11.0	10.3	70.1	69.8	1.03	1.00	6.21	5.87
	Two sides	<i>Rhizobium</i>	12.3	12.0	66.8	66.6	3.08	3.02	9.26	8.37
		Glyphosate	16.3	15.3	68.1	67.7	3.02	2.92	9.38	8.47
		*R + Gly	16.7	16.3	69.3	68.3	3.32	3.24	10.09	9.77
		Hand pulling	12.0	11.3	65.6	65.2	1.93	1.85	8.10	7.31
		Untreated	9.7	9.3	64.7	63.7	1.62	1.56	7.96	6.59
Sakha 4	One side	<i>Rhizobium</i>	7.3	6.7	73.9	72.9	0.71	0.7	1.60	1.31
		Glyphosate	10.7	10.3	80.7	79.4	1.22	1.19	4.75	3.87
		*R + Gly	11.7	11.3	82.1	80.3	1.54	1.48	5.62	4.92
		Hand pulling	6.0	5.7	74.0	73.6	0.82	0.79	1.65	1.20
		Untreated	4.3	4.0	72.6	72.3	0.63	0.55	1.53	1.12
	Two sides	<i>Rhizobium</i>	6.3	6.0	70.8	70.3	1.07	1.11	2.34	2.14
		Glyphosate	10.7	9.3	74.7	73.3	1.91	1.81	5.72	5.45
		*R + Gly	11.3	10.3	75.5	74.5	2.34	2.25	6.81	6.47
		Hand pulling	5.3	4.7	68.7	68.5	1.25	1.18	2.34	2.15
		Untreated	4.0	3.7	68.3	67.8	1.03	0.98	2.25	2.07
L.S.D	0.05		NS	NS	NS	NS	1.53	1.46	6.43	4.39

\*R + Gly = *Rhizobium leguminosarum* + Glyphosate

**Table 18. Correlation coefficient among all studied characters analysis between faba bean yield and its components in 2015 /2016 and 2016 / 17 seasons.**

studied characters	No. broomrape spikes plant <sup>-1</sup>	No. broomrape spikes m <sup>-2</sup>	Broomrape dry weight (g m <sup>-2</sup> )	No. nodules plant <sup>-1</sup> at 45 DAS	Plant Height (cm)	No. branches Plant <sup>-1</sup>	No. pods plant <sup>-1</sup>	100 seed weight	Straw yield	Seed yield
Broomrape spikes length (cm)	0.825**	0.813**	0.831**	0.341*	-0.0503	-0.544**	-0.534**	-0.165	-0.417**	-0.406*
No. broomrape spikes plant <sup>-1</sup>		0.993**	0.991**	0.359*	-0.715	-0.662**	-0.701**	-0.175	-0.469**	-0.599**
No. broomrape spikes m <sup>-2</sup>			0.998**	0.371*	-0.738**	-0.667**	-0.702	-0.333**	-0.485**	-0.620**
Broomrape dry weight (g m <sup>-2</sup> )				0.375*	-0.737**	-0.669**	-0.698**	-0.186	-0.486**	-0.617**
No. nodules plant <sup>-1</sup> at 45 DAS					0.194	0.109	0.133	0.232*	0.275*	0.201*
Plant Height (cm)						0.802	0.856**	0.748**	0.755**	0.903**
No. branches Plant <sup>-1</sup>							0.877**	0.607*	0.591*	0.727*
No. pods plant <sup>-1</sup>								0.616*	0.729**	0.846**
100 seed weight									0.791**	0.812**
Straw yield										0.842*
2016/2017 season										
Broomrape spikes length (cm)	0.876**	0.835**	0.838**	0.332*	-0.482	-0.527**	-0.533**	-0.157	-0.409**	-0.420**
No. broomrape spikes plant <sup>-1</sup>		0.985**	0.986**	0.386*	-0.680**	-0.655**	-0.684**	-0.213*	-0.458**	-0.595**
No. broomrape spikes m <sup>-2</sup>			0.999**	0.388*	-0.724**	-0.676**	-0.694**	-0.158	-0.492**	-0.632**
Broomrape dry weight (g m <sup>-2</sup> )				0.404*	-0.717**	-0.668**	-0.682**	-0.164	-0.478**	-0.621**
No. nodules plant <sup>-1</sup> at 45 DAS					0.189	0.102	0.152	0.227*	0.132	0.171
Plant Height (cm)						0.791**	0.857**	0.775**	0.754**	0.927**
No. branches Plant <sup>-1</sup>							0.865**	0.617*	0.594*	0.771*
No. pods plant <sup>-1</sup>								0.514*	0.744**	0.887**
100 seed weight									0.683*	0.869**
Straw yield										0.849**

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

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## تأثير بعض معاملات مكافحة الهالوك و الكثافة النباتية على انتاجية صنفين من الفول البلدى مروة خليل علي محمد<sup>1</sup>، ابراهيم السيد سليمان<sup>2</sup> و محمد عماد زكي قتيير<sup>2</sup> اقسم بحوث المحاصيل البقولية - معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية - مصر. <sup>2</sup>المعمل المركزي لبحوث الحشائش - مركز البحوث الزراعية - الجيزة - مصر.

اجريت تجريبه في ارض مصابة طبيعيا بالهالوك بمحطة البحوث الزراعية بسخا - كفر الشيخ خلال موسمي الزراعة 2015 / 2016 ، 2016 / 2017 م لدراسة تأثير صنفين من الفول البلدي (مصر 3 ، سخا 4) والزراعة (علي ريشه واحدة ، علي ريشتين) وخمسة معاملات لمكافحة الهالوك (ريزوبيوم بمعدل 20 جم / كجم بذرة خلط مع التقلوي ، جليفوسيت رش مرتين بمعدل 36 جم مادة فعالة / فدان مرتين بينهما ثلاث اسابيع الاولى عند بداية التزهير ، ريزوبيوم + جليفوسيت ، نقاوة يدوية مرتين ومعاملة الكنترول (بدون معاملة)) وذلك لمعرفة مدى مساهمة هذه العوامل منفردة او مجتمعة علي مكافحة الهالوك وانتاجية محصول الفول البلدي تحت ظروف العدوي الطبيعية بالهالوك . استخدم تصميم القطع المنشقة مرتين مع اربعة مكرارات . اظهرت النتائج ان صنف الفول البلدي مصر3 في حالة الزراعة علي ريشة واحدة مع استخدام مبيد جليفوسيت مرتين بمعدل36 جم مادة فعالة / ف قد احدث انخفاض في عدد الشماريخ للنبات وفي المتر المربع والوزن الجاف لشماريخ الهالوك / م2 بنسبة 96.6 و97.9 و98 % في الموسم الاول وبنسبة 96.2 ، 97.2 ، 97.5 % في الموسم الثاني علي التوالي مقارنة بصنف الفول البلدي الحساس للاصابة بالهالوك سخا 4 مع معاملة الكنترول و الزراعة علي ريشتين . كذلك ادت الزراعة بالصنف مصر3 علي ريشتين ومعاملة الرش بالجليفوسيت مع التلقيح بالريزوبيوم الي زيادة محصول البذور للفول البلدي (أردب / فدان) بنسبة 84.8 و 88.5 % في كلا موسمي الزراعة علي التوالي مقارنة بالصنف سخا4 مع معاملة الكنترول في حالة الزراعة علي ريشه واحدة . توصي هذه الدراسة باستخدام حزمة متكاملة لمكافحة الهالوك مكونة من الزراعة بصنف مصر 3 لانه يتحمل الاصابة بالهالوك نسبيا ورش مبيد الجليفوسيت مرتين بمعدل 36 جم مادة فعالة /ف مع التلقيح بالريزوبيوم مع الزراعة علي ريشة واحدة للحصول علي أعلى نسبة مكافحة لحشيشة الهالوك واعلي محصول من بنور الفول البلدي تحت ظروف الاراضي المصابة بالهالوك بمحافظة كفر الشيخ.