

Evaluation of Integrated Broomrape (*Orobanche crenata*) Management Packages under Effect of Varieties, Seeding Rates and Roundup Treatment in Faba Bean under Sandy Soil Conditions

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ABSTRACT

Broomrape is a determining factor for faba bean cultivation in Egypt especially under sandy soil conditions. For this reason two field experiments were conducted in naturally infested fields with broomrape under sandy soil conditions at Ismailia Agricultural Research Station, Ismailia governorate during 2014/15 and 2015/16 winter seasons to study the effect of degree interaction between three faba bean varieties namely Giza843, Misr3 and Giza 3, two seeding rates at 30 and 60kg seed/fed. and two broomrape control treatments namely Roundup twice at 75 cc/fed. and untreated check on broomrape management and faba bean productivity. A split split plot design with three replicates was used, faba bean varieties were assigned to the main plots and seeding rates were allocated in sub plots, while weed control treatments were distributed randomly in sub sub plots. Results revealed that both faba bean varieties Misr3 and Giza843 exhibited significant decrease in numbers and weight of broomrape spikes/m² estimated by 87.0 and 91.0% & 49.2 and 53.3 % in 2014/15 winter season and by 86.1 and 90.6% & 47.9 and 54.5 % in 2015/16 winter season, respectively as compared with the susceptible variety Giza 3. Faba bean varieties Misr3 and Giza843 significantly increased faba bean yield and its components in both seasons as compared with variety Giza 3. Seed rate of 30kg/fed. significantly decreased the number and weight of broomrape spikes/m² by 16.8 and 11.5% in 2014/15 winter season and by 15.3 and 18.0% in 2015/16 winter season, respectively as compared to seed rate of 60kg/fed. Seed rate of 30kg/fed. significantly increased faba bean yield components in both seasons except plant height and seed yield (ardab/fed.) which significantly decreased with seed rate of 30kg/fed. in both seasons as compared to seed rate of 60kg/fed.

Roundup applied twice significantly decreased the number and dry weight of broomrape spikes/m² by 75.2 and 73.1% in the first seasons and by 72.6 and 69.8% in the second season, respectively, as compared with untreated check. Roundup applied twice significantly increased faba bean yield and its components in both seasons as compared with untreated check. The increases in seed yield (ardab/fed.) were 89.1 and 86.3% in the first and second seasons, respectively, as compared with untreated check. Analysis of the role of studied broomrape control measures and their possible integration was analyzed and correlation between broomrape infestation levels with faba bean seed yield was negative.

Thus, from this study the best control package for growing faba bean in sandy soil infested with broomrape is by planting Misr 3 or Giza 843 cultivars through November with 2 sprays of Roundup at 30 kg/seeding rate in infested fields with broomrape in Ismailia area.

Key words: varieties, seed rates, Roundup, broomrape and faba bean.

INTRODUCTION

Broomrape parasitic weed is a detrimental pest for the cultivation of faba bean in Egypt which cause significant losses in the yield of faba bean up to 80% and in some cases make farmers stop to grow faba bean under heavy infestation conditions. Up till now no single control measure is sufficient by itself to control this parasite in this crop. Thus, successful strategy for broomrape management which depends on adoption of integral effects of combination of tolerant varieties and rationale chemical control measures and suitable cultural practices is very necessary.

For faba bean varieties recommended cultivars vary in their response to broomrape infestation. In Egypt, Nassib (1982) reported that percentage of *Orobanche* infested faba bean plants and the

number as well as the total dry weight of *Orobanche* spikes/faba bean plant were lower in Giza 402 than those of other varieties as Rebaya40, Giza2 and Giza4 which were showing resistant to broomrape infection. In Egypt, Khalil (1983) found that Giza402 plants were tolerant to *Orobanche* infestation and produce more than one metric ton of seed/ha. Gadalla *et al.* (2010) proved that Giza3 was susceptible cultivar and Giza843 was tolerant to *Orobanche* infection, which had the lowest *Orobanche* tubercles/plant. Amer *et al.* (2012) found that the differences between varieties were affect significant on growth, plant height, number branches plant⁻¹, pod length and number of seed pod⁻¹, respectively. Ismail (2013) revealed that faba bean variety Misr1 decreased number and dry

weight of *Orobanche* spikes by 17.3 and 17.0%, respectively, as compared with variety Giza 40.

On other hand many researchers stated that glyphosate application twice at the rate of 178.7 cc/ha gave broomrape control by 96-99.1% and increasing faba bean seed yield/faddan by 100-149.5 than untreated infested check (Hassanein and Kholosy (1997), Hassanein *et al.* (1998-a), Al-Marsafy *et al.* (2001), EL-Metwally *et al.* (2013) and Ismail (2013). The effects of Roundup on broomrape tubercle is attributable to its selective accumulation in the young parasite plant up to a level of three times as high as that in faba bean host root three days after spraying (Zahran *et al.* (1980) and Hassanein and Kholosy (1997).

For the above previous reasons, the aim of this work was to determine the best packages of cultivars, seeding rates and glyphosate treatments for broomrape control in heavy broomrape infested fields of faba bean and yield productivity in sandy soil under Ismailia soil conditions.

MATERIALS AND METHODS

Two field experiments were conducted at Ismailia Agricultural Research Station, Ismailia Governorate during 2014/15 and 2015/16 winter seasons in sandy naturally heavily infested soil with broomrape to study the integral effects of twelve treatments which were the combinations of three faba bean cultivars, two faba bean seeding rates and weed control treatment on broomrape and faba bean productivity. Experimental design was split split-plot experiment with three replications. Each sub plot area was 10.5 m² which contains of five ridges 3.5 m length and 0.6 m apart as follow:

A- Main plots: (Faba bean cultivars): Misr 3, Giza 843 and Giza 3.

B-Sub plots: (faba bean seeding rates): 30kg, and 60kg.

C- Sub-sub plots: (weed control treatment):

1- Roundup 48% WSC (Glyphosate) applied at the rate of 75 cc/fed at the beginning of the flowering stage and after 21 days from the first application.

2- Unweeded check (control).

The herbicidal treatments were sprayed with a CP3 knapsack sprayer equipped with one nozzle boom with 200 liters of water/fed. Nitrogen fertilization and other cultural practices were carried out as recommended. Faba bean were planted in 20th and 24th November in both seasons. The preceding summer crop was maize in both seasons. The sprinkler irrigation system was used. The two field experiments were conducted in the same site. Physical properties of the experimental soil are presented in Table A.

Table A: Physical properties of soil at the experimental site

Soil characteristics				Soil texture
Coarse sand %	Fine sand %	Silt %	Clay %	
25.32	69.37	3.82	1.49	Sandy

Data recorded:

1- Broomrape:

Before faba bean harvest immediately both number and dry weight of broomrape spike /m² were recorded and degree of faba bean to broomrape infestation was determined under various studied treatments according to the scale in (Table B).

2- Faba bean yield and its components:

At harvest, samples of ten plants were collected at random from the central ridges of each plot and the following criteria were recorded: Plant height (cm), number of branches/plant, number of pods/plant, weight of pods/plant (g), weight of seeds/plant (g), 100-seed weight/plant (g) and seed yield (ardab/fed) which determined by harvest the plot area.

Statistical analysis:

All data were subjected to proper statistical analysis of split split plot design according to procedure outlined by Snedecor and Cochran (1967). Simple correlation matrix was carried out for the two seasons to investigate the degree of relationship among number and weight of broomrape spike /m² and yield and its components of faba bean according to Steel and Torrie (1980) and means were compared at 5% level of significance by the least significant different L.S.D test.

Table B: The suggested scale of *Orobanche* infestation in host plants to *Orobanche* (adopted from Hassanein *et al.*, 1998-b)

Host susceptibility to <i>Orobanche</i> infection	Score		
	<i>Orobanche</i> Incidence (%)	<i>Orobanche</i> severity no of spikes/host plant	Yield losses %
Highly susceptible (HS)	100	10	100
Moderately susceptible (MS)	60 - 90	07-Sep	60- 90
Moderately tolerant (MT)	40 - 60	04-Jul	40- 60
Tolerant (T)	0 - 30	01-Mar	Oct-30
Resistant (R)	>10	1 > 2	No effect
Immune (I)	0	0	No effect

RESULTS AND DISCUSSION

A- Main effects:

1- Effect of faba bean cultivars:

On broomrape:

Table 1 show the differences among the three studied faba bean cultivars in *Orobanche* infection which reached the level of significant at 5% level and showed that both faba bean cultivars namely Misr3 and Giza843 recorded the highest reduction parentages on both numbers and weight of broomrape spikes/m² in both studied seasons 87.0 and 91.0% & 49.2 and 53.3 % in 2014/15 winter season and by 86.1 and 90.6% & 47.9 and 54.5 % in 2015/16 winter season, respectively as compared with the susceptible cultivar Giza 3. 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 broomrape injury.

On faba bean yield and yield components:

Results in Table 2 show that all faba bean cultivars differed significantly in faba bean seed yield and its components in both 2014/15 and 2015/16 winter seasons. Concerning faba bean plant height the tallest plants of faba bean belonged to cultivars Giza 843 and Misr3 which were taller by 10.2 and 7.5% in 2014/15 season and by 10.1 and 7.2% in 2015/16 season compared to cultivar Giza 3. The highest numbers of branches/plant of faba bean were obtained from the cultivars Misr 3 and Giza 843 which increased by 36.7 and 23.4% in 2014/15 season and by 42 and 24.7% in 2015/16 season compared over cultivar Giza3 respectively.

The highest numbers of pods/plant of faba bean belonged to the cultivars Misr 3 and Giza 843 which recorded increase in number of pods/plant by 26.2 and 15.4% in 2014/15 season and by 26.1 and 13.1% in 2015/16 season compared to cultivar Giza3. The heaviest pods/plant (g) of faba bean belonged to the cultivars Misr 3 and Giza 843 which gave increases in weight of pods/plant by 29.1 and 23% in 2014/15 season and by 24.5 and 23.4% in 2015/16 season compared to cultivar Giza3. The heaviest seeds/plant (g) of faba bean belonged to the cultivars Misr 3 and Giza 843 which gave increases in weight of seed/plant by 28.3 and 20.7% in 2014/15 season and by 27 and 19% in 2015/16

season compared to cultivar Giza3. The heaviest 100-seed weight (g) cultivars of faba bean belonged to the cultivars Misr 3 and Giza 843 which gives increase in weight of 100-seed by 20.4 and 16.7% in 2014/15 season and by 12.9 and 9.5% in 2015/16 season compared to cultivar Giza3. The highest seeds yield of faba bean resulted from the cultivars Misr 3 and Giza 843 (tolerant/resistant cultivars) which gave increases in seed yield (ardab/fed) by 158.2 and 95.9% in 2014/15 season and by 129.5 and 111.9% in 2015/16 season compared to susceptible cultivar Giza3. These results were in agreement with those obtained by Gadalla *et al.* (2010), Amer *et al.* (2012), Ismail (2013) and Ibrahim *et al.* (2014).

From the previous results depending on *Orobanche* severity scale Giza 3 was considered as highly susceptible cultivar to *Orobanche* infection. Concerning *Orobanche* severity considered as susceptible, resistant or tolerant cultivars (high than 10 spikes broomrape was highly susceptible, 7-9 spikes broomrape was moderately susceptible, 4-7 was moderately tolerant, 2-3 was tolerant, less than >3 spike/faba bean plant was Resistant). These results proved that Misr3 and Giza843 considered tolerant and Giza3 was highly susceptible according to the scale suggested by Hassanein *et al.* (1998-b) Table (B). These findings are in harmony with those reported by Gadalla *et al.* (2010).

2- Effect of faba bean seeding rates:

On broomrape:

Data in Table 3 show that faba bean seed rate of 60kg/fed. recorded the highest number and weight of broomrape spikes/m² owing to the increase in number of faba bean plants per unit area in both seasons, respectively as compared to seed rate of 30kg/fed. Seed rate of 30kg/fed. The number and weight of broomrape spikes/m² decreased by 16.8 and 11.5% in 2014/15 winter season and by 15.3 and 18.0% in 2015/16 winter season, respectively as compared to seed rate of 60kg/fed. This may be due to increase in biomass of root system of faba bean plants which increase the access of root exudates and consequently increase exudates stimulation for broomrape seed germination.

Table 1: Effect of faba bean cultivars on number and weight of *Orobanche* spikes / m² in 2014/15 and 2015/16 winter seasons

Cultivars	season	2014/2015 winter season		2015/2016 winter season	
		No. of <i>Orobanche</i> spikes (m ²)	Weight of <i>Orobanche</i> spikes (g/m ²)	No. of <i>Orobanche</i> spikes (m ²)	Weight of <i>Orobanche</i> spikes (g/m ²)
Misr 3		7.7	91.6	8.8	97.3
Giza 843		30	473.5	33.1	472.3
Giza 3		59.1	1014.2	63.5	1037.4
LSD at 0.05%		6.86	92.16	2.99	32.5

Table 2: Effect of cultivars on yield and its components of faba bean in 2014/15 and 2015/16 winter seasons.

Cultivars	2014/15 winter season						
	Plant height (cm)	No. of branches / plant	No. of pods/ plant	Weight of pods/ plant(g)	Weight of seeds/ plant(g)	Weight of 100 seed(g)	Seed yield ardab/fed
Misr 3	106.2	3.8	18.8	52.3	42.2	72.6	6.71
Giza 843	108.7	3.43	17.2	49.8	39.7	70.4	5.74
Giza 3	98.8	2.78	14.9	40.5	32.9	60.3	2.93
LSD at 5%	1.07	0.4	0.63	1.54	1.17	0.62	0.52
	2015/16 winter season						
	Plant height (cm)	No. of branches / plant	No. of pods/ plant	Weight of pods/ plant(g)	Weight of seeds/ plant(g)	Weight of 100 seed(g)	Seed yield ardab/fed
Misr 3	104.7	3.62	18.3	47.3	40	72.5	6.15
Giza 843	106.9	3.18	16.4	46.9	37.5	70.3	5.68
Giza 3	97.1	2.55	14.5	38	31.5	64.2	2.68
LSD at 5%	1.88	0.17	0.37	1.22	0.76	0.88	0.44

Table 3: Effect of faba bean seeding rates on number and weight of *Orobanche* spikes / m² in 2014/15 and 2015/16 winter seasons

Seeding rate kg/ faddan	Seasons	2014/15 winter season		2015/16 winter season	
		No. of <i>Orobanche</i> spikes (m ²)	Weight of <i>Orobanche</i> spikes (g/m ²)	No. of <i>Orobanche</i> spikes (m ²)	Weight of <i>Orobanche</i> spikes (g/m ²)
30		29.3	494.3	32.2	482.6
60		35.2	558.6	38	588.7
LSD at 5%		2.86	35.84	3.33	35.25

On faba bean yield and yield components:

Results in Table 4 show that the two studied seeding rates of faba bean differed significantly concerning their faba bean seed yield and its components namely; plant height, number of branches/plant, number and weight of pods/plant, weight of seed/plant and weight of 100 seed in both 2014/15 and 2015/16 winter seasons. Faba bean plant height tended to increase with 60kg/fed. seeding rate by 2.1 and 2.1 percent, respectively in both seasons as compared with seeding rate of 30kg/fed. This may be due to competition between faba bean plants under higher plant density. The highest numbers of branches/plant of faba bean were obtained from the seed rate of 30kg/fed. with values of 3.56 and 3.34 branches/plant compare to the smallest numbers of branches/plant from the seed rate of 60kg/fed. with values of 3.11 and 2.89 branches/plant in both seasons, respectively.

The highest numbers of pods/plant of faba bean belonged to the seed rate of 30kg/fed. with the values of 17.4 and 16.8 pods compared to the smallest number of pods/plant which belonged to the seed rate of 60kg/fed. with values of 16.6 and 15.9 pods in both seasons, respectively. The heaviest pods/plant of faba bean belonged to the seed rate of 30kg/fed. with values of 48.6 and 45.8 (g) in both seasons compared to the lowest weight of pods/plant which belonged to the seed rate of 60kg/fed. with values of 46.5 and 43.0 (g) in both seasons, respectively. The heaviest seeds/plant of faba bean belonged to the seed rate of 30kg/fed. with values of 39.2 and 37.4 (g) in both seasons compared to the lowest weight of seeds/plant which belonged to the seed rate of 60kg/fed. with values of 37.3 and 35.3(g) in both seasons, respectively.

Table 4: Effect of seeding rates on yield and its components of faba bean in 2014/15 and 2015/16 winter seasons

Seeding rate kg/faddan	2014/15 winter season						
	Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Weight of pods/ plant (g)	Weight of seeds/ plant (g)	Weight of 100 seed (g)	Seed yield ardab/ fed
30	103.5	3.56	17.4	48.6	39.2	70.3	4.9
60	105.7	3.11	16.6	46.5	37.3	67.9	5.35
LSD at 5%	1.04	0.2	0.59	1.2	0.95	0.53	0.21
	2015/16 winter season						
	Plant height (cm)	No. of branches/ plant	No. of pods/ plant	Weight of pods/ plant (g)	Weight of seeds/ plant (g)	Weight of 100 seed (g)	Seed yield ardab/ fed
30	101.8	3.34	16.8	45.8	37.4	70.3	4.73
60	104	2.89	15.9	43	35.3	67.7	4.95
LSD at 5%	0.88	0.26	0.52	1.16	0.92	0.48	0.1

The heaviest 100-seed weight (g) of faba bean was the seed rate of 30kg/fed. with the same value of 70.3 (g) as compared to the lowest weight of 100-seed that resulted from planting faba bean by seed rate of 60kg/fed. with values of 67.9 and 67.7 (g) in both seasons, respectively. The highest seeds yield of faba bean resulted from the seed rate of 60kg/fed. with values of 5.35 and 4.95 (ardab/fed) as compared to the lowest yield of seeds which belonged to the seed rate of 30kg/fed. with values of 4.9 and 4.37 (ardab/fed) in 2014/15 and 2015/16 winter seasons, respectively.

3-Effect of broomrape control treatment:

On broomrape:

Data in Table 5 revealed that Roundup applied twice at the rate of 75 cc/fed at the beginning of the flowering stage and after 21 days from first application decreased both number and dry weight of broomrape spikes/m² by 75.2 and 73.1% in the first seasons and by 72.6 and 69.8% in the second season, respectively, as compared with untreated check. This effect is due to that Roundup translocate to tubercles of broomrape during underground stage, so it makes early effects. These results are in agreement with those obtained by Zahran *et al.* (1980) and Hassanein and Kholosy (1997) they reported that the action of glyphosate on *O. 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.

On faba bean seed yield and yield components:

Data in Table 6 revealed that the tallest plants of faba bean resulted from Roundup applied twice at

the rate of 75 cc/fed at the beginning of the flowering stage and after 21 days from first application in both seasons which increased by 8.9 and 9.5 percent as compared to untreated check in 2014/15 and 2015/16 seasons, respectively. Similar results were obtained for number of branches/plant of faba bean which increased from Roundup applied twice by 31.6 and 26.9 percent as compared to untreated check in 2014/15 and 2015/16 seasons, respectively. Roundup applied twice increased number of pods/plant of faba bean by (17.3 and 14.1%) in both season, respectively, as compared with untreated control. Roundup applied twice increased weight of pods/plant and weight of seeds/plant (g) by (15.6 and 14.3%) and (14.0 and 12.9%) in 2014/15 and 2015/16 seasons, respectively, as compared with untreated control.

Weight of 100-seed (g) was not affected significantly by weed control treatments in both seasons.

Roundup applied twice significantly increased seed yield (ardab/fed) by 89.1 and 86.3% in the first and second seasons, respectively, as compared with untreated check. This increase of seed yield per faddan may be due to the increase of faba bean growth and yield components namely number of branches/plant, number of pods/plant, weight of pods/plant, seed weight/plant and due to the decrease in the number and dry weight of broomrape spikes. The above results are in agreement with those by Al-Marsafy *et al.* (1998), Al-Marsafy *et al.* (2001), Ismail (2013) and Hegab *et al.* (2014).

Table 5: Effect of Roundup treatment on *Orobanche* growth in 2014/15 and 2015/16 winter seasons

Seasons	2014/15 winter season		2015/16 winter season	
	No. of <i>Orobanche</i> spikes (m2)	Weight of <i>Orobanche</i> spikes (g/m2)	No. of <i>Orobanche</i> spikes (m2)	Weight of <i>Orobanche</i> spikes (g/m2)
Roundup 2 spray	12.8	223.3	15.1	248.8
Untreated check	51.7	829.6	55.1	822.6
LSD at 5%	2.24	27.35	4.16	45.11

Table 6: Effect of Roundup treatment on yield and its components of faba bean in 2014/15 and 2015/16 winter season

Roundup application	2014/15 winter season						
	Plant height (cm)	No. of branches/plant	No. of pods/plant	Weight of pods/plant (g)	Weight of seeds/plant (g)	Weight of 100 seed (g)	Seed yield ardab/fed
Roundup 2 spray	109	3.79	18.3	51	40.8	69.2	6.71
Untreated check	100.1	2.88	15.6	44.1	35.7	69.1	3.55
LSD at 5%	1.27	0.18	0.28	0.63	0.47	0.65	0.46
Roundup application	2015/16 winter season						
	Plant height (cm)	No. of branches/plant	No. of pods/plant	Weight of pods/plant (g)	Weight of seeds/plant (g)	Weight of 100 seed (g)	Seed yield ardab/fed
Roundup 2 spray	107.6	3.54	17.7	47.3	38.5	69.1	6.3
Untreated check	98.3	2.79	15.2	41.5	34.1	69	3.38
LSD at 5%	1.06	0.22	0.29	0.83	0.44	0.67	0.54

B-Effect of interactions:**1- Effect of interaction between faba bean cultivars and seeding rates:**

The effect of interaction between the three faba bean cultivars under two seeding rates on *Orobanche*, faba bean seed yield and its components was not statistically significant. Thus, the data were not discussed.

2- Interaction between faba bean cultivars and Roundup treatment on *Orobanche*, seed yield and its components:

The effect of interaction between faba bean cultivars and Roundup treatment on *Orobanche*, faba bean seed yield per faddan and its components was statistically significant in all studied characters namely number of pods/plant, weight of pods/plant (g), weight of seed/plant (g) and seed yield (ardab/fed) and was statistically insignificant in plant height, number of branches/plant and weight of 100-seed (g) Table (7).

On broomrape:

The effect of interaction between faba bean cultivars and broomrape control treatment was statistically significant on both number and weight of *orobanche* spikes/m² in both seasons. Table (8) show that planting faba bean Misr 3 variety with Roundup application twice at the rate of 75 cm³/fed gave the highest reduction percentage in both number and weight of *orobanche* spikes/m² which were estimated by 97.5, 96.6% and 99.1, 98.7% in 2014/15 and 2015/16 seasons, respectively as compared with untreated Giza 3 cultivar treatment. Meanwhile planting Giza 843 cultivar with Roundup application twice at the rate of 75 cm³/fed reduced the number and weight of *orobanche* spikes/m² by 89, 87.6% and 92.3, 91.7% in 2014/15 and 2015/16 seasons, respectively as compared with untreated Giza 3 cultivar. These results according to the scale suggest by Hassanein *et al* (1998-b) suggest that Misr3 can be considered as resistant cultivar and Giza 843 as resistant/tolerant cultivar to broomrape infestation and the use of Roundup raised broomrape control package to almost 90% reduction. The obtained results were in agreement with those obtained by Ismail and Fakkar (2008).

On faba bean yield and yield components:

Table (9) indicated that growing Misr 3 variety with Roundup spray twice at the rate of 75 cm³/fed gave the highest values of number and weight of pods/plant (g), weight of seeds/plant (22.6, 56.2 and 44.7) in the first season and (21.9, 49.8 and 43.4) in the second season, respectively as compared with untreated Giza 3 cultivar which gave the lowest values (13, 37.5 and 30.5) in the first season and (12.6, 33.7 and 29.2) in the second seasons respectively. The highest yield of faba bean seeds (ardab/fed) was obtained from spraying Misr 3 cultivar with Roundup twice at the rate of 75 cm³/fed which surpassed the unsprayed Giza 3 cultivar by 430.5 and 479.5% in both seasons, respectively.

3- Interaction between seeding rates and Roundup treatments:**On faba bean yield and yield components:**

The results in Table 10 show that the effect of interaction between seeding rates and Roundup treatment was statistically significant on number of branches/plant, weight of pods/plant (g), weight of seeds/plant (g) and seed yield (ardab/fed.) in both seasons, but the same interaction was not significant on plant height (cm), number of pods/plant and weight of 100 seed (g) in both seasons. Data in Table (10) indicated that seed rate of 30kg/fed with application of Roundup twice at the rate of 75 cm³/fed gave the highest values of number of branches/plant, weight of pods/plant (g) and weight of seeds/plant (g) which were 3.74, 50.9 and 41.3 in the first season and 3.6, 48 and 40.2 in the second seasons, respectively as compared with untreated seed rate of 60kg/fed which gave the lowest values (2.9, 44.6 and 35.6) in the first season and (2.62, 40.5 and 33.3) in the second season, respectively. The highest yield of seeds (ardab/fed) was obtained from seed rate of 60 kg/fed with application of Roundup twice at the rate of 75 cm³/fed which surpassed the 30 kg/fed untreated seed rate by 80.3 and 84% in both seasons, respectively which mean that increasing seed rate can be integrated with Roundup treatment partially for improving faba bean seed yield.

Table 7: The significance effect of the interaction between cultivars and Roundup treatments on *Orobanche*, seed yield and its components in 2014/15 and 2015/16 winter seasons

Characters Season	2014/15 winter season	2015/16 winter season
Number of Orobanche spikes/m ²	3.88	7.21
Weight of Orobanche spikes (g/m ²)	47.4	78.17
Plant height (cm)	NS	NS
Number of branches/plant	NS	NS
Number of pods/plant	0.49	0.54
Weight of pods/plant (g)	1.08	1.44
Weight of seeds/plant (g)	0.81	0.76
Weight of 100 seed (g)	NS	NS
Seed yield (ardab/fed)	0.24	0.31

Table 8: Effect of the interaction between faba bean cultivars and Roundup treatment on *Orobanche* in 2014/15 and 2015/16 winter seasons

Cultivars	Roundup application	2014/15 winter season				2015/16 winter season			
		No. of <i>Orobanche</i> Spikes/m ²	% of Reduction	Weight of <i>Orobanche</i> Spikes/m ²	% of Reduction	No. of <i>Orobanche</i> Spikes/m ²	% of Reduction	Weight of <i>Orobanche</i> Spikes/m ²	% of Reduction
Mistr 3	Roundup2 sprays	2.2	99.7	15.2	99.1	3.0	96.6	21.4	98.7
	Untreated check	12.4	86.3	170.7	89.7	14.5	83.6	173.6	89.7
Giza 843	Roundup2 sprays	9.6	89.0	128.6	92.3	11.0	87.6	139.2	91.7
	Untreated check	53.7	38.6	820.1	50.6	55.6	37.2	806.5	52.1
Giza 3	Roundup2 sprays	35.1	60.0	368.7	77.8	39.3	55.4	394.7	86.5
	Untreated check	87.5	0	1661.5	0	88.	0	1682.9	0
LSD at 0.05		3.88		47.40		7.21		78.17	

Table 9: Effect of the interaction between cultivars and Roundup treatment on yield and its components of faba bean in 2014/15 and 2015/16 winter seasons

Cultivars	Roundup application	2014/15 winter season				2015/16 winter season			
		No. of pods/ plant	Weight of pods/plant (g)	Weight of seeds/plant (g)	Seed yield arda/bfed	No. of pods/ plant	Weight of pods/plant (g)	Weight of seeds/plant (g)	Seed yield arda/bfed
Mistr 3	Roundup2 sprays	22.6	56.2	44.7	9.05	21.9	49.8	43.4	8.48
	Untreated check	15.1	48.4	36.9	4.37	14.7	44.8	36.6	3.82
Giza 843	Roundup2 sprays	19.5	51.9	42.0	7.41	18.2	48.6	39.9	7.33
	Untreated check	14.9	47.7	37.4	4.07	14.6	45.3	35.1	4.04
Giza 3	Roundup2 sprays	16.8	43.5	35.3	4.15	16.4	42.5	33.7	3.89
	Untreated check	13.0	37.5	30.5	1.71	12.6	33.7	29.3	1.46
LSD at 0.05		0.49	1.08	0.81	0.24	0.54	1.44	0.76	0.31

Table 10: Effect of the interaction between seeding rates and Roundup treatment on yield and its components of faba bean in 2014/15 and 2015/16 winter seasons

Seeding rate kg/faddan	Roundup application	2014/15 winter season				2015/16 winter season			
		No. of branches / plant	Weight of pods/ plant (g)	Weight of seeds/ plant (g)	Seed Yield ardab / fed	No. of branches/ plant	Weight of pods/ plant (g)	Weight of seeds/ plant (g)	Seed Yield ardab/ fed
30	Roundup 2sprays	3.74	50.9	41.3	6.10	3.60	48.0	40.2	5.99
	Untreated check	3.37	46.3	37.1	3.71	3.08	43.6	34.4	3.46
60	Roundup 2sprays	3.32	48.4	39.0	6.68	3.16	45.5	37.3	6.36
	Untreated check	2.90	44.6	35.6	4.02	2.62	40.5	33.3	3.53
LSD at 0.05		0.31	0.88	0.69	0.44	0.26	1.18	0.65	0.31

4- Interaction among faba bean cultivars, seeding rates and Roundup treatment on *Orobanche*, seed yield and its components:

Data in Table 11 show that the effect of interaction among faba bean cultivars, seed rates and weed control treatments was significant on number, weight of *orobanche* spikes/m², weight of pods and seeds/plant and seed yield (ardab/faddan) meanwhile it was not significant on plant height, number of branches and pods/plant and weight of 100-seed in both seasons.

On broomrape:

Data in Table (12) show that the highest reduction in number and weight of *orobanche* spikes/m² was recorded for Misr 3 cultivar and seed rate of 30kg/fed followed by Roundup application twice at the rate of 75 cm³/fed by 98.1, 99.2% and 97.9, 99% in 2014/15 and 2015/16 seasons, respectively as compared with untreated Giza 3 cultivar and seed rate of 60kg/fed. Giza 843 cultivar with seed rate of 30kg/fed and spraying Roundup twice at the rate of 75 cm³/fed gave reduction in number and weight of *orobanche* spikes/m² by 91.4, 93.4% and 90.5, 93.1% in 2014/15 and 2015/16 seasons, respectively as compared with untreated Giza 3 cultivar and seed rate of 60kg/fed. The

results obtained were in agreement with those obtained by Gadalla *et al.* (2010). The effect of various broomrape control measures on broomrape and faba bean seed yield ardab/faddan as comparing treatments No 10 and 12, there is no significant differences between number or weight of broomrape spikes/m². The effect of seeding rates on both number or fresh weight of broomrape/m² or faba bean seed yield ardab/faddan under susceptible cultivar Giza3 was not statistically significant at 5% level. Concerning the effect of faba bean cultivar, results in treatments No 2, 3 and 10 demonstrated that Misr3 and Giza843 decreased both number and weight of *Orobanche* and increased faba bean seed yield ardab/faddan by 292.5 and 235.6% in 1014/15 season and by 275 and 246.5% in 2015/16 season than susceptible Giza3, respectively. The effect of Roundup application with cultivars Misr3 and Giza843 increased faba bean seed yield ardab/faddan by 273.2 and 266.6% in 1014/15 and 2015/16 seasons, respectively than untreated check which mean that the best treatment can give the best seed yield is used treated cultivar Misr3 by Roundup twice at the rate of 75 cm³/fed with seed rate of 30kg/fed.

Table 11: The significance effect of the interaction among cultivars, seeding rates and Roundup treatment on *Orobanche*, seed yield and its components in 2014/15 and 2015/16 winter seasons

Characters	Season	2014/15 winter season	2015/16 winter season
	Number of <i>Orobanche</i> spikes/m ²		4.62
Weight of <i>Orobanche</i> spikes (g/m ²)		65.42	79.70
Plant height (cm)		NS	NS
Number of branches/plant		NS	NS
Number of pods/plant		NS	NS
Weight of pods/plant (g)		1.53	1.40
Weight of seeds/plant (g)		1.15	1.08
Weight of 100 seed (g)		NS	NS
Seed yield (ardab/fed)		0.34	0.29

Table 12: Effect of the interaction among cultivars, seeding rates and Roundup treatment on number and weight of *Orobanchae* spikes / m², % of broomrape control, weight of pods and seeds/plant (g), seed yield (ardab/fed) and % of seed yield increase in 2014/15 and 2015/16 winter seasons

Components items	No. of Package	Package components	Seeding rates kg/faddan	Roundup treatments	number of <i>Orobanchae</i> spikes/m ²		weight of <i>Orobanchae</i> spikes/m ²		% of broomrape control		Weight of pods/plant (g)		Weight of seeds/plant (g)		Seed yield artab/faddan		% of seed yield increase from check	
					2014/15 winter season	2015/16 winter season	2014/15 winter season	2015/16 winter season	2014/15 winter season	2015/16 winter season	2014/15 winter season	2015/16 winter season	2014/15 winter season	2015/16 winter season	2014/15 winter season	2015/16 winter season	2014/15 winter season	2015/16 winter season
1	Misir 3	Faba bean	30	Treated	1.7	2.0	13.8	17.9	99.2	99.0	56.2	51.7	46.8	44.6	7.82	7.23	357.3	341.0
2	Misir 3	cultivar	30	Untreated	13.7	15.6	167.4	180.2	90.1	89.5	49.6	45.0	40.2	38.5	4.69	4.21	174.3	157.7
3	Misir 3	bean	60	Treated	1.9	2.2	16.7	21.6	99.0	98.7	54.4	49.3	43.5	40.7	8.36	7.74	389.1	372.1
4	Misir 3	rates	60	Untreated	14.5	17.7	178.2	186.4	89.4	89.2	47.6	42.8	37.4	35.8	5.97	5.40	249.1	229.3
5	Giza 843	Roundup	30	Treated	7.8	9.1	110.8	118.0	93.4	93.1	54.7	51.5	46.1	43.9	6.62	6.61	287.1	303.0
6	Giza 843	treatments	30	Untreated	52.0	55.3	831.4	852.6	50.7	50.4	46.9	43.6	36.7	34.5	3.74	3.73	118.7	127.4
7	Giza 843	2014/15	60	Treated	9.5	10.2	132.2	141.3	92.2	91.8	51.6	48.0	41.5	39.4	7.37	7.26	331.1	342.7
8	Giza 843	2015/16	60	Untreated	55.4	59.0	874.5	892.4	48.2	48.1	44.4	41.7	34.8	32.6	5.22	5.13	205.3	212.8
9	Giza 3	2014/15	30	Treated	31.4	35.2	355.6	368.7	78.9	78.6	46.2	43.9	38.5	37.1	3.94	3.31	130.4	101.8
10	Giza 3	2015/16	30	Untreated	86.7	91.5	1641.7	1685.2	2.6	1.9	39.7	37.5	32.4	31.2	1.71	1.64	00	00
11	Giza 3	control	60	Treated	36.1	38.6	382.7	400.4	77.3	76.7	43.0	40.8	35.7	33.8	4.17	3.92	143.9	139.0
12	Giza 3	artab/faddan	60	Untreated	90.8	95.4	1685.2	1718.3	0.0	0.0	35.6	33.4	28.2	26.5	1.90	1.84	11.1	12.2
		LSD at 0.05			4.62	6.86	65.42	79.70	1.32	1.45	1.53	1.40	1.15	1.08	0.34	0.29	54.24	49.56

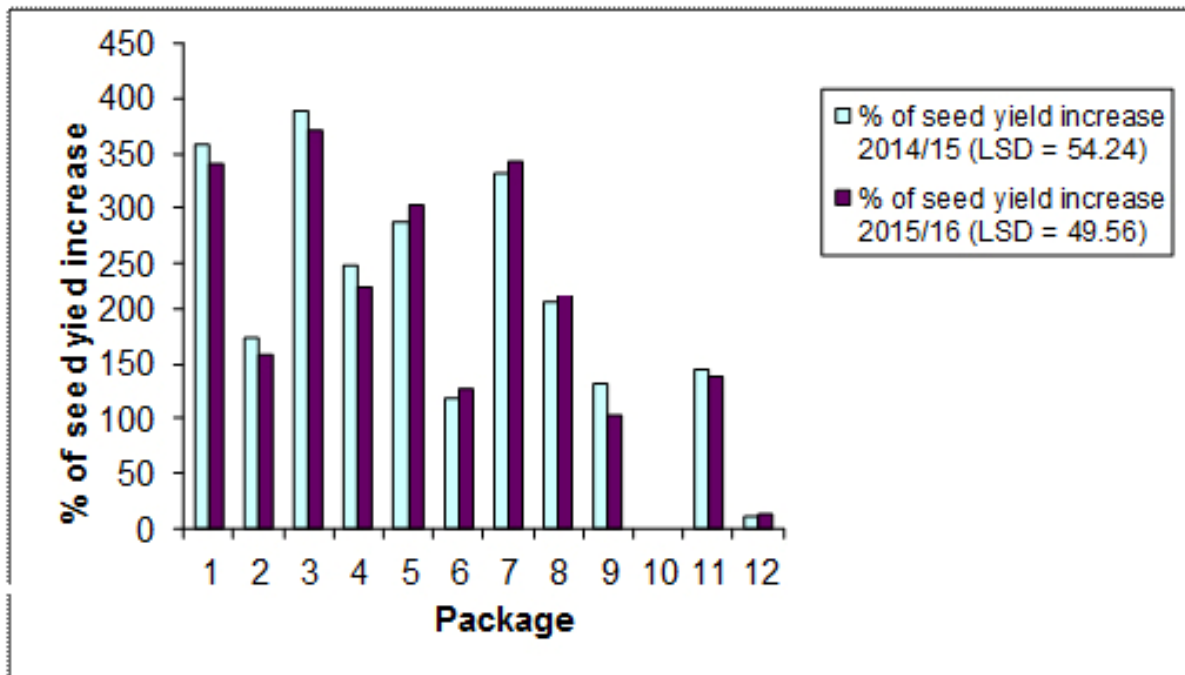
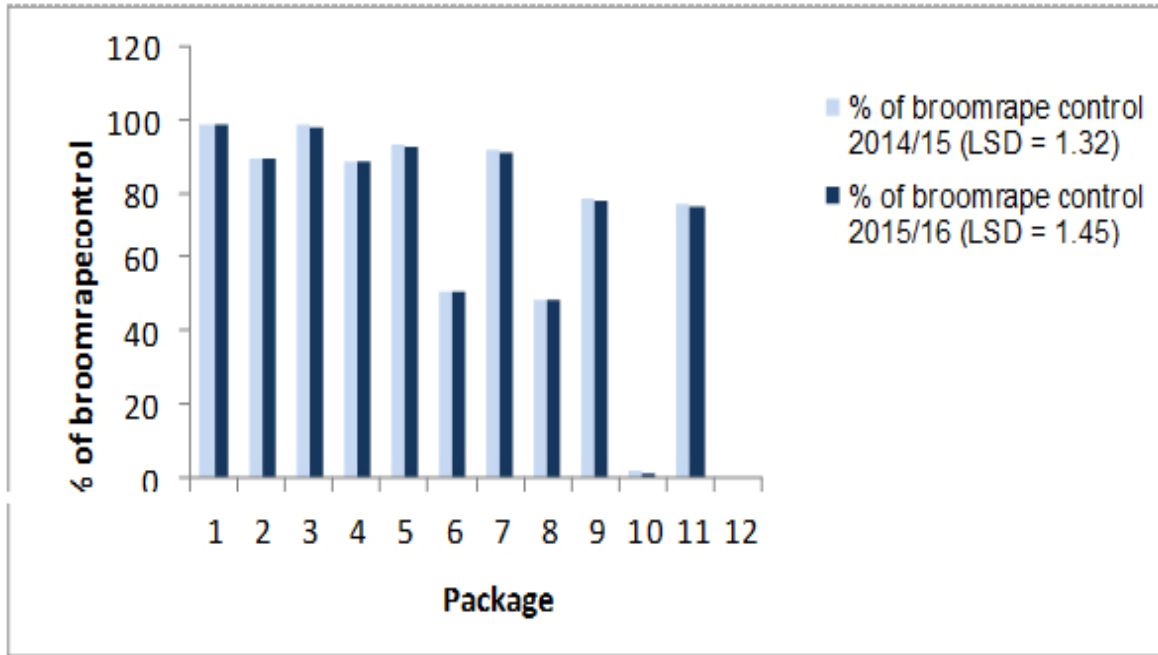


Fig 1: Effect of the interaction among cultivars, seeding rates and Roundup treatments on % of broomrape control and % of seed yield increase in 2014/15 and 2015/16 winter seasons.

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|----------------------------|-----------------------------|-----------------------------|
| 1- Misr 3+30kg+Roundup. | 2- Misr 3+30kg+Untreated. | 3- Misr 3+60kg+Roundup. |
| 4- Misr 3+60kg+Untreated. | 5- Giza 843+30kg+Roundup. | 6- Giza 843+30kg+Untreated. |
| 7- Giza 843+60kg+Roundup. | 8- Giza 843+60kg+Untreated. | 9- Giza 3+30kg+Roundup. |
| 10- Giza 3+30kg+Untreated. | 11- Giza 3+60kg+Roundup. | 12- Giza 3+60kg+Untreated. |

On faba bean seed yield and yield components:

Table 12 show that the package which consist of planting Misr 3 cultivar with seed rate of 30kg/fed and Roundup spraying twice at the rate of

75 cm³/fed gave the highest values of weight of pods/plant (g) and weight of seeds/plant (g) which were 56.2, 46.8 (g) and 51.7, 44.6 (g) in 2014/15 and 2015/16 seasons, respectively as compared with

untreated Giza 3 cultivar and seed rate of 60kg/fed treatment which gave the lowest values of 35.6, 28.2 (g) and 33.4, 26.5 (g) in 2014/15 and 2015/16 seasons, respectively. The highest yield of seeds (ardab/fed) was obtained from Misr 3 cultivar with seed rate of 60kg/fed and spraying Roundup twice at the rate of 75 cm³/fed which surpassed by 389.1 and 372.1% in both seasons, respectively as compared with untreated Giza 3 cultivar and seed rate of 30kg/fed. Giza 843 cultivar with seed rate of 60kg/fed and spraying Roundup twice at the rate of 75 cm³/fed surpassed in seed yield (ardab/fed) by 331.1 and 342.7% in 2014/15 and 2015/16 seasons, respectively as compared with untreated Giza 3 cultivar and seed rate of 30kg/fed. The results obtained were in agreement with those obtained by Hassanein and Kholosy (1997).

Analysis of *Orobanche* control packages on faba bean productivity:

Table (12) and Figure (1) show that planting Misr 3 cultivar with 30 kg seeds/fed. spraying twice with Roundup gave 99.2 and 99% control for broomrape with increase in faba bean seed yield by 357.3 and 341% ardab/fed., followed by Giza 834 cultivar with 30 kg seeds/fed. sprayed twice Roundup gave 93.1 and 93.1% control for broomrape with increase in faba bean seed yield with 287.1 and 303% ardab/fed., meanwhile the use of Giza 3 cultivar gave 78.9 and 78.6% control of

broomrape with faba bean seed yield increase by 130.4 and 101.8% ardab/fed., in 2014/15 and 2015/16 seasons, respectively with no significant differences from seeding rate of 60kg/fed. Thus, from this study there was a possibility for growing faba bean in sandy soil infested with broomrape by planting Misr 3 or Giza 843 cultivars through November with 2 sprays of Roundup at 30 kg/seeding rate.

Correlation among studied characters and faba bean yield:

Data presented in Table 13 indicated clearly that simple correlation coefficients between number and weight of broomrape spikes/m² and faba bean yield was statistically significant and strongly negative at 5% level. This means that number and weight of broomrape spikes/m² were more aggressive in their parasitism to seed yield (ardab/fed.) of faba bean. Also, correlation analysis revealed that the yield increases were positively contributed to the increases in growth characters and yield components.

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Table 13: Combined analysis of correlation coefficient among studied characters

Characters	No. of branches / plant	No. of pods/ plant	Weight of pods/ plant (g)	Weight of seed/ plant (g)	Weight of 100 seed (g)	No. of <i>Orobanche</i> spikes (m ²)	Weight of <i>Orobanche</i> spikes (g)	Seed yield ardab/ fed
Plant height (cm)	0.713	0.765	0.823	0.793	0.569	-0.742	-0.749	0.930
No. of branches/ plant		0.872	0.856	0.870	0.552	-0.819	-0.815	0.813
No. of pods/ plant			0.948	0.958	0.568	-0.828	-0.834	0.895
Weight of pods/ plant (g)				0.959	0.579	-0.794	-0.813	0.909
Weight of seed/ plant (g)					0.571	-0.797	-0.821	0.905
Weight of 100 seed (g)						-0.554	-0.599	0.559
No. of <i>Orobanche</i> spikes (m ²)							0.929	-0.857
Weight of <i>robanche</i> spikes (g)								-0.870

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