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Effect of Sowing Dates and Herbicide "Glyphosate" on Broomrape (*Orobanche Crenata)* Control and Economic Evaluation of Faba Bean Productivity Under New Lands Conditions

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ABSTRACT

Two field experiments were undertaken at Ismailia Agricultural Research Station, Ismailia governorate, in broomrape-infested fields with sandy soil conditions during the 2020/21 and 2021/22 seasons to investigate the influence of interaction of faba bean sowing dates (25th October, 10th and 25th November) and six broomrape control treatments [glyphosate twice (6 and 8 weeks after sowing) at 50 cc/fed, glyphosate three times (6, 8 and 10 weeks after sowing) at 50 cc/fed., glyphosate twice (6 and 8 weeks after sowing) at 75 cc/fed, glyphosate three times (6, 8 and 10 weeks after sowing) at 75 cc/fed, hand pulling twice (90 and 110 days after sowing)] and untreated check] on broomrape control and faba bean productivity. We implemented a split plot design with four replicates. The main plots were allocated with sowing dates, whereas broomrape control treatments were distributed at random in sub plots. The results showed that the faba bean sowing date on November 25th recorded the highest reduction percentages on number and dry weight of broomrape spikes/m^2 in both sowing seasons, which were 73.8 and 88.1% in 2020/21 season and 71.5 and 87.1% in 2021/22 season, respectively, followed by the sowing date on November 10th, which recorded 63 and 70.1% in 2020/21 season and 59.5 and 69.5% in 2021/22 season. The planting dates of 10th November and 25th November produced the greatest seed yield/fed of faba bean, with increases in seed yield (ardab / fed) of 44.6 and 14.3% in the 2020/21 season and 46.6 and 15.5% in the 2021/22 season, respectively, as compared to the sowing date of 25th October. Glyphosate at 75 cc/fed reduced the quantity and dry weight of broomrape spikes/m2 by 93.8 and 92.4% in the first season, and by 92.4 and 92.1% in the second season, respectively, as compared to the untreated control. Glyphosate, on the other hand, boosted faba bean seed output and itsconstitutes in both seasons as compared to the untreated control. In the first and second seasons, the increases in seed output (ardab/fed) were 154.3 and 144.7%, respectively, as compared to the untreated control. The highest net income was obtained by sowing faba bean on the 10th of November with glyphosate twice at 75 cc/fed, which yielded (10450 and 10720 L.E) in the 2020/21 and 2021/22 seasons, respectively, as opposed to sowing faba bean on the 25th of October and untreated (check), which yielded the highest losses of net income (-3275 and -2750 L.E) in the 2020/21 and 2021/22. Thus, the optimum control package for growing faba bean in sandy soil infested with broomrape might be proposed by planting faba bean on November 10th with glyphosate twice (6 and 8 weeks after sowing) at 75 cc/fed in Ismailia area.

Keywords: Sowing dates, glyphosate, broomrape and faba bean.

1. Introduction

Broomrape parasitic weed is a damaging pest for faba bean agriculture in Egypt, causing considerable output losses of up to 80% and, in some circumstances, forcing farmers to quit growing faba bean under high infestation conditions. Manschadi *et al.,* report that *Orobanche crenata*, Forsk

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(*Crenate broomrape*) is a serious limitation to legume agriculture in the Mediterranean region, impacting 1.12 million hectares of faba bean (*Vicia faba* L.) land (1997). The damaging impact of O. crenata on legumes causes many farmers to postpone or terminate their production. Because legumes play a key role in crop rotation (for soil development) in Mediterranean agriculture, and are an essential component of a sustainable agricultural system, this has a significant economic and agronomic impact. Until recently, no one management method has been sufficient to control this parasite in this crop. Because a single approach does not provide comprehensive control, a strategy utilizing a variety of strategies is required. One of these methods is delayed seeding, which has a significant impact on *Orobanche crenata* attack in legumes. Delayed sowing is advised by El-Ghareib *et al.,* (2019) to avoid severe parasite infections. However, certain legumes have a lengthy life cycle, and delayed seeding might reduce output due to the shorter cropping season, according to Zaitoun and Ibrahim (1998). According to Hassanein *et al.,* (2000), the late planting date (30 November) lowered the quantity and dry weight of *Orobanche sp*. Many studies, on the other hand, indicated that applying glyphosate twice at a rate of 178.7 cc/ha reduced broomrape control by 96-99.1% and increased faba bean seed yield/faddan by 100-149.5 compared to untreated infected controls. Al-Marsafy *et al.,* (2001), Ismail and Fakkar (2008), EL-Metwally *et al.,* (2013), Ismail (2013), and Eid *et al.,* (2017). Glyphosate's effects on broomrape tubercle are due to its selective accumulation in the early parasite plant, which is three times as high as that in the faba bean host root three days after spraying, according to El-Degwy *et al.,* (2010) and Mahmoud and Hemeid (2019). The goal of this study was to find the optimal combinations of planting dates and herbicide glyphosate for broomrape control and faba bean productivity under Ismailia Governorate circumstances.

2. Materials and methods

Two field experiments were conducted at the Ismailia Agricultural Research Station in the Ismailia Governorate during the winter seasons of 2020/21 and 2021/22 in sandy naturally heavily infested soil with broomrape to study the effect of eighteen treatments, which were combinations of three sowing dates and six broomrape control treatments, on broomrape control and faba bean productivity. The experimental design consisted of a split plot experiment with four replications. Each sub plot area was 10.5 m^2 which includes of five ridges 3.5 m length and 0.6 m spacing as follow:

A- Main plots: (Sowing dates):
1- 25th October.
2- 10th November.
3- 25th November.

B- Sub plots: (Broomrape control treatments):
1- Glyphosate (Roundup 48% WSC) twice (6 and 8 weeks after sowing) applied at the rate of 50 cc/fed.
2- Glyphosate (Roundup 48% WSC) three times (6, 8 and 10 weeks after sowing) applied at the rate of 50 cc/fed.
3- Glyphosate (Roundup 48% WSC) twice (6 and 8 weeks after sowing) applied at the rate of 75 cc/fed.
4- Glyphosate (Roundup 48% WSC) three times (6, 8 and 10 weeks after sowing) applied at the rate of 75 cc/fed.
5- Hand pulling twice (90 and 110 days after sowing).
6- Untreated 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 seeds (variety Giza 843) were used for sowing in two seasons. The preceding summer crop was peanut in both seasons. The sprinkler irrigation system was used. Physical properties of the experimental soil are presented in Table (a).

Table a: Physical properties of soil at the experimental site in 2020/21 and 2021/22 seasons.

Seasons	Soil characteristics				Soil texture
	Coarse sand %	Fine sand %	Silt %	Clay %	
2020/21	25.4	69.4	3.8	1.4	Sandy
2021-22	24.5	68.8	4.2	2.5	Sandy

The meteorological data for the two growing seasons, which included monthly average values of maximum and minimum air temperature ^{o}C, relative humidity % and rainfall are presented in Table (b).

Table b: Maximum and minimum temperature, relative humidity and rainfall recorded at Ismailia weather station (Ismailia Governorate) in 2020/21 and 2021/22 seasons.

Month	Temperature ^{o}C						Relative humidity %						Rainfall mm	
	2020/21			2021/22			2020/21			2021/22			2020/21	2021/22
	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Max.	Min.	Aver.	Aver.	Aver.
Oct.	29.6	20.0	24.80	29.5	19.9	24.70	88.1	21.7	54.90	88.2	21.8	55.00	3.50	3.30
Nov.	26.3	16.0	21.15	26.2	15.8	21.00	88.3	22.5	55.40	88.4	22.6	55.50	6.10	6.00
Dec.	20.5	10.6	15.55	20.4	10.5	15.45	86.6	21.7	54.15	86.7	21.8	54.25	9.00	8.00
Jan.	19.2	8.1	13.65	19.1	8.0	13.55	87.2	21.5	54.35	87.3	21.6	54.45	14.10	14.00
Feb.	20.6	8.3	14.45	20.5	8.2	14.35	86.0	18.7	52.35	86.1	18.8	52.45	11.00	10.00
Mar.	23.7	10.8	17.25	23.6	10.7	17.15	86.3	22.5	54.40	88.4	22.6	54.50	8.80	8.00
Apr.	28.6	13.9	21.25	28.5	13.8	21.15	88.6	19.6	54.10	88.7	19.7	54.20	5.50	5.00

2.1. Data collected

2.1.1. Broomrape

Prior to faba bean harvest, the number and dry weight of broomrape spikes per m^2 were promptly recorded.

2.1.2 Faba bean yield and its constituents:

At harvest, ten plants were randomly selected from the center ridges of each plot and the following criteria were recorded:

Plant height (cm), number of branches/plant, number of pods/plant, weight of seeds/plant (g), 100-seed weight/plant (g), and seed yield (ardab/fed) are all determined by the harvest plot area.

2.1.3. Economic analysis:

Economic analysis was performed to analyze the variations between the many researched elements in order to achieve the best profitability by using economic criteria such as gross income, total cost, net income, and net income/costs ratio, similar to the procedures presented by (Buckett, 1981). Economic criteria were evaluated using the following formulas:

1- Gross Income (GI) = Total revenue (LE) from selling all faba bean production.
2- Total Cost (TC) = Variable Cost + Fixed Cost.
3- Net income (NI) = Gross Income (LE) –Total Costs (LE).
4- Profit (P) = Net Income (LE) / Total Costs (LE) × 100.
5-

2.2. Statistical analysis:

All data were performed to suitable statistical analysis of split plot design according to Snedecor and Cochran's process (1967). According to Steel and Torrie (1980), a simple correlation was created for the two seasons to investigate the degree of relationship between the number and weight of broomrape spikes/m^2 and yield and its components of faba bean, and means were compared at the 5% level of significance by using least significant different L.S.D test.

3. Results and Discussion

3.1. Effect of sowing dates:

3.1.1. On broomrape:

Table (1) revealed that the differences in Orobanche infection among the three studied faba bean sowing dates, which reached the level of significance at the 5% level, and revealed that the 25th November sowing date recorded the highest reduction percentage on number and dry weight of

broomrape spikes/m^2 in both sowing seasons, which were 73.8 and 88.1% in 2020/21 season and 71.5 and 87.1% in 2021/22 season, respectively. Following that, the 10th November sowing date reduced the proportion of broomrape spikes/m^2 by 63 and 70.1% in the 2020/21 season and by 59.5 and 69.5% in the 2021/22 season, respectively, as compared to the 25th October sowing date. This decrease might be attributed to a reduction in air temperature, which delayed broomrape attachment to faba bean plants and delayed emergence above soil surface in planting dates of November 25th and 10 th, and so partially evaded broomrape harm. These findings agreed with those of Hassanein *et al.,* (2000) and El-Gareib *et al.,* (2019).

Table 1: Effect of sowing dates on number and dry weight of *Orobanche* spikes/m^2 at harvest in 2020/21 and 2021/22 seasons.

Season	2020/21 season		2021/22 season	
Sowing dates	No. of *Orobanche* spikes (m^2)	Dry weight of *Orobanche* spikes (g/m^2)	No. of *Orobanche* spikes (m^2)	Dry weight of *Orobanche* spikes (g/m^2)
25th Oct.	42.7	228.5	44.9	234.8
10th Nov.	15.8	68.3	18.2	71.6
25th Nov.	11.2	27.2	12.8	30.1
LSD at 5%	5.22	12.69	6.47	15.50

3.1.2. On faba bean yield and its constitutes:

Table (2) results indicated that all faba bean sowing dates varied considerably in faba bean seed yield and components in both the 2020/21 and 2021/22 seasons. In terms of plant height, the tallest faba bean plants belonged to sowing dates 10th November, followed by sowing dates 25th November in the 2020/21 and 2021/22 seasons, as compared to sowing dates 25th October. The greatest number of faba bean branches/plant were achieved from planting date of 10th November, which were 3 and 3.5 branche/plant, followed by sowing date 25th November, which recorded 2.6 and 2.9 branche/plant, as compared to sowing date 25th October (2.5 and 2.7 branche/plant) in 2020/20 and 2021/22 seasons, respectively.

Table 2: Effect of sowing dates on yield and its components of faba bean at harvest in 2020/21 and 2021/22 seasons.

Sowing dates	Plant height (cm)	No. of branches/ plant	No. of seeds/ plant	Weight of seeds/plant (g)	Weight of 100 seed (g)	Seed yield (ardab/fed)
			2020/21 season			
25th Oct.	99	2.5	16.3	11.4	63.4	6.3
10th Nov.	101.5	3	30	21.6	68.8	8.1
25th Nov.	100	2.6	21.9	15.6	66.9	7.0
LSD at 5%	0.38	0.07	3.14	1.18	0.53	0.17
			2021/22 season			
25th Oct.	100.1	2.7	17.9	12.1	64	6.5
10th Nov.	105	3.5	32.5	23.5	70.8	8.4
25th Nov.	101.5	2.9	24.5	17.4	67.6	7.4
LSD at 5%	0.35	0.10	4.15	2.08	2.53	0.18

The faba bean planting dates with the most seeds per plant were recorded with the 10th and 25th of November, respectively. They increased the number of seeds/plant by 84 and 34.4% in the 2020/21 season, and by 81.6 and 36.9% in the 2021/22 season, respectively, compared to the sowing date of October 25th. The highest faba bean seeds/plant (g) recorded by the planting dates of 10th November, followed by 25th November, which increased the weight of seeds/plant by 89.5 and 36.8% in the 2020/21 season and by 94.2 and 43.8% in the 2021/22 season, respectively, compared to the planting date of 25th October. The highest100-seed weight (g) of faba bean were recorded by 10th November planting date,

followed by the 25th November, which increased the weight of 100-seed by 8.5 and 5.5% in the 2020/21 season, and by 10.6 and 5.6% in the 2021/22 season, respectively, compared to the sowing date of the 25th October. The planting dates of 10th November and 25th November produced the highest seed yields/fed of faba bean, with increases in seed yield (ardab/fed) of 44.6 and 14.3% in the 2020/21 season and 46.6 and 15.5% in the 2021/22 season, respectively, compared to the sowing date of 25th October. These findings agreed with those of Zaitoun and Ibrahim (1998), Hassanein *et al.,* (2000), and El-Gareib *et al.,* (2019).

3.2. Effect of broomrape control treatments:

3.2.1. On broomrape:

Data in Table (3) revealed that glyphosate was applied three times (6, 8 and 10 weeks after sowing at 75 cc/fed), glyphosate was applied twice (6 and 8 weeks after sowing at 75 cc/fed), glyphosate was applied three times (6, 8 and 10 weeks after sowing at 50 cc/fed). When compared to the untreated control, glyphosate twice (6 and 8 weeks after planting at 50 cc/fed) resulted in the greatest reductions in the number and dry weight of broomrape spikes/m^2, followed by hand plucking twice (90 and 110 days after sowing). These decreases of previous treatments on number of broomrape spikes/m^2 were 93.8, 85.7, 75.6, 70.6 and 45.9% in 2020/21 season and 92.4, 85.4, 73.9, 69.2 and 44.4% in 2021/22 season, respectively as compared with untreated check. These decreases of previous treatments on dry weight of broomrape spikes/m^2 were 92.4, 85.4, 75.4, 69.8 and 48.3% in 2020/21 season and 92.1, 85.5, 76, 71.5 and 48.8% in 2021/22 season, respectively as compared with untreated check. These decreases are caused by Glyphosate transfer to broomrape tubercles during the subterranean stage, resulting in early consequences. These findings agreed with those of Hassanein *et al.,* (1998-a), Al-Marsafy *et al.,* (2001), and Eid *et al.,* (2017).

Table 3: Effect of broomrape control treatments on number and dry weight of *Orobanche* spikes/m^2 in 2020/21 and 2021/22 seasons.

Broomrape control treatments	No. of *Orobanche* spikes (m^2)	Dry weight of *Orobanche* spikes (g/m^2)	No. of *Orobanche* spikes (m^2)	Dry weight of *Orobanche* spikes (g/m^2)
	2020/21 season		2021/22 season	
Glyphosate 50/2	22.1	96.9	23.1	99.3
Glyphosate 50/3	16.4	75	18.4	76.7
Glyphosate 75/2	9.7	46.2	11	48.4
Glyphosate 75/3	5.4	23.5	7	26.5
Hand Pulling (twice)	33.8	163.9	37.2	170.2
Untreated (check)	66.4	318.5	69.6	328.2
LSD at 5%	4.68	10.80	4.26	13.27

3.2.2. On faba bean yield and its constitutes:

The results in Table (4) showed that all glyphosate treatments and hand pulling twice varied significantly in terms of faba bean seed yield/fed and its constituents, namely plant height, number of branches/plant, number and weight of seeds/plant, and weight of 100 seed in both the 2020/21 and 2021/22 seasons. glyphosate applied twice (6 and 8 weeks after sowing at 75 cc/fed), glyphosate applied three times (6, 8 and 10 weeks after sowing at 50 cc/fed), glyphosate applied twice (6 and 8 weeks after sowing at 50 cc/fed.), glyphosate applied three times (6, 8 and 10 weeks after sowing at 75 cc/fed.) followed by hand plucking twice (90 and 110 days after sowing) recorded the greatest values of plant height, number of branches/plant, number and weight of seeds/plant, weight of 100 seed and seed yield (ardab/fed) in both 2020/21 and 2021/22 seasons, respectively in both seasons as compared with untreated (check). This might be attributed to the largest reductions in numbers and dry weights of broomrape spikes/plant of all glyphosate applied times and rates treatments and hand pulling twice. The treatments with the greatest seed yields of faba bean were glyphosate treated twice at 75 cc/fed, glyphosate applied three times at 50 cc/fed, and glyphosate applied twice at 50 cc/fed. As glyphosate was sprayed three times at 75 cc/fed., followed by hand pulling twice, seed yield (ardab/fed.) increased by 154.3, 137.1, 125.7, 111.4, and 100% in the 2020/21 season, and by 144.7, 126.3, 115.8, 105.3, and

92.1% in the 2021/22 season, respectively, when compared to untreated (check). These findings were in agreement with those obtained by EL-Metwally *et al.,* (2013), Ismail (2013) and Mahmoud and Hemeid (2019).

Table 4: Effect of broomrape control treatments on yield and its constitutes of faba bean at harvest in 2020/21 and 2021/22 winter seasons.

Broomrape control treatments	Plant height (cm)	No. of branches/ plant	No. of seeds/ plant	Weight of seeds/plant (g)	Weight of 100 seed (g)	Seed yield (ardab/fed)
2020/21 season						
Glyphosate 75/3	99.3	2.4	22.2	15.2	66.1	7.4
Glyphosate 50/2	100.7	2.7	27.7	18.7	66.5	7.8
Glyphosate 50/3	101.6	3	30.1	20.4	67.2	8.3
Glyphosate 75/2	102.8	3.4	37.6	24.6	67.6	9.1
Hand Pulling (twice)	98.9	2.3	18.8	11.7	65.6	6.9
Untreated (check)	97.7	1.5	14.3	8.9	65.1	3.5
LSD at 5%	0.92	0.26	1.44	1.56	0.63	0.33
2021/22 season						
Glyphosate 75/3	100.6	2.6	23.7	15.9	66.8	7.6
Glyphosate 50/2	101.9	3	29.2	19.2	67.2	8
Glyphosate 50/3	104	3.2	33.7	22	68	8.6
Glyphosate 75/2	104.4	4.0	41.1	28.1	68.6	9.4
Hand Pulling (twice)	100.2	2.5	20.3	13.8	66.3	7.1
Untreated (check)	99	1.8	14.6	10.1	65.9	3.7
LSD at 5%	1.02	0.28	1.40	2.18	2.71	0.44

3.3. Effect of the interaction between sowing dates and broomrape control treatments:

3.3.1. On faba bean yield and its constitutes:

The interaction between sowing dates and broomrape control treatments had no statistically significant influence on faba bean yield components. As a result, the data were not discussed.

3.3.2. On number, dry weight of *Orobanche* and seed yield of faba bean:

The interaction between faba bean sowing dates and broomrape control treatments had a statistically significant influence on the number and dry weight of Orobanche spikes/m^2 and seed yield /fed (Table 5).

3.3.3. On number and dry weight of broomrape:

In all seasons, the interaction between faba bean sowing dates and broomrape control treatments had a statistically significant influence on the number and dry weight of Orobancke spikes/m^2. Table (5) illustrated that sowing faba bean on November 25th with glyphosate application three times at the rate of 75 cc/fed recorded the maximum percentage reduction in both number and dry weight of Orobancke spikes/m^2 estimated by 97.9, 98.3% and 96.8, 97.9% in the 2020/21 and 2021/22 seasons, respectively, when compared to planting faba bean on October 25th and untreated (check). Meanwhile, planting faba bean on November 10th with glyphosate application three times at the rate of 75 cc/fed reduced the percentage of both number and dry weight of Orobancke spikes/m^2 by 95, 97.1% and 93.8, 96.7% in the 2020/21 and 2021/22 seasons, respectively, when compared to planting faba bean on October 25th and untreated (check). According to the scale proposed by Hassanein *et al.,* (1998-a), the application of glyphosate reduced the broomrape control package by over 90%.

3.3.4. On faba bean seed yield:

The interaction between faba bean planting dates and broomrape control treatments was statistically significant on seed production of faba bean (ardab/fed) in both seasons, according to Table (5). Sowing faba bean on November 10th with glyphosate application twice at a rate of 75 cc/fed resulted in the highest faba bean seed yield (ardab/fed) values, which were exceeded by 311.5 and 279.3% in the 2020/21 and 2021/22 seasons, respectively, when compared to sowing faba bean on October 25th and untreated (check). However, sowing faba bean on November 25th with glyphosate

application twice at the rate of 75 cc/fed increased the percentage of seed yield (ardab/fed) by 230.8 and 210.3% in the 2020/21 and 2021/22 seasons, respectively, as compared to planting faba bean on October 25th and untreated (check). The results gained agreed with those obtained by Ismail and Fakkar (2008).

Table 5: Effect of the interaction between sowing dates and broomrape control treatments on number and dry weight of *Orobanche* spikes (m^2) and seed yield of faba bean in 2020/21 and 2021/22 seasons.

Sowing dates	Broomrape control treatments	No. of *Orobanche* spikes (m^2)	Dry weight of *Orobanche* spikes (g/m^2)	Seed yield (ardab/fed)	No. of *Orobanche* spikes (m^2)	Dry weight of *Orobanche* spikes (g/m^2)	Seed yield (ardab/fed)
		2020/21 season			2021/22 season		
25th Oct.	Glyphosate 75/3	41.7	191.8	6.1	42.1	195.5	6.8
	Glyphosate 50/2	30.4	141	6.9	33.7	144.6	6.9
	Glyphosate 50.3	15	81.5	7.5	16.4	83.2	7.8
	Glyphosate 75/2	9.4	43.3	8.1	11.8	47.3	8.2
	Hand Pulling (twice)	62.6	331.2	6.4	65.2	342.7	6.5
	Untreated (check)	97.4	584.5	2.6	100.5	595.9	2.9
10th Nov.	Glyphosate 75/3	9.7	20.5	8.3	10	21.7	8.5
	Glyphosate 50/2	6.5	17.8	9	7.8	19.7	9.3
	Glyphosate 50/3	4.2	15.1	9.6	5.5	16.4	9.8
	Glyphosate 75/2	2	10.2	10.7	3.2	12.6	11
	Hand Pulling (twice)	12.4	29.9	7.6	14.9	32.7	7.7
	Untreated (check)	32.7	70.4	4.3	35.8	77.8	4.5
25th Nov.	Glyphosate 75/3	15	78.6	7.4	17.3	80.9	7.7
	Glyphosate 50/2	12.6	66.5	7.6	13.9	67.8	7.9
	Glyphosate 50/3	10.3	42.2	8	11.4	45.7	8.4
	Glyphosate 75/2	4.9	17.1	8.6	6.2	19.6	9
	Hand Pulling (twice)	26.4	130.8	6.9	31.5	136.2	7.2
	Untreated (check)	68	300.9	3.6	72.6	310.9	3.9
LSD at 5%		5.14	5.67	0.58	5.32	6.58	0.58

3.4. Correlation among studied characters and faba bean yield:

The data in Table (6) clearly showed that the simple correlation coefficient between the number and dry weight of broomrape spikes/m^2 and faba bean production was statistically significant and strongly negative at the 5% level. This means that the quantity and dry weight of broomrape spikes/m^2 were more aggressive in their rarasitism to faba bean seed production (ardab/fed). In addition, Correlation research demonstrated that increases in the number and weight of seeds/plant, 100-seed weight, and seed yield (ardab/fed) positively contributed to yield enhancements. As a result, if used at the appropriate time and rate for broomrape control, the herbicide glyphosate can play a significant role in enhancing faba bean productivity.

Table 6: Correlation coefficient analysis among all studied characters faba bean and broomrape weed.

Characters	Dry weight of broomrape spikes/m²	Plant height (cm)	No. Of branches/plant	No. Of seeds/plant	Weight of seeds/plant (g)	100-seed weight (g)	Seed yield (ardab/fed)
No. Of broomrape spikes/m²	0.995**	-0.996**	-0.569**	-0.576**	-0.569**	-0.583**	-0.598**
Dry weight of broomrape spikes/m²		-0.990**	-0.562**	-0.568**	-0.562**	-0.576**	-0.586**
Plant height (cm)			0.536**	0.543**	0.535**	0.550**	0.570**
No. Of branches/plant				0.576**	0.569**	0.583**	0.597**
No. Of seeds/plant					0.532**	0.548**	0.567**
Weight of seeds/plant (g)						0.993**	0.585**
100-seed weight (g)							0.988**

*Significant at 5% level of probability
**Significant at 5% level of probability

3.5. Economic evaluation:

According to the data in Table (7), the following planting dates and broomrape control treatments were statistically significant on the economic assessment of faba bean production:

3.5.1. Gross Income (GI):

In both seasons, data showed that sowing dates and broomrape control measures had a statistically significant effect on faba bean GI. The best treatment was sowing faba bean on November 10th with glyphosate application twice at a rate of 75 cc/fed, which resulted in the highest values of faba bean GI (18045 and 18315 L.E) with increases of 371.8 and 321% in 2020/21 and 2021/22 seasons, respectively, when compared to sowing faba bean on October 25th and untreated (check).

3.5.2. Total Coasts (TC):

The data revealed that sowing dates were not statistically significant on faba bean TC in both seasons, while broomrape control treatments were statistically significant on faba bean TC in both seasons. Sowing faba bean on November 10th with glyphosate treatment twice at a rate of 75 cc/fed or hand plucking twice resulted in the highest values of TC for sowing faba bean, which were only surpassed by 7% in both seasons when compared to untreated (check).

3.5.3. Net Income (NI):

Sowing dates and broomrape control treatments were statistically significant on NI of faba bean in both seasons, according to the data. The optimum treatment was seeding faba bean on November 10th and applying glyphosate twice at a rate of 75 cc/fed, which resulted in the biggest increases of faba bean NI (10450 and 10720 L.E) in the 2020/21 and 2021/22 seasons, respectively, when compared to seeding faba bean on October 25th and untreated (check), which resulted in the largest faba bean NI losses (-3275 and -2750 L.E) in the 2020/21 and 2021/22 seasons.

.3.5.4. Profit (P):

Data showed that planting dates and broomrape control treatments had a statistically significant effect on faba bean profit in both seasons. The optimum treatment was seeding faba bean on November 10th with glyphosate spraying twice at a rate of 75 cc/fed, which resulted in the greatest profit values (1.376 and 1.411%) in the 2020/21 and 2021/22 seasons. respectively, when compared to seeding faba bean on October 25th and untreated (check), which yielded the lowest profit values (-0.461 and -0.387%) in the 2020/21 and 2021/22 seasons.

Table 7: Effect of sowing dates and broomrape control treatments on economic evaluation of faba bean yield in 2020/21 and 2021/22 seasons

Treatments	GI				TC				NI				P			
	25th Oct.	10th Nov.	25th Nov.	Mean	25th Oct.	10th Nov.	25th Nov.	Mean	25th Oct.	10th Nov.	25th Nov.	Mean	25th Oct.	10th Nov.	25th Nov.	Mean
2020/20 Season																
75/3	10905	13673	12270	12283	7280	7280	7280	7280	3625	6393	4990	5003	0.498	0.878	0.685	0.687
50/2	11288	14798	12775	12954	7420	7420	7420	7420	3868	7378	5355	5534	0.521	0.994	0.722	0.746
50/3	11903	15968	12910	13594	7430	7430	7430	7430	4473	8538	5480	6164	0.602	1.149	0.738	0.830
75/2	13140	18045	13635	14940	7595	7595	7595	7595	5545	10450	6040	7345	0.730	1.376	0.795	0.967
Hand pulling (twice)	9863	11438	10388	10563	7600	7600	7600	7600	2263	3518	2788	2856	0.298	0.463	0.367	0.376
Untreated (check)	3825	6375	5400	5200	7100	7100	7100	7100	-3275	-725	-1700	-1900	-0.461	-0.101	-0.239	-0.267
Mean	10154	13383	11230	11589	7404	7404	7404	7404	2750	5925	3826	4167	0.365	0.793	0.511	0.557
LSD 5%	**254.9**				**24.97**				**254.9**				**0.032**			
2021/22 Season																
75/3	11280	13830	12720	12610	7280	7280	7280	7280	4000	6550	5440	5330	0.549	0.900	0.747	0.732
50/2	11980	15248	12915	13381	7420	7420	7420	7420	4560	7828	5495	5961	0.615	1.055	0.749	0.806
50/3	12593	16050	13525	14056	7430	7430	7430	7430	5163	8620	6095	6626	0.595	1.160	0.820	0.892
75/2	13148	18315	14490	15318	7595	7595	7595	7595	5553	10720	6895	7723	0.731	1.411	0.908	1.017
Hand pulling (twice)	10005	11115	10763	10628	7600	7600	7600	7600	2405	3838	3163	3135	0.316	0.505	0.416	0.412
Untreated (check)	4350	6863	5813	5675	7100	7100	7100	7100	-2750	-237	-1288	-1425	-0.387	-0.033	-0.181	-0.200
Mean	10559	13570	11704	11944	7404	7404	7404	7404	3155	6219	4300	4558	0.419	0.833	0.576	0.609
LSD 5%	263.15				24.97				263.15				0.0387			

GI = Total revenue (LE) from selling all faba bean production, **TC =** Variable Cost + Fixed Cost, **NI =** Gross Income (LE) –Total Costs (LE), **P =** Net Income (LE) / Total Costs (LE) × 100.

4. Conclusion

The current experiments' findings clearly demonstrated the need of seeding faba bean on November 10th and using glyphosate twice (6 and 8 weeks after sowing) at 75 cc/fed to reduce broomrape in faba bean fields. Under Ismailia area conditions research, these approaches resulted in the greatest decrease of broomrape weed while also increasing seed yield productivity of faba bean crop in Egypt.

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