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(Original Article)

Effect the Intercropping of Some Legume Crops and Spraying Glyphosate Herbicide on Control *Orobanche crenata* Forsk and Faba Bean Productivity

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Abstract

This study was carried out at Assiut government on a farm naturally infested with *Orobanche crenata* during 2021/2022 and 2022/2023 seasons. The objectives of this recent study were to investigate the effect of intercropping some trap crops i.e; (Fenugreek, Lupine and Egyptian clover), spraying glyphosate and hand pulling on the control of controlling broomrape yield faba bean and its components. The results obtained revealed that intercropping treatments, spraying with glyphosate and hand pulling would help in reducing the infestation of *Orobanche* in faba bean. Consequently, the number of branches, number of pods and pod weight/plant of faba bean were significantly increased with intercropping with each of fenugreek, lupin and Egyptian clover. Seed yield /plot of faba bean cultivars increased with all broomrape control treatments. Misr1 cultivar was associated with a decreased the number and dry weight of broomrape spikes/m^2 as 13.9 and 32.0% and by 24.5 and 37 % in first and the second season compared with Giza 716 cultivar, respectively. The interaction between intercropping systems, glyphosate, hand pulling treatments and cultivars gave the highest reduction in the number and dry weight of broomrape in both seasons and increased the faba bean seed yield. Consequently, the economic return also increased. Both stepwise and simple regression analyses exerted that that the seed yield/plant was effective for seed yield/plot with contribution of $R^2 = 0.231$. Other traits were ranking after seed yield/plant..The remarkable obtained negative and highly significant correlation recorded between seed yield/plot and each of number of broomrape/m^2 (-0.828** and -0.737**)

Keywords: *Faba bean, Intercropping with fenugreek, Lupine, Egyptian clover.*

Introduction

Faba bean (*Vicia faba, L.*) is an essential legume used as a source of protein for both humans and animals. It has high capacity for nitrogen fixation as well as assisting the diversification of agro-ecosystems by indirectly boosting the associated diversity of wild fauna. The faba bean also serves an important agronomic function (Köpke and Nemecek, 2010). In 2021, the area of cultivated faba bean in Egypt reached about 26,382 ha^{-1}, which produced about 105,052 ton

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of dry seeds (FAO, 2021). Broomrapes (*Orobanche crenata* Forsk), a parasitic weed, is the most severe biotic stressor of faba bean, causing large production losses and occasionally totally eradicating the crop. As of now, no single control strategy is adequate to eradicate this parasite from this crop. Therefore, an effective management plan for broomrape eradication is required, which depended on using a combination of resistant cultivars, sensible chemical control techniques, and appropriate cultural practices (Eid *et al*., 2017). According to Kakahy *et al*. (2012), the differences among cultivars had a substantial impact on growth and seed yield. Additionally, according to EL-Metwally *et al.* (2013) and Ismail (2013), glyphosate spraying reduced broomrape by 96–99.1% and enhanced faba bean seed output. Moreover, a technique for encouraging concurrent crop production and soil fertility build up is intercropping. It is a low-cost method of broomrape management, as already used in some parts of Africa (Oswald et al., 2002 and El-Sherbeni *et al*., 2021). According to Bakheit *et al*. (2002) and El-Sherbeni *et al*. (2021) certain crops including flax, fenugreek, lupin, and Egyptian clover were employed as trap or capture crops. The reduction in *Orobanche crenata* emerging spikes, reached 52% when intercropped with fenugreek (Abo-Shall and Raghe 2014). intercropping faba bean with each of lupin, fenugreek, and Egyptian clover significantly decreased faba bean. *Orobanche crenata* Forsk infestations, which in turn enhanced seed output and economic return (Bakheit *et al*. 2002). The goal of the current research was to measure how the *Orobanche* infestation could be affected by both intercropping faba bean cultivars with certain legume crops i.e; fenugreek, lupin, and Egyptian clover and using glyphosate herbicide. With the intention of raising farmers' non-farm income, the faba bean output and the crop's reaction to intercropping were taken into consideration. Furthermore, utilizing both correlation coefficient and stepwise regression analyses, to explore the contributions of yield attributes on the seed yield under these conditions were studied.

Materials and Methods

Two experiments were conducted during the winter growing seasons of 2021/2022 and 2022/2023 at Agronomy Department, Faculty of Agricultural, Assiut University, Egypt. *Orobanche* was naturally abundant and evenly distributed over the field. The experimental site's soil had a clay texture, an average pH of 7.8, 44.2% saturation capacity, 1.62% organic nitrogen, 0.09% total nitrogen, and 1.2 parts per million of accessible phosphorus. In the first and second seasons, October 19th and 20th were sowing dates of trap crops and various varieties of faba beans, respectively. On one side of the ridge, two plants per hill with an interrow spacing of 60 cm and an interplant spacing of 10 cm were planted with faba bean seeds. On the other side of the ridge, the intercrops (Egyptian Clover, Fenugreek, or Lupin) were drilled in a randomized complete block design with three replications, using the indicated seeding rate at the same time as the main crop. Every experiment's treatments were set up using a split-plot design. The sub-plot measured 10.5 m^2 and consisted of four rows spaced 60 cm apart and 3.5 m in length.

The treatments were arranged across the experimental units as follows:

A. Main plots

1. Solid faba bean without any treatment as untreated (control).

2. Solid faba bean +hand-pulling of *Orobanche*.

3. A faba bean + cv. Giza2 Lupine (*Lupinus termis*)

4. A fenugreek (*Trigonella Foenum-graecum*) cv. Giza2 combined with faba beans

5. A faba bean + Egyptian clover (*Trifolium alexandrinum*) cv. Helaly.

6. A Spraying faba beans with Round up 48% (glyphposate) at 3.6g/feddan twice: once at the start of the flowering period and again 21 days apart.

B. The subplot (cultivars).

b1- Misr-1, b2- Giza 843, and b3- Giza 716.

At harvesting, a random sample of ten guarded faba bean plants per plot were used to measure the following: plant height, cm; height of the first pod, cm; number of branches/ plant and number of pods/plant. Additionally, each plot's plants were observed to exhibit the following characteristics for the primary crop's seed yield/plot; 100 seed weight; *Orobanche* spike dry weight/m^2 and number of *Orobanche* spikes/m^2. Additionally, the intercrops' seed output was noted.

Statistical analysis

A. Data analysis

For every season, the gathered data were properly statistically analyzed using the split-plot design method as described by Gomez and Gomez (1984). L.S.D. was used for the mean comparisons at the 5% probability level. Moreover, as done by Samadzadeh *et al*. (2013), The determination of the economic return for each treatment was determined on yield of each treatment and used the official prices of these crops according to the Ministry of Agriculture, Cairo, Egypt 2021

B- Simple, partial and stepwise regression analyses

Simple, partial and stepwise regression analyses were run out to reveal the importance of the dependent variables among the studied traits affecting the seed yield/plot in the all obtained 18 intercropping and cultivars of faba been. All regressions analyses were done as by Naser and Leilah (1993), Shafshak *et al*,1995 and Samadzadeh *et al*., (2013).

C- Correlation coefficient analysis

The phenotypic correlation coefficients were calculated between each pairs of the studied traits as outlined by Walker (1960).

Results and Discussions

1. Analysis of variance

The mean squares of the interaction between intercropping treatments and faba bean cultivars was significant or highly significant in both sowing seasons for studied traits, except for plant height and seed yield/plot in both seasons,100-seed weight in first season and number of broomrape/m^2 in second season (Table 1). These results might explore the effect of the intercropping systems and faba bean cultivars and monitored how these factors affected each other. Consequently, care must be taken when sowing these cultivars of faba bean under different intercropping system, as well as, when spraying the glyphosate to control the broomrape under such conditions. Moreover, the treatments of intercropping and glyphosate spraying were significant or highly significant for all studied traits in both seasons. At the same time, faba bean cultivars were significant or highly significantly differed for all studied traits in both sowing seasons, except for, plant height, number of branches/plant and seed yield/plot in both sowing seasons and seed yield/plant in first sowing season. These results illustrated how faba bean genotypes differed in their performance for different traits under various intercropping and glyphosate spraying to control the broomrape. These results are in line with those reported by Bakheit *et al* (2002), Briache *et al* (2019) and El-Sherbeni *et al* (2021).

Table 1. Analysis of variance of the studied traits for intercropping system and spray glyphosate across the two sowing seasons.

Traits	Source of variations									
	Intercropping (In)		Error(a)		Cultivars (C)		S*C		Error(b)	
	2021 /2022	2022 /2023	2021 /2022	2022 /2023	2021 /2022	2022 /2023	2021 /2022	2022 /2023	2021/ 2022	2022 /2023
D.F	5		10		2		10		24	
Plant height (cm)	419.21**	105.80*	17.10	23.86	15.15	81.24	54.18	83.55	38.87	40.21
Number of branches/plant	2.13**	0.56*	0.16	0.16	0.25	0.23	0.46*	0.81**	0.12	0.15
Height to first pod (cm)	133.52**	113.88**	3.95	4.32	117.78**	89.08**	53.83**	103.59**	7.52	3.53
Number of pods/plant	60.41**	15.95**	1.96	0.38	117.98**	20.74**	16.92**	6.31**	3.14	0.59
Pods to Weight /plant	218.63**	124.22*	7.79	33.01	198.65**	145.36**	63.51**	66.28**	10.47	15.08
Seed yield/plant (g)	439.21**	78.75**	20.14	9.33	9.64	31.68*	195.75**	44.44**	18.29	9.11
Seed yield (kg/plot).	3.18**	2.82**	0.05	0.05	0.06	0.15	0.19	0.11	0.15	0.05
100-seed weight (g)	100.61**	79.74**	15.44	26.77	515.98**	526.79**	26.31	39.33*	22.93	14.24
Number of broomrape/m^2	45.41**	10.19*	0.49	3.19	1.24**	27.35**	0.62**	2.49	0.11	1.21
Broomrape dry weight/ (g/m^2)	7685.56**	1861.77	48.86	815.74	743.93**	7418.99**	307.61**	689.32*	42.88	261.09

*and **significant at the 5% and 1% levels of probability, respectively.

Effect of intercropping system, glyphosate and pulling treatment on faba bean yield and its components

The results in Table 2 revealed that, the intercropping system, glyphosate spraying and pulling significantly decreased the numbers and dry weight of broomrape /m^2 in both seasons compared with untreated (control). The percentage of reduction across treatments in controlling of broomrape /m^2 ranged between 75.20 to 78.53 with an average of 56.17% and between 12.50 to 37.50 with an

average of 19.63 % in 2021/2022 and 2022/2023, respectively. The highest values were recorded with the treatments of faba bean with Lupine and glyphosate spraying in 2021/2022 and 2022/2023 seasons, respectively. Concerning to dry weight of broomrape/m^2, the reduction percentage varied between 51.24 to 79.68 with as average of 54.45 and between 6.19 to 34.02 with an average of 16.89% in 2021/2022 and 2022/2023 seasons, respectively. Moreover, the highest values of the duction in dry weight of broomrape/m^2 resulted from intercropping of faba bean with Lupine and glyphosate spraying in 2021/2022 and 2022/2023 seasons, respectively. This means that intercropping treatments, spraying with glyphosate and pulling would help to reduce the infestation of *Orobanche* in the faba bean crop. Consequently, the number of branches, number of pods/plant, pods weight/plant were significantly increased with the intercropping of faba bean with each of fenugreek, lupine, Egyptian clover, and spraying with glyphosate, as well as pulling treatment, when compared with no pulling in both seasons. All broomrape control treatments and trap crops gave high values of number of branch/plant, numbers of pods/plant, pods weight/plant, seed yield/plot and 100 seed weight and retunes than untreated check treatment in both seasons (Table 2). Seed yield/plot of faba bean cultivars increased by all broomrape control treatments. The highest values of seed yield were obtained when the faba bean cultivars coupled with fenugreek and lupine in the first and second seasons which recorded 171.23 and 246.58% in the first season and 212.68 and 205.63% in the second season compared to untreated treatment (no pulling), respectively (Table 2).

The decrease in *Orobanche* infestation Table 2 by planting fenugreek or lupine may be due to the fact that these plants secrete some chemical which inhibit the germination of *Orobanche* seeds or prevent the infestation of faba bean by *Orobanche*. Also, may be due to the growth of these crops, which covers the soil surface and prevents light and others environmental factors required for the germination of *Orobanche* from reaching the weed. These results are in agreement with those obtained by Al-Menoufi (1991) and El-Sherbeni *et al* (2021)

Effect of Cultivars

The results in Table 2 exhibited that the three tested faba bean cultivars were significantly different in their rate of infestation represented by the number of broomrape spikes/m^2 and broomrape dry weight/m^2, As well as the height of the first pod, number of pods/plant, pods weight/plant, seed yield and 100 seed weight in both seasons. Misr 1 cultivar decreased the number and dry weight of broomrape spikes/m^2 by 13.85 and 31.99 % and by 24.30 and 37.50 % in first and second seasons as compared with faba bean Giza 716 cultivar, respectively. The results might be due to the death of broomrape plants effected by Misr 1 plant due to of penetration of the hauls, mechanical barriers formation or inhibition of broomrape seed germination by chemicals and substances released by root. The obtained results are in line with those found by Briache *et al* (2019) and El-Sherbeni *et al* (2021). Also, Eid *et al* (2017) whose found that using the best control package for growing faba bean in sand soil infested with broomrape is by planting Misr 3 or

Giza 843 cultivars during November along with spray of glyphosate. Moreover, the data in Table 2 showed that the faba bean Giza 843 recorded the highest values of number of pods/ plant, pod weight/ plant. seed yield/ plant and seed yield/plot in both seasons.

Table 2. Effect of intercropping systems and herbicide treatments on faba bean yield and its components of faba bean in 2021/2022 and 2022/2023 seasons.

Cultivar / Intercrop	Plant height (cm)								Number of branches/plant							
	2021\2022				2022\2023				2021\2022				2022\2023			
	Misr 1	Giza 843	Giza 716	Means	Misr 1	Giza 843	Giza 716	Mean	Misr 1	Giza 843	Giza 716	Means	Misr 1	Giza 843	Giza 716	Mean
Fb no pullnig	101.00	104.33	112.67	106.00	94.47	91.05	95.91	93.81	2.48	2.00	2.80	2.43	4.24	4.07	3.48	3.93
Fb with pulling	107.13	108.13	108.33	107.86	99.52	86.13	82.83	89.49	3.07	3.40	3.33	3.27	3.87	4.35	3.90	4.04
Fb+F	97.00	90.92	90.33	92.75	82.37	91.20	90.47	88.01	2.80	2.37	2.53	2.57	4.00	4.84	4.00	4.28
Fb+L	90.00	95.00	96.42	93.81	95.20	97.05	91.91	94.72	2.97	4.00	3.13	3.37	3.90	3.07	4.33	3.77
Fb+E	92.50	94.20	91.67	92.79	95.33	103.07	92.73	97.04	2.95	2.67	3.27	2.96	3.87	3.47	3.99	3.78
Fb+Gly	99.67	105.67	94.33	99.89	92.88	94.33	85.53	90.91	3.20	4.13	3.73	3.69	3.87	5.13	4.07	4.36
Mean	97.88	99.71	98.96	98.85	93.30	93.81	89.90	92.33	2.91	3.10	3.13	3.05	3.96	4.16	3.96	4.03
LSD 0.05 In	4.34				5.13				0.43				0.42			
LSD 0.05 C	N.S				N.S				N.S				N.S			
LSD 0.05 In*C	N.S				N.S				0.57				0.65			

Cultivar / Intercrop	Height to first pod (cm)								Number of pods/plant							
	2021\2022				2022\2023				2021\2022				2022\2023			
	Misr 1	Giza 843	Giza 716	Means	Misr 1	Giza 843	Giza 716	Mean	Misr 1	Giza 843	Giza 716	Means	Misr 1	Giza 843	Giza 716	Mean
Fb no pullnig	34.57	35.00	45.67	38.41	27.33	22.04	39.70	29.69	9.03	12.00	8.87	9.97	5.83	8.73	6.37	6.98
Fb with pulling	32.47	32.47	31.33	32.09	23.17	16.33	28.28	22.59	16.60	16.53	11.53	14.89	7.67	10.61	6.17	8.15
Fb+F	30.53	39.33	33.80	34.55	29.64	33.00	27.33	29.99	14.33	11.09	10.20	11.87	8.47	6.48	6.53	7.16
Fb+L	27.83	25.40	35.47	29.57	38.67	25.30	33.71	32.56	15.97	22.60	10.50	16.36	7.37	6.00	6.90	6.76
Fb+E	29.67	39.33	31.80	33.60	32.73	33.67	28.98	31.79	14.17	12.58	10.00	12.25	7.13	9.67	7.70	8.17
Fb+Gly	24.47	26.00	32.00	27.49	24.67	33.67	32.67	30.34	18.93	16.73	12.67	16.11	9.13	13.27	8.67	10.36
Mean	29.92	32.92	35.01	32.62	29.37	27.34	31.78	29.49	14.84	15.26	10.63	13.57	7.60	9.13	7.06	7.93
LSD 0.05 In	2.08				2.18				1.46				0.65			
LSD 0.05 C	1.89				1.29				1.22				0.53			
LSD 0.05 In*C	4.61				3.21				2.98				1.30			

Cultivar / Intercrop	Pods Weight /plant								Seed yield/plant (g)							
	2021\2022				2022\2023				2021\2022				2022\2023			
	Misr 1	Giza 843	Giza 716	Means	Misr 1	Giza 843	Giza 716	Mean	Misr 1	Giza 843	Giza 716	Means	Misr 1	Giza 843	Giza 716	Mean
Fb no pullnig	34.34	35.33	29.32	33.00	30.51	33.34	24.35	29.40	28.36	44.11	24.02	32.16	28.13	32.00	26.76	28.96
Fb with pulling	42.33	47.42	41.48	43.70	36.84	36.94	30.83	34.87	33.89	37.98	47.37	50.77	34.12	34.54	38.28	35.65
Fb+F	27.95	34.18	31.87	31.30	28.18	32.04	30.38	30.20	35.37	35.87	46.07	39.10	31.49	28.51	28.19	29.40
Fb+L	35.74	52.77	32.11	40.20	32.21	47.38	32.31	37.30	51.77	54.30	46.24	39.75	39.31	40.93	26.75	35.66
Fb+E	36.98	38.85	42.93	39.60	30.97	37.29	40.36	36.21	50.40	30.32	34.84	38.52	34.63	30.11	31.08	31.94
Fb+Gly	43.01	43.60	37.73	41.50	43.06	38.02	33.54	38.21	31.45	33.63	28.91	31.33	29.12	31.46	32.33	30.97
Mean	36.73	42.03	35.91	38.20	33.63	37.50	31.96	34.36	38.54	39.37	37.91	38.61	32.80	32.93	30.57	32.10
LSD	2.93				6.03				4.71				3.21			
0.05 In	2.22				2.67				**N.S**				**2.07**			
LSD	5.44				6.53				7.19				5.16			

N. S =non-significant; Fb no pullnig: Faba bean without pulling; Fb with pulling: Faba bean with pulling; Fb+F: Faba bean +fenugreek; Fb+L: Faba bean +Lupines; Fb+E: Faba bean +Egyptian clover; Fb+Gly: faba bean spraying with glyphosate.

Table 2. Continued.

Cultivar / Intercrop	Seed yield (kg/plot).								100-seed weight (g)							
	2021\2022				2022\2023				2021\2022				2022\2023			
	Misr 1	Giza 843	Giza 716	Mean	Misr 1	Giza 843	Giza 716	Mean	Misr 1	Giza 843	Giza 716	Means	Misr 1	Giza 843	Giza 716	Mean
Fb no pullnig	0.80	0.86	0.53	0.73	0.89	0.74	0.51	0.71	69.50	67.34	78.11	71.65	69.50	63.54	78.76	70.60
Fb with pulling	1.69	1.69	1.68	1.69	1.58	1.39	1.59	1.52	68.92	78.99	84.77	77.56	66.72	76.81	83.62	75.72
Fb+F	1.87	2.01	2.07	1.98	2.25	2.32	2.08	2.22	68.17	68.60	80.44	72.40	68.00	68.00	77.32	71.11
Fb+L	2.04	2.86	2.68	2.53	1.91	2.42	2.18	2.17	69.56	78.44	77.59	75.20	68.33	76.57	81.43	75.44
Fb+E	1.78	1.72	1.28	1.59	1.93	1.66	1.32	1.64	75.25	80.70	84.91	80.29	74.44	80.29	79.75	78.16
Fb+Gly	1.50	1.21	1.61	1.44	1.34	1.40	1.30	1.34	68.34	73.15	77.97	73.15	67.22	72.92	77.57	72.57
Mean	1.61	1.73	1.64	1.66	1.65	1.66	1.50	1.60	69.96	74.54	80.63	75.04	69.04	73.02	79.74	73.93
LSD	0.22				0.23				4.13				5.43			
0.05 In	N.S				N.S				3.29				2.59			
LSD	N.S				N.S				N.S				6.35			

Cultivar / Intercrop	Number of broomrape /m^2								Broomrape dry weight/ (g/m^2)							
	2021\2022				2022\2023				2021\2022				2022\2023			
	Misr 1	Giza 843	Giza 716	Mean	Misr 1	Giza 843	Giza 716	Mean	Misr 1	Giza 843	Giza 716	Means	Misr 1	Giza 843	Giza 716	Mean
Fb no pullnig	7.33	7.67	8.33	7.78	5.00	10.00	9.00	8.00	81.08	97.94	123.65	100.89	55.71	128.46	132.57	105.58
Fb with pulling	3.33	3.33	3.33	3.33	5.00	7.00	8.00	6.67	53.75	45.57	48.25	49.19	82.37	96.89	117.86	99.04
Fb+F	1.00	2.00	2.33	1.78	6.00	7.00	8.00	7.00	14.21	20.93	32.39	22.51	84.64	73.18	112.65	90.16
Fb+L	1.67	2.33	1.00	1.67	4.67	6.00	6.00	5.56	19.64	27.58	14.28	20.5	60.48	69.94	85.39	71.94
Fb+E	2.67	3.00	3.33	3.00	5.67	5.67	7.67	6.33	29.35	46.88	50.34	42.19	64.83	88.17	117.4	90.13
Fb+Gly	2.67	2.67	3.33	2.89	4.00	5.00	6.00	5.00	39.82	35.58	46.06	40.49	57.98	67.27	83.72	69.66
Mean	3.11	3.50	3.61	3.41	5.06	6.78	7.44	6.43	39.64	45.75	52.5	45.96	67.67	87.32	108.27	87.75
LSD 0.05 In	0.73				1.87				7.34				N.S			
LSD 0.05 C	0.23				0.76				4.50				11.12			
LSD 0.05 In*C	0.56				N.S				11.01				27.18			

N. S =non-significant; Fb no pullnig: Faba bean without pulling; Fb with pulling: Faba bean with pulling; Fb+F: Faba bean +fenugreek; Fb+L: Faba bean +Lupines; Fb+E: Faba bean +Egyptian clover; Fb+Gly: faba bean spraying with glyphosate.

Effect of the interaction between intercropping system, glyphosate spraying, pulling treatments and faba bean cultivars

The interaction between broomrape control treatments and cultivars increased most of yield and its components in both seasons as shown in (Table 2). Faba bean Giza 843 cultivar recorded the highest values of most studied traits in both seasons as complained with Giza 716. Meanwhile, the interaction between fab bean Giza 843 cultivar and lupine gave the highest values (2.86 and 2.42) followed by fenugreek (2.01 and 2.32 kg) of seed yield/plot in first and second seasons, respectively. The heaviest 100-seeds of faba bean were obtained under hand pulling on Giza 716 cultivar with as average of 84.91 with Egyptian clover and 83.62g with pulling in first and second seasons, respectively. These results are in agreement with those reported by Briache *et al* (2014) and Eid *et al* (2017). In addition, the data in Table 2 showed that the interaction between intercropping system, glyphosate, pulling treatment and cultivars gave the highest reduction in the numbers of broomrape spike/m^2 and dry weight of broomrape/m^2 in both seasons. The highest reduction was recorded with using faba bean with fenugreek

for the numbers of broomrape/m^2 obtained by the interaction between faba bean Misr1 and Giza 843 cultivars in first season and using glyphosate spraying in second season.

The economic return

The determination of the economic return for the studied treatments in each intercropping system, spraying glyphosate and pulling and for faba bean planted alone were recorded in Table 3. The data revealed that the economic return increased when intercropping faba bean with lupine, fenugreek or Egyptian clover. It was clear that the superiority of intercropping lupine or fenugreek with faba bean was affected by the rate of *Orobanche* infestation.

Table 3. Economic returns from intercropping systems Fenugreek, Lupine and Egyptian clover and glyphosate spraying of faba bean with glyphosate. under natural soil infestation with *Orobanche*

		Treatments					
		Fb no pulling	Fb with pulling	Fb+F	Fb+L	Fb+E	Fb+Gly
Seed yield of faba bean (kg/fad)	2021-2022	306.6	709.8	831.6	1062.6	667.8	604.8
	2022-2023	298.02	638.4	932.4	911.4	688.8	562.8
Seed yield of intercrop (kg/fad)	2021-2022	---------	---------	403.2	205.8	10710	---------
	2022-2023	---------	---------	474.6	109.2	11667	---------
Revenue (L.E/fad)	2021-2022	3955	9156	10727+5604	13707+3910	8614+2225	7802
	2022-2023	3847	8235	12022+6596	11757+2075	8885+2424	7260

Fb no pullnig: Faba bean without pulling; Fb with pulling: Faba bean with pulling; Fb+F: Faba bean +fenugreek; Fb+L: Faba bean +Lupines; Fb+E: Faba bean +Egyptian clover; Fb+Gly: faba bean spraying with glyphosate. The official price for these crops was calculated according to the Ministry of Agriculture, Cairo, Egypt, 2021.

Simple, partial and stepwise regression analyses

Simple, partial and stepwise regression analyses were running for the obtained 18 intercropping and cultivars of faba been applying one dependent trait i.e., seed yield/plot and all other studies were used as independent traits as presented in Table 4

a-Simple, partial and stepwise regression analyses

The stepwise regression analysis for dependent trait of seed yield/plot was expressed one fitted model i.e., Model 1 who has only one independent trait (seed yield/plant) of seed yield/plot which gave $R^2 = 0.231$. Furthermore, the simple regression analysis, which included one trait as independent trait and one dependent trait i.e. seed yield/plot, revealed that the highest three independent traits for their contributions into seed yield/plot in ranking were seed yield/plant (Model 1, as exerted in stepwise regression), plant height (Model 2) and height of first pod (Model 4) were recorded R^2 values of 0.231, 0.226 and 0.208, respectively (Table 4). Moreover, the partial regression analysis which included two from the three previous independent traits increased the contributing into the seed yield/plot as plant height and seed yield/plant (Model 8), and plant height and height of first pod and seed yield/plant (Model 9) and plant height and height of the first pod (Model 10) with R^2 in ranking of 0.360, 0.353 and 0.269, respectively. It is

remarkable result that the partial regression analysis included that previous best three independent traits i.e plant height, height of first pod and seed yield/plant (Model 11) increased their combine contribution into seed yield/plot to $R^2 = 0.370$. This is logical result that the model 11 included the genetic make-up of the three traits that contributed to seed yield/plot.

b-Expected and actual values comparison

The actual and expected seed yield/plot under all treatments which out yielded from all the regression fitted models were presented according to their regression equations in Table 5. The expected seed yield/plot for the obtained fitted model were insignificant difference comparing to the actual seed yield/plot into the all models of regressions analyses as revealed by values of *t-test*, which were less than unity in all models (Table 5). Moreover, the estimates of correlation coefficients (r) between the expected and actual seed yield were positive and high, which ranged from 0.481 (Model 1) to 0.609 (Model 11). These results displayed the effeteness of stepwise and other regression analyses to determine the strongest traits through their genetic contribution into high seed yield of faba bean.

Table 4. Stepwise, simple and partial regression analyses for contributions of studied traits into seed yield weight/plot

Regression	Model	Traits	r^2	Regression equations for expected WSPP
*, **	**1**	**Seed yield/plant (g)**	0.231	$\hat{Y}$ = 3.133 - 0.043 **Seed yield/plant (g)**
**	**2**	**Plant height (cm)**	0.226	$\hat{Y}$ = 7.671 - 0.063 **Plant height (cm)**
	3	**Number of branches/plant**	0.055	$\hat{Y}$ = 0.345 + 0.364 **Number of branches/plant**
	4	**Height to first pod (cm)**	0.208	$\hat{Y}$ = 7.646 - 0.121 **Height to first pod (cm)**
	5	**Number of pods/plant**	0.051	$\hat{Y}$ = 1.055 + 0.054 **Number of pods/plant**
	6	**Pods to Weight /plant**	0.051	$\hat{Y}$ = 0.851 + 0.022 **Pods to Weight /plant**
	7	**100-seed weight (g)**	0.006	$\hat{Y}$ = 1.075 + 0.007 **100-seed weight (g)**
***	**8**	**Plant height (cm) + Seed yield/plant (g)**	0.36	$\hat{Y}$ = 7.563 - 0.049 **Plant height (cm)** - 0.34 **Seed yield/plant (g)**
	9	**Height to first pod (cm)+ Seed yield/plant (g)**	0.353	$\hat{Y}$ = 7.620 - 0.096 **Height to first pod (cm)** - 0.350 **Seed yield/plant (g)**
	10	**Plant height (cm)+ Height to first pod (cm)+**	0.269	$\hat{Y}$ = 6.387 - 0.380 **Plant height (cm)** + 0.638 **Height to first pod (cm)**
	11	**Plant height (cm) + Height to first pod (cm) + Seed yield/plant (g)**	0.370	$\hat{Y}$ = 6.928 - 0.210 **Plant height (cm)** + 0.320 **Height to first pod (cm)** - 0.031 **Seed yield/plant (g)**

*, **, *** Stepwise, Simple and Partial regression analysis, respectively.

Table 5. Actual and expected seed yield/plot obtained through the simple, partial and stepwise regression analyses

System	Cult.	Actual Seed yield /plot.kg	Expected seed yield/plot						
			Seed yield/plant, g (Model 1)	Plant height, cm (model 2)	Height to first pod, cm (Model 4)	Plant height, cm + Seed yield/plant, g (Model 8)	Height to first pod, cm + Seed yield/plant, g (Model 9)	Plant height, cm + Height to first pod, cm (Model 10)	Plant height, cm + Height to first pod, cm + Seed yield/plant, g (Model 11)
Fb no pulling	Misr1	**0.85**	1.17	1.51	1.53	1.23	1.18	1.47	1.15
	Giza843	**0.64**	1.09	1.52	1.55	1.16	1.11	1.42	1.07
	Giza716	**0.69**	1.56	1.10	1.15	1.21	1.18	1.03	1.08
Fb with pulling	Misr1	**1.64**	1.67	1.16	1.17	1.34	1.29	1.27	1.30
	Giza843	**1.54**	1.58	1.55	1.55	1.58	1.52	1.62	1.53
	Giza716	**1.64**	1.29	1.57	1.56	1.36	1.29	1.69	1.36
Fb+F	Misr1	**2.06**	1.89	2.02	1.99	2.19	2.12	2.13	2.16
	Giza843	**2.20**	1.75	1.79	1.80	1.89	1.86	1.71	1.77
	Giza716	**2.05**	1.54	1.98	1.98	1.87	1.82	1.91	1.78
Fb+L	Misr1	**1.98**	1.92	1.80	1.82	2.03	2.01	1.66	1.87
	Giza843	**2.55**	1.50	1.62	1.60	1.56	1.49	1.79	1.58
	Giza716	**2.52**	2.04	1.74	1.72	2.09	2.03	1.83	2.03
Fb+E	Misr1	**1.86**	1.30	1.75	1.77	1.52	1.47	1.68	1.43
	Giza843	**1.47**	1.83	1.46	1.48	1.70	1.67	1.41	1.58
	Giza716	**1.52**	1.72	1.86	1.85	1.92	1.87	1.92	1.88
Fb+Gly	Misr1	**1.42**	1.81	1.61	1.57	1.80	1.72	1.84	1.83
	Giza843	**1.51**	1.73	1.37	1.35	1.56	1.49	1.56	1.56
	Giza716	**1.26**	1.82	2.01	1.97	2.12	2.04	2.15	2.11
Average		**1.63**	**1.62**	**1.63**	**1.63**	**1.67**	**1.62**	**1.67**	**1.61**
r		**-**	**0.481**	**0.476**	**0.456**	**0.601**	**0.595**	**0.519**	**0.609**
t		**-**	**0.948**	**0.976**	**0.975**	**0.686**	**0.929**	**0.712**	**0.884**
r^2		**-**	**0.231**	**0.226**	**0.208**	**0.360**	**0.353**	**0.269**	**0.370**

Fb no pullnig: Faba bean without pulling; Fb with pulling: Faba bean with pulling; Fb+F : Faba bean +fenugreek ; Fb+L : Faba bean +Lupines ; Fb+E : Faba bean +Egyptian clover ; Fb+Gly : faba bean spraying with glyphosate.

Table 6. Phenotypic correlation coefficients between each pairs of studied traits under all treatments in both sowing seasons

	Season	Number of branches/plant	Height to first pod, cm	Number of pods/plant	Pods Weight /plant, g	Seed yield/plant, g	100-seed weight, g	Seed yield /plot, kg	Number of broomrape /m²	Broomrape dry weight, g/m²
Plant height (cm)	1st	0.160	0.193	0.038	0.153	0.284	0.061	-0.451	0.565*	0.632**
	2nd	-0.306	0.271	0.234	0.306	-0.228	-0.179	-0.008	-0.263	-0.256
	Average	-0.66	0.996**	0.139	0.191	0.269	-0.057	-0.476*	0.396	0.465
Number of branches/plant	1st		-0.578*	0.532*	0.721**	-0.29	0.414	0.378	-0.370	-0.313
	2nd		-0.471*	0.455	0.212	0.067	-0.252	0.052	-0.175	-0.047
	Average		0.02	0.597**	0.614**	-0.315	0.138	0.235	-0.455	-0.311
Height to first pod (cm)	1st			-0.752**	-0.552*	0.164	0.189	-0.352	0.495*	0.542*
	2nd			-0.232	-0.272	-0.564*	0.123	0.074	-0.107	-0.103
	Average			0.190	0.244	0.242	-0.045	-0.456	0.358	0.440
Number of pods/plant	1st				0.771**	-0.246	-0.279	0.329	-0.419	-0.405
	2nd				0.428	-0.023	-0.406	-0.067	-0.630**	-0.554*
	Average				0.725	-0.191	-0.368	0.225	-0.569*	-0.536*
Pods Weight /plant(g)	1st					-0.146	0.240	0.298	-0.301	-0.241
	2nd					-0.101	-0.019	0.107	-0.338	-0.250
	Average					-0.163	0.120	0.226	-0.322	-0.236
Seed yield/plant (g)	1st						0.079	-0.441	0.675**	0.584*
	2nd						-0.125	-0.380	0.205	0.090
	Average						-0.009	-0.480*	0.670**	0.485*
100-seed weight (g)	1st							0.121	0.007	0.107
	2nd							0.028	0.308	0.474*
	Average							0.079	0.141	0.297
Seed yield (kg/plot).	1st								-0.828**	-0.817**
	2nd								-0.323	-0.398
	Average								-0.737**	-0.73**
Number of broomrape /m²	1st									0.974**
	2nd									0.912**
	Average									0.939**

Correlation coefficient

The correlation coefficient between each pair of studied traits was calculated and presented in Table 6. The results revealed that the remarkable observes were recorded for the obtained negative and highly significant between seed yield/plot and each of number of broomrape/m^2 (-0.828** and -0.737**) and broomrape dry weight, g/m^2 (-0.817** and -0.730**) in first sowing season and concerning to the average of both sowing seasons, respectively. Second sowing season possessed the same negative correlation but without significance. The most important yield components such as number of pods/plant and pods weight/plant exhibited the same direction of negative correlation with both of number and weight of broomrape/m^2 with either of significant or not correlation values on both seasons and their average. Moreover, one of the attributed yield traits i.e. number of branches/plant exerted the same negative correlation coefficient with number and weight of broomrape/m^2. These obtained results were logic due to the decreased broomrape around faba bean plants will increase their productivity and seed yield and for its components. (EL-Sherbeni *et al*., 2021).

Conclusion

Finally, we can conclude that intercropping faba bean with some trap crops (Fenugreek, Lupine, and Egyptian clover), spraying with glyphosate and pulling on growing to leant cultivar Misr1 and some trap crops gave the highest reduction in *Orobanche* injury in faba bean. Also, cultivar Giza 843 gave the highest seed yield.

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تأثير تحميل بعض المحاصيل البقولية والرش بالجليفوسات على مكافحة الهالوك وانتاجية الفول البلدي ومكوناته

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الملخص

أجريت هذه الدراسة في مزرعة كلية الزراعة جامعة اسيوط الموبوءة طبيعياً بنبات الهالوك خلال الموسمين 2022/2021 ،2023/2022 وكان الهدف من الدراسة معرفة تأثير تحميل بعض المحاصيل البقولية (الحلبة والترمس والبرسيم المصري) وكذلك الرش بالجليفوسات والعزيق على مكافحة الهالوك وكذلك محصول الفول البلدي ومكوناته. أظهرت النتائج أن معاملات التحميل والرش بالجليفوسات والعزيق من شأنها أن تساعد في تقليل الإصابة بنبات الهالوك في محصول الفول البلدي. ونتيجة لذلك، لوحظ زيادة معنوية في عدد الأفرع وعدد القرون ووزنها /نبات من خلال تحميل الفول البلدي مع كل من الحلبة والترمس والبرسيم المصري والرش بالجليفوسات بالإضافة إلى معاملة العزيق بالمقارنة مع عدم العزيق في كلا الموسمين. زيادة محصول البذور/قطعة لأصناف الفول البلدي زادت فى كل معاملات مكافحة الهالوك. أدى الصنف مصر 1 إلى انخفاض العدد والوزن الجاف لسنابل الهالوك/ م^2 بنسبة 13.9 ،32.0% ،24.5 ،37 % في الموسم الأول والثاني مقارنة بالصنف جيزة 716 على التوالي. أعطى التفاعل بين نظم التحميل والجليفوسات ومعاملة العزيق والأصناف أعلى انخفاض في العدد والوزن الجاف للهالوك ومن ثم زيادة إنتاجية بذور الفول البلدي في كلا موسمي التحميل. ونتيجة لذلك أرتفع أيضا العائد الاقتصادي. أظهر كل من تحليل الانحدار المتعدد والبسيط أن محصول بذور النبات الفردي كان أعلى الصفات مساهمة في محصول بذور القطعة التجريبية معطياً مساهمة قدرها 0.231. سجلت قيم ارتباط عالية المعنوية وسالبة بين المحصول البذري وكل من عدد سنابل الهالوك (-0.828 ، -0.737) .