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EFFECT OF GLYPHOSATE, SALICYLIC ACID, NITROGEN AND ORGANIC FERTILIZATION ON BROOMRAPE CONTROL AND FABA BEAN PRODUCTIVITY

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ABSTRACT: ***In Upper Egypt, the level of broomrape infestation is so high because of high temperature which led to decline of faba bean area. The control of two field experiments were conducted in a heavy infested soil with broomrape in Shandaweel Research Station, Sohag Governorate, Agricultural Research Center during 2016/17 and 2017/18 winter seasons to study the effected potential integration between nitrogen and manure fertilizers hand pulling and interaction between selective herbicides and salicylic acid on control for broomrape and increased faba bean productivity. Each experiment contained three levels of (nitrogen fertilization at rate 20 kg/fed., organic manure fertilizers at rate 20 m^3/fed, nitrogen fertilization at rate 10 kg /fed + organic manure fertilizers at rate 10 m^3/fed and without fertilizer (untreated check) and eight broomrape control treatments (Glyphosate twice at rate 75 cm^3/fed - Glyphosate once at rate 75 cm^3/fed. + Salicylic acid once at 200 mg/one liter water - Glyphosate once at rate 50 cm^3/fed + Salicylic acid once at 200 mg/one liter water - Salicylic acid thrice at rate 200 mg/one liter water - Hand pulling twice and untreated (control). Split plot design in three replications were used. Faba bean cultivar was Giza -843 and plot area was 10.5 m^2.***

The results revealed that fertilizers reduced significantly Orobanche infestation in 2016/17 and 2017/18 seasons. Addition of 20 kg N-fertilizer/fed and N-fertilization at 10 kg /fed + O.M-fertilizers at 10 m^3/fed increased number plants of faba bean/plot by (10.28 & 6.84%) and (2.84 & 1.18%), decreased number of plant infestation/plot by (33.41 & 17.40%) and (13.86 & 10.58%), number of broomrape spikes /plot by (31.49 & 22.16%) and (15.44 & 12.83%) and dry weight broomrape spikes/plot by (31.38 & 22.00%) and (15.45 & 12.84%) in 2016/17 and 2017/18 seasons, respectively, compared with non-fertilizer check. Nitrogen fertilization and nitrogen fertilization +Organic manure fertilizer recorded the highest values for plant height (cm), number of branches/plant, number of pods/plant, weight of pods/plant (g), seed weight/plant (g), 100-seed weight (g) and seed yield /fed in both seasons compared with non-fertilizer.

Broomrape control treatments decreased significantly numbers and weight broomrape spikes (g/plot) of Orobanche in 2016/17 and 2017/18 seasons. Glyphosate at rate twice at 75 cm^3/fed and Glyphosate once at rate 75 cm^3/fed. + Salicylic acid once at 200 mg/one liter water increased number plants of faba bean/plot by (12.44 & 12.35%) and (4.61 & 4.12%) and decreased the number of plant infestation of faba bean/plot by (59.43 & 46.69%) and (52.52 & 51.54%), number of broomrape spikes /plot by (55.06 & 50.64%) and (49.63 & 49.48%) and dry weight of broomrape spikes/plot by (55.10 & 50.69%) and (49.62 & 49.47%) in 2016/17 and 2017/18 seasons, respectively, as compared with untreated (control). Glyphosate at rate twice and glyphosate once + Salicylic acid once gave the heist values number of pods/plant, weight of pods/plant (g), seed weight/plant (g), 100-

seed weight and seed yield /fed. in both seasons compared with untreated check in both seasons.

Through this study, salicylic acid can be used as a safe alternative to plants and the environment as a new trend in broomrape control and increasing the production of faba bean.

Key words: ***Glyphosate, Salicylic acid, broomrape control, faba been.***

INTRODUCTION

In the Nile valley, Egypt, faba bean fields are often infested with *Orobanche* spp. In Middle and Upper Egypt, the level of infestation is so high that there has been a complete crop failure the yield losses usually due to *Orobanche* infestation is proportional according to the level of infestation which could reach up to 90-100% (Anonymous, 1994) and (Saxena *et al.* 1994) by 5-100%. The control of this parasitic weed is very difficult because no measure adequate by itself for controlling *Orobanche*. Further, due to many reasons as the late attachment to the host make the use of pre-emergence herbicides not suitable in one side, also limited selectivity with post-emergence herbicides in faba bean.

Many researchers reported that the high nitrogen application reduced development of Egyptian broomrape and crenata broomrape as reported by Van Hezewijk *et al*. (1991). Demonstrated significant reductions of *Orobanche crenata* Forsk in faba bean following applications of ammonium sulfate equivalent to 14 and 28 kg N/ha. Pieterse (1991) reported that nitrogenous fertilizers reduced crenate broomrape seed germination and radical length of germinated seedlings.

Urea and ammonium sulfate were shown to decrease the percentage of seed germination and radical elongation of crenate broomrape when applied during pre-conditioning and germination (Pieterse 1991). Jain and Foy (1992) stated that the effects of N from different sources had different inhibitory effects. Experiments on the direct effects of nitrogen on broomrape seeds strongly implicate the reduced forms of nitrogen such as urea, ammonium sulfate. Demirkan and Nemli (1994) demonstrated that high soil nitrogen fertility has been suggested to reduce the severity of crop damage caused by broomrape. Nandula *et al*. (1996) found that the effects of N from different sources had different inhibitory effect on broomrape seeds. Ismail (2013) revealed that adding 10 and 20 kg N/fed reduced *Orobanche* infestation by 22.3 and 43.9% , while improved seed yield by 14.9 and 13.1%, respectively, than unfertilized plots. Organic manure improved seed yield by 1.5 and 4.2%, respectively, than without manure. Fakkar *et al* (2016) indicated that the mineral fertilizer reduced both the number and weight of broomrape spikes followed by organic fertilizer recorded the highest values of yield and yield attributes as compared with the unfertilized.

Herbicides and Salicylic acid are the most important of the available methods for *Orobanche spp.* control. Ward *et al* (1991) indicated that Salicylic acid (SA) is a chemical defence-inducer that enhanced resistance to various pathogens and induces disease resistance and systemic acquired resistance (SAR) gene expression. Gorlach *et al* (1996) demonstrated that Benzothiadiazole (BTH) is a synthetic functional analogue of SA and its application to plants has been proposed to be an applicable strategy to control *Orobanche* parasitism. Al-Marsafy *et al* (2001) revealed that increased faba bean seed yield by 416, 372 and 312% obtained by the application of glyphosate twice and/or *Orobanche* hand-pulling twice 30 and 110 days after sowing compared to the untreated check. Luque *et al* (2004)

noted that the effect of salicylic acid reduced broomrape infection under controlled conditions by limiting the success in attachment and retarding the development of established tubercles. Gonsior *et al* (2004) revealed that (SA) applications reduced the total *Orobanche. foetida* number and the number of tubercles reaching stage 5, but did not induce necrosis of developing parasite tubercles. Kusumoto *et al* (2007) stated that in clover, root application of (SA) and (BTH) significantly reduced the number of established *Orobanche. minor* parasites by more than 75%. Ismail and Fakkar (2008) noted that the best treatments for faba bean yield and quality were achieved from hand pulling twice. Also, they found is applied (SA) increased plant's tolerance to several a biotic stresses and also influence a range of diverse processes in plants, including seed germination, stomata closure, ion uptake and transport, membrane permeability, photosynthesis and plant growth rate (Aftab *et al*. (2010). Bayoumi *et al* (2013) indicated that application of glyphosate at 75 cm^3/fed recorded the lowest broomrape population by 85.85%. Ismail (2013) stated that application of glyphosate alone or as complement with hand pulling gave higher reduction in the number and weight of broomrape by 97.1, 97.1, 97.0, and 97.3%, respectively, as compared with untreated chick and improved seed yield by 75.6 and 72.1%, respectively. El-Metwally *et al* (2013) reported that glyphosate application three times significantly increased seed yield over the unweeded check by 85.1%. Abbes *et al* (2014) found that (SA) and (BTH) applications reduced the total number of faba bean broomrape spike by 46.45% and 77.06%, and the dry weight of broomrape spike by 47.03% and 70.3%, respectively. El-Rokiek *et al* (2015) found that the maximum yield was obtained by the addition of ammonium sulfate to glyphosate at 37.5 ml/fed compared with the infected control. Fakkar *et al* (2016) stated that foliar application of glyphosate two times significantly decreased the number, dry weight of broomrape. Hand pulling twice and application of glyphosate two times 50+75 caused increase in faba bean seed yield of 75.8 and 72.2%, respectively. Eid *et al* (2017) indicated that foliar application glyphosate twice significantly decreased the number and dry weight of broomrape spikes/m^2 by 75.2 and 73.1% in the first season and by 72.6 and 69.8% in the second season, respectively, while the increased seed yield /fed. were 89.1 and 86.3% in the first and second seasons, respectively, as compared with untreated check.

So, this study is aimed to estimate the magnitude of contribution of the use of mineral and manure fertilizers, hand pulling and selective herbicide alone or as in integration with each other for controlling broomrape and study their effect on yield and its components of faba bean.

MATERIALS AND METHODS

Two field experiments were conducted at Shandaweel Research Station, Sohag Governorate during 2016/17 and 2017/18 winter seasons to study the effect of nitrogen, organic manure fertilizers and broomrape control in faba bean crop in naturally infested soil with broomrape. Soil texture of the experimental plots in both seasons was sandy loam.

Soil analysis

Surface soil samples (0-30 cm) were collected before planting from the experimental sites in two seasons for physical and chemical characters and their data is listed in Table (1).

Table (1): Soil characterization for the experimental site.

Seasons	Texture	$CaCO_3$%	Soil pH	O.M %	Available nutrients in soil (ppm)			
					N	P	K	Zn
2016/17	Clay loom	7.70	7.8	1.2	18.5	18	38	0.47
2017/18	Clay loom	7.82	7.8	1.05	20	22	40	0.52

Each experiment included twenty four treatments which were in combination of four fertilization treatments and six broomrape control treatments in a split plot design in three replications as follows:

A- Main plots: Fertilization

1- Nitrogen fertilization was soil applied as ammonium sulphate (33.5 % N) at a rate of 20 kg N/fed before the first and the second irrigations of faba bean.

2- Organic manure fertilizers (Table 2) at a rate of 20 m^3 /fed was applied before sowing.

3- Nitrogen fertilization at rate 10 kg /fed + Organic manure fertilizers at rate 10 m^3/fed

4- None fertilization (untreated check).

B- Sub plots: Broomrape control treatments:

1-Foliar application of Glyphosate, 2 times with equal rate of 75 cm^3/fed, applied at the beginning of the flowering stage with 21 days interval between two applications.

2-Foliar application of Glyphosate, one time with equal rate of 75 cm^3/fed at the beginning of the flowering stage followed by foliar application of Salicylic acid at 200 mg/one liter water at 30 days after planting.

3- Foliar application of Glyphosate, one time at a rate of 50 cm^3/fed, at the beginning of the flowering stage + foliar application of Salicylic acid at 200 mg/one liter water at 30 days after planting.

4- Foliar application of Salicylic acid thrice at faba bean germination is complete, at 30 days after planting and beginning of the flowering stage at rate of 200 mg/one liter water solution of the corresponding times.

5-Hand pulling twice.

6-Untreated (control).

Salicylic acid (SA) ($C_7H_6O_3$): Salicylic acid or 2-hydroxybenzoic acid was prepared by solving SA in ethyl alcohol. Every sub-sub plot which was treated with SA received 200 mg.

Glyphosate (48% WSC): N-(phosphonomethyl) glycine.

Faba bean cultivar (Giza- 843) was planted in 12th and 18th November in during 2016/2017 and 2017/2018 respectively, with a rate of 35 kg seeds/feddan. The sub sub plot area was 10.5 m^2 contains five rows 3.5 m length and 60 cm apart. The normal cultural practices were carried out according to the local recommendations. The herbicidal treatments were sprayed with a knapsack sprayer with one nozzle boom. The water volume used was 200 liters/fed.

Table (2): Chemical analysis of farm yard manure (FYM) applied in the trait:

Component	Organic matter %	pH	Total nitrogen %	Organic carbon %	C/N Ratio	P %	K %
Fertilizer of (FYM)	20.02	7.7	0.49	11.61	23.69	0.24	1.10

Data recorded:

A-Broomrape:

The following data were recorded:

1-Number of plants of faba bean/plot (10.5 m^2).

2-Number of infested faba bean plants/plot (10.5 m^2).

3-Number of broomrape spikes/plot.

4-Weight of broomrape spikes/plot (g).

5-Broomrape incidence % =

$$\frac{\text{No. of infested host plants by broomrape}}{\text{Total number of host plant(faba bean)}} \times 100$$

6-Broomrape severity = Average number of spikes/host plant.

B - Yield and its components

At harvest in mid-April, samples of ten faba bean plants were collected at randomly from the central rows of each plot to study the following criteria: plant height (cm), number of branches/plant, number of pods/plant, weight of pods (g/plant), seed weight (g/plant) and 100-seed weight (g). Seed yield/fed. were estimated from the whole of each plot.

Statistical analysis:

The collected data were statistically analyzed according to the method described Snedecor and Cochran (1981). Least Significant Differences (LSD-received) test was used for comparison between means of treatments.

RESULTS AND DISCUSSION

A- Effect of fertilization treatments

1- Broomrape characters

Data in Table (3) revealed that fertilizer increased significantly number of faba bean plants/plot (10.5 m^2) but reduced no. of infested faba bean plants, no. of broomrape spikes and dry weight spikes/plot of broomrape compared with un fertilizerd 2016/17 and 2017/18 seasons.

Nitrogen fertilization at a rate of 20 kg N/fed before the first and the second irrigations of faba bean and nitrogen fertilization at 10 kg/fed+ Farm yard manure at a rate of 10 m^3/fed (Organic manure) increased significantly number of faba bean plants/plot by (11.46% and 10.18%) in 2016/17 season and by (2.84 and 1.18%) in 2017/18 season, respectively, compared to without fertilizer treatment.

Nitrogen fertilization and nitrogen fertilization +Organic manure fertilizer decreased number of infested faba bean plants/plot by (33.41 & 17.40) and (13.86 & 10.58%), number of spikes broomrape/plot by (31.49 & 22.16%) and (15.44 & 12.83%) and dry weight spikes (g/plot) of broomrape by (31.38 & 22.00%) and (15.45 & 12.84%) in 2016/17 and 2017/18 seasons, respectively, compared with non-fertilizer check.

Nitrogen fertilization at rate 20 kg/fed and nitrogen fertilization at rate 10 kg /fed +Organic manure fertilizers at rate 10 m^3/fed gave the highest reduction incidence (10.27 & 12.99%) and (12.63 & 13.17%) and severity (0.13 & 0.15%) and (0.14 & 0.15%) of broomrape as compared to non-fertilizer (15.65 & 14.76%) and (0.12 & 0.18%) in 2016/17 and 2017/18 seasons, respectively.

This might be due to nitrogenous fertilizers reduced crenate broomrape seed germination and radicle length of germinated seeding. Nitrogen from different sources had different inhibitory

effects. The effect could be due to a direct interaction with the metabolism of broomrapes by altering the osmotic balance (Ernst 1988), since high nitrogen supply would reduce the uptake of potassium (Welte and Wemer 1963) for which the parasite has a high demand (Ernst 1988). Also, several authors reported direct toxicity by nitrogen fertilizers to seeds of broomrape. These results are in line with those obtained by Van Hezewijk *et al* (1991), Demirkan and Nemli (1994), Nandula *et al*. (1996), Ismail (2013) and Fakkar *et al* (2016).

Organic manure fertilizer at 20 m^3/fed decreased number of plant infestation/plot, number of broomrape spikes/plot and dry weight of broomrape spikes (g/plot) by (8.37, 16.36 and 16.33%) in 2016/17 season and by (9.46, 11.15 and 11.16%) in 2017/18 seasons, respectively, compared with non-fertilizer check. These results are in line with those obtained by Jain and Foy (1992).

2- Yield and yield components of faba

The data in Table (4) revealed that using fertilizers had significant influence on yield and yield components of faba in 2016/17 and 2017/18 seasons. Applied of 20 kg N/fed and N-fertilization at 10 kg /fed + O.M-fertilizers at 10 m^3/fed recorded the highest values for plant height (cm), number of branches/plant, number of pods/plant, weight of pods/plant (g), seed weight/plant (g), 100-seed weight (g) and seed yield/fed in both seasons compared with non-fertilizer.

Application of N-fertilization and N-fertilization + O.M-fertilizers significantly increased number of pods/plant by (35.41 & 18.46%) and (11.15 & 7.44%), weight of pods/plant by (27.07 & 11.07%) and (18.61 & 10.13%), seed weigh/plant by (30.98 & 13.98%) and (23.26 & 13.23%), 100-seed weight by (18.94 & 10.54%) and (14.78 & 7.89%) and seed yield /fed.by (19.76 & 15.42%) and (19.65 & 16.70%) in 2016/17 and 2017/18 seasons, respectively, as compared with non-fertilizer treatment.

Table (3): Effect of fertilizer on broomrape growth characters in 2016/17 and 2017/18 seasons

Broomrape control treatments	No. of faba bean plants/plot	No. of infested faba bean plants/plot	No. of broomrape spikes /plot	Weight of broomrape Spikes /plot	Incidence %	Severity
	2016/17 season					
Nitrogen fertilization	218.39	22.38	27.67	116.20	10.27	0.13
Organic manure fertilizers	210.33	30.75	33.78	141.68	14.94	0.16
Nitrogen + Organic manure fertilizers	215.89	27.72	31.44	132.07	12.99	0.15
Untreated (check)	195.94	33.56	40.39	169.33	17.65	0.21
$L.S.D_{0.05}$	9.83	2.66	3.22	13.54	1.45	0.02
	2017/18 season					
Nitrogen fertilization	211.39	26.22	30.72	129.03	12.63	0.14
Organic manure fertilizers	207.89	27.56	32.28	135.57	13.36	0.16
Nitrogen + Organic manure fertilizers	209.61	27.22	31.67	133.00	13.17	0.15
Untreated (check)	205.39	30.44	36.33	152.60	14.76	0.18
$L.S.D_{0.05}$	12.61	3.19	3.10	13.02	1.87	0.3

***Plot area was 10.5 m^2**

Table (4): Effect of fertilizer on yield and yield components of faba in 2016/17 and 2017/18 seasons

Broomrape control treatments	Plant height (cm)	No .of branches / plant	No. of pods / plant	Weight of pods / plant	Seed weight (g) / plant	100-seeds weight (g)	Seed yield (Ardab) / fed.
2016/17 season							
Nitrogen fertilization	129.61	3.33	34.19	72.66	62.03	71.03	6.06
Organic manure fertilizers	121.50	2.96	27.98	62.74	51.49	64.24	5.68
Nitrogen + Organic manure fertilizers	123.75	3.20	29.91	63.51	53.98	66.07	5.84
Untreated (check)	120.08	2.90	25.25	57.18	47.36	59.77	5.06
$L.S.D_{0.05}$	2.83	0.18	1.71	2.78	3.18	2.65	0.23
2017/18 season							
Nitrogen fertilization	127.27	3.65	28.82	67.22	61.04	69.11	6.09
Organic manure fertilizers	121.67	3.13	26.19	60.34	51.75	61.76	5.54
Nitrogen + Organic manure fertilizers	123.64	3.20	27.86	62.41	56.07	64.96	5.94
Untreated (check)	119.34	2.96	25.93	56.67	49.52	60.21	5.09
$L.S.D_{0.05}$	1.94	0.12	2.04	2.37	2.00	2.75	0.31

Organic manure fertilizer at 30 m^3/fed. significantly increased number of pods/plant by (10.81 and 1.00%), weight of pods plant by (9.72 and 6.48%), seed weigh/plant by (8.72 and 4.50%), 100-seed weight by (7.48 and 2.57%) and seed yield/fed. by (12.25 and 8.84%) in 2016/17 and 2017/18 seasons, respectively, as compared without fertilizer. This may be due to the role of nitrogen fertilizer or organic manure in inhibitory effect on Broomrape, this will reflected on yield due its component of faba bean.

These results are in line with those obtained by Jain and Foy (1992), some researchers have reported that the addition of manure and nitrogenous fertilizers improved crop yields due to a detrimental effect of the fertilizers on the parasitic infestations, but others have attributed the beneficial effects of nitrogenous fertilization directly to improve crop performance and tolerance to attack by parasite. Similar results were reported by Nandula *et al*. (1996), Ismail (2013), Shaban *et al.* (2013) and Fakkar *et al.* (2016).

B-Effect of broomrape control treatments:

1- Broomrape

Data in Table (5) indicated that broomrape control treatments significantly reduced broomrape characters compared with untreated control in 2016/17 and 2017/18 seasons.

Foliar application of Glyphosate (48% WSC) at 2 times with equal rate 75 cm^3/fed at the beginning of the flowering stage with 21 days interval between each

one (T1), Salicylic acid thrice (T4) applied when faba bean germination is complete, at 30 days after planting and beginning of the flowering stage at rate 200 mg/one liter water solution of the corresponding compounds and Glyphosate used at one times with equal rate 75 cm^3/fed (T2). at the beginning of the flowering stage followed by Salicylic acid once at 200 mg/one liter water at 30 days after planting increased significantly number plants of faba bean/plot but decreased no. of infested faba bean plants/plot, no. of broomrape spikes/plot and dry weight broomrape spikes/plot of broomrape compared with untreated in both seasons.

Foliar application of Glyphosate twice at 75 cm^3/fed (T1) and Salicylic acid thrice at 200 mg/one liter water (T4) increased number plants of faba bean/plot by (12.44 & 12.35%) and (4.61 & 4.12%) but decreased the number of faba bean plants/plot by (59.43 & 46.69%) and (52.52 & 51.54%), number of broomrape spikes /plot by (55.06 & 50.64%) and (49.63 & 49.48%) and dry weight broomrape spikes/plot by (55.10 & 50.69%) and (49.62 & 49.47%) in 2016/17 and 2017/18 seasons, respectively, as compared with untreated (T6) (control).

Table (5): Effect of broomrape control treatments on broomrape growth characters in 2016/17 and 2017/18 seasons

Broomrape control treatments	No. of faba bean plants /plot	No. of infested faba bean plants /plot	No. of broomrape spikes /plot	Weight of broomrape Spikes /plot	Incidence %	Severity
	2016 / 17 Winter season					
T1- Glyphosate twice 75	216.92	19.67	25.42	106.76	9.61	0.12
T2- Glyphosate once 75+ Salicylic acid once	216.58	25.68	29.50	123.90	11.86	0.14
T3- Glyphosate once 50+ Salicylic acid once	210.25	25.67	29.75	124.95	12.34	0.14
T4- Salicylic acid thrice	216.75	24.34	27.92	117.23	11.21	0.13
T5-Hand pulling twice	207.42	26.16	30.75	126.15	12.28	0.14
T6- Untreated (chick)	192.92	48.38	56.58	237.75	26.47	0.30
$L.S.D_{0.05}$	6.38	3.34	4.41	18.52	1.78	0.03
	2017 / 18 Winter season					
T1- Glyphosate twice 75	211.58	22.83	27.58	115.85	10.90	0.13
T2- Glyphosate once 75+ Salicylic acid once	210.58	23.75	28.25	118.65	11.77	0.14
T3- Glyphosate once 50+ Salicylic acid once	21017	24.58	28.75	120.75	11.75	0.14
T4- Salicylic acid thrice	210.58	23.33	27.66	116.20	11.07	0.12
T5-Hand pulling twice	206.25	24.58	29.50	123.90	11.54	0.14
T6- Untreated (chick)	202.25	48.08	54.75	229.95	23.85	0.27
$L.S.D_{0.05}$	9.38	3.05	3.37	13.72	1.74	0.02

Foliar application of Glyphosate twice at 75 cm^3/fed (T1) and Salicylic acid thrice at 200 mg/one liter water (T4) gave the lowest incidence by (9.610 & 11.21%) and (10.90 & 11.07%) and severity (0.12 & 0.13%) and (0.13 & 0.12%), respectively, of broomrape as compared to untreated in both seasons. Hand pulling twice (T5) gave the lowest values number plants of faba bean/m^2, no. of plant of faba bean infestation, no. of broomrape spikes /plot and dry weight broomrape spikes/plot of broomrape at compared with untreated in both seasons.

This effect due to Glyphosate treatment with broomrape underground stage, so it makes early effects, while, the effect of hand pulling is usually after broomrape emergence above ground. These results are in agreement with those of Kharrat and Halila (1999) and Bakheit *et al*. (2001). Abbes *et al* (2014) demonstrate that (SAR) is capable of being an important method to control broomrapes and to form an integrated control strategy leading to reduce soil infestation by *Orobanche*.

2- Yield and yield components of faba

Data recorded in Table (6) revealed broomrape control treatments significantly differed yield and yield components in both seasons.

Foliar application of Glyphosate twice at 75 cm^3/fed (T1), Salicylic acid thrice at 200 mg/one liter water (T4) and Glyphosate once at 75 cm^3/fed+ Salicylic acid once at 200 mg/one liter water (T2) gave the highest values of plant height (cm), number of branches/plant, number of pods/plant, weight of pods/plant (g), seed weight/plant (g) and seed yield /fed. than glyphosate once at 50 cm^3/fed + Salicylic acid once at 200 mg/one liter water at 30 days after planting and hand pulling twice (T5) compared with untreated (T6) (control)in both seasons.

Foliar application of Glyphosate twice at 75 cm^3/fed (T1) Salicylic acid thrice at 200 mg/one liter water (T4) significant by increased number of pods/plant by (39.86 & 33.96%) and (16.89 & 16.18%), weight of pods plant by (22.53 & 19.12%) and (17.19 & 15.29%), seed weigh/plant by (25.54 & 24.40%) and (20.07 & 18.23%), 100-seed weight by (31.18 & 28.77%) and (5.77 & 4.04%) and seed yield by (73.82 & 72.42%) and (72.40 & 70.19%) in 2016/17 and 2017/18 seasons, respectively, as compared with non-fertilizer.

Foliar application of Glyphosate once at 75 cm^3/fed + Salicylic acid once at 200 mg/one liter water (T2) and Glyphosate once at 50 cm^3/fed + Salicylic acid once at 200 mg/one liter water (T3) increased number of pods/plant by (27.79 & 25.29%) and (15.44 & 14.48%), weight of pods plant by (15.24 & 14.55%) and (14.53 & 13.76%), seed weigh/plant by (23.60 & 20.38%) and (17.17 & 13.15%), 100-seed weight by (28.47 & 27.32%) and (3.05 & 2.64%) and seed yield /fed by (71.87 & 69.92%) and (69.64 & 69.36%) in 2015/16 and 2016/17 seasons, respectively, as compared with non-fertilizer. Hand pulling twice (T5) increased number of pods/plant by (22.78 & 14.9%), weight of pods plant by (11.81 & 13.50%), seed weigh/plant by (10.23 and 9.82%), 100-seed weight by (21.17 & 1.05%) and seed yield /fed. by (63.79 & 64.90%) in 2016/17 and 2017/18 seasons, respectively, as compared with non-fertilizer.

This increase of faba bean seed yield may be due to the increase in number of pods/plant, weight of pods/plant (g), seed weight/plant (g) and the decrease of number and dry weight of broomrape spikes. These results are in agreement with those of Ismail and Fakkar (2008), Bayoumi *et al* (2013), Ismail (2013), Fakkar *et al* (2013), El-Metwally *et al* (2013), Abbes *et al* (2014), El-Rokiek *et al* (2015) and Fakkar *et al* (2016).

Table (6): Effect of broomrape control treatments on yield and yield components of faba bean in 2016/17 and 2017/18 seasons.

Broomrape control treatments	Plant height (cm)	No. of branches /plant	No. of pods / plant (g)	Weight of pods / plant (g)	Seed weight / Plant (g)	100-seeds Weight (g)	Seed yield / fed (ardab).
	2016 / 17 Winter season						
T1- Glyphosate twice 75	131.55	3.55	32.91	68.97	57.46	69.72	6.24
T2- Glyphosate once 75+ Salicylic acid once	126.74	3.42	30.07	64.87	56.57	68.28	6.17
T3- Glyphosate once 50+ Salicylic acid once	124.32	3.21	29.48	64.48	55.10	67.67	6.10
T4- Salicylic acid thrice	126.67	3.46	31.52	67.05	56.94	68.44	6.19
T5-Hand pulling twice	123.67	3.15	28.89	62.94	50.45	64.40	5.88
T6- Untreated (chick)	109.45	1.86	23.53	56.29	45.77	53.15	3.59
L.S.D$_{0.05}$	2.54	0.18	2.14	3.55	3.35	2.78	0.24
	2017 / 18 Winter season						
T1- Glyphosate twice 75	126.11	3.62	28.17	64.30	57.97	67.60	6.19
T2- Glyphosate once 75+ Salicylic acid once	125.29	3.43	27.82	62.84	56.57	65.86	6.09
T3- Glyphosate once 50+ Salicylic acid once	125.20	3.34	27.59	62.42	54.63	65.60	6.08
T4- Salicylic acid thrice	127.27	3.52	28.00	63.26	57.08	66.49	6.11
T5-Hand pulling twice	122.10	3.41	27.52	62.28	53.02	64.58	5.92
T6- Untreated (chick)	112.06	2.18	24.10	54.87	48.28	63.91	3.59
L.S.D$_{0.05}$	2.82	0.23	1.95	2.55	2.43	2.51	0.29

C-Interactions

1-Effect of interactions between fertilizer and broomrape control treatments on broomrape.

Data in Table (7) showed that the effects of interactions between fertilizer and broomrape control treatments on broomrape were statistically significant at (0.05) in 2016/17 and 2017/18 seasons.

The effect of interaction between fertilizer and broomrape control treatments on no.of plant infection/plot, number of broomrape spikes (plot) incidence% and severity% were statistically significant at (0.05) level except for number of plants faba bean/plot and weight of broomrape spikes (g/plot) in both seasons.

The highest reduction incidence of broomrape optioned by N-fertilizer at 20 kg/fed and N-fertilizer at 10 kg/fed+ O.M-fertilizer at 10 m^3/fed under Glyphosate twice 75 cm^3/fed and Salicylic acid thrice in both seasons. These results demonstrate the role of integration between N-fertilizer, agricultural, mechanical and chemical methods in controlling broomrape in faba bean. Hand

pulling and herbicide in these results is very clear and effective. These results are in good harmony with those reported by Mekky *et al*. (2003), Khalil *et al*. (2010), Kawochar *et al*. (2011), El-Metwally *et al*. (2013), Fakkar *et al* (2013), El-Rokiek *et al* (2015) and Fakkar *et al* (2016).

Table (7): Effect of interaction between fertilizer and broomrape control treatments on broomrape growth characters in 2016/17 and 2017/18 seasons.

Fertilizer	Broomrape control treatments	No. of infested faba bean plants/plot		No. of broomrape spikes/plot		Incidence %		Severity	
		2016/17	2017/18	2016/17	2017/18	2016/17	2017/18	2016/17	2017/18
Nitrogen fertilization	1- Glyphosate twice 75	15.00	21.00	19.67	24.67	6.70	9.77	0.08	0.11
	2- Glyphosate 75+ Salicylic acid	19.67	21.33	24.33	26.33	9.26	11.87	0.11	0.13
	3- Glyphosate 50+ Salicylic acid	20.33	23.33	26.00	27.33	9.27	12.07	0.12	0.14
	4- Salicylic acid thrice	18.33	21.33	23.33	26.00	8.60	10.23	0.10	0.12
	5-Hand pulling twice	21.33	23.67	26.33	27.00	9.40	12.63	0.12	0.14
	6- Untreated (chick)	39.67	46.67	46.33	53.00	18.40	22.43	0.21	0.26
Organic manure fertilizers	1- Glyphosate twice 75	17.04	21.33	21.33	23.33	8.43	9.07	0.10	0.12
	2- Glyphosate 75+ Salicylic acid	27.02	25.00	29.33	28.00	10.66	11.07	0.14	0.13
	3- Glyphosate 50+ Salicylic acid	27.39	25.67	31.34	28.33	11.77	1160	0.15	0.14
	4- Salicylic acid thrice	25.04	21.67	28.67	27.67	10.60	10.87	0.13	0.13
	5-Hand pulling twice	33.67	26.00	32.33	30.67	12.71	13.40	0.16	0.14
	6- Untreated (chick)	54.33	45.67	59.67	55.67	23.77	24.17	0.32	0.26
Nitrogen fertilization + Organic manure fertilizers	1- Glyphosate twice 75	18.33	19.33	22.33	24.67	7.87	9.90	0.10	0.11
	2- Glyphosate 75+ Salicylic acid	23.67	23.00	26.67	28.33	12.21	10.27	0.12	0.13
	3- Glyphosate 50+ Salicylic acid	26.33	23.67	28.33	29.67	12.53	11.16	0.13	0.14
	4- Salicylic acid thrice	22.33	22.67	26.00	25.00	11.81	10.10	0.11	0.13
	5-Hand pulling twice	27.67	23.67	29.33	30.33	16.30	11.17	0.13	0.16
	6- Untreated (chick)	48.00	48.33	56.00	52.00	28.90	23.17	0.28	0.28
Untreated (check)	1- Glyphosate twice 75	23.33	24.67	30.33	30.00	11.60	11.80	0.15	0.14
	2- Glyphosate 75+ Salicylic acid	29.33	25.67	35.33	30.66	15.47	12.47	0.18	0.15
	3- Glyphosate 50+ Salicylic acid	33.33	26.00	40.33	33.00	15.53	12.77	0.18	0.16
	4- Salicylic acid thrice	23.67	25.65	31.67	30.67	12.87	12.33	0.17	0.15
	5-Hand pulling twice	34.00	29.00	40.67	35.33	15.63	13.57	0.19	0.16
	6- Untreated (chick)	57.33	51.67	64.33	58.33	34.80	25.63	0.39	0.29
$L.S.D_{0.05}$		6.68	6.10	8.82	6.53	3.57	3.22	0.05	0.04

2- Interaction between manure and broomrape control treatments on yield of faba bean:

The effects of interaction between fertilizer and broomrape control treatments were statistically significant on yield and yield components in both seasons except for plant height, n.of pods/plant and weight of pods/plants in both seasons. Using of N-fertilizer at 20 kg/fed and N-fertilizer at 10 kg/fed+ O.M-fertilizer at 10 m^3/fed under glyphosate twice 75 cm^3/fed and Salicylic acid thrice gave the highest values number of branches/plant, number of pods/plant, weight of pods/plant (g), seed weight/plant (g) and seed yield /fed. in both seasons (Table 8).

Table (8): Effect of interaction between fertilizer and broomrape control treatments on yield and yield components of faba bean in 2016/17 and 2017/18 seasons.

Fertilizer	Broomrape control treatments	No. of branches/plant		Weight of seeds/plant (g)		100-seeds Weight (g)		Seed yield (ardab)/fed.	
		2016/17	2017/18	2016/17	2017/18	2016/17	2017/18	2016/17	2017/18
Nitrogen fertilization	1- Glyphosate twice 75	4.10	3.94	67.63	64.33	74.50	73.17	6.87	6.66
	2- Glyphosate 75+ Salicylic acid	3.47	3.89	63.70	62.53	74.13	72.00	6.27	6.17
	3- Glyphosate 50+ Salicylic acid	3.36	3.81	63.43	62.10	73.27	71.00	6.17	6.07
	4- Salicylic acid thrice	3.51	3.91	64.30	64.07	74.37	72.50	6.80	6.60
	5-Hand pulling twice	3.34	3.79	61.73	61.10	72.07	70.27	5.90	5.70
	6- Untreated (chick)	2.19	2.59	51.43	52.13	57.87	55.70	4.53	4.33
Organic manure fertilizers	1- Glyphosate twice 75	3.78	3.63	57.90	57.27	71.77	66.30	6.80	6.30
	2- Glyphosate 75+ Salicylic acid	3.42	3.38	54.50	52.87	66.96	64.30	6.33	5.90
	3- Glyphosate 50+ Salicylic acid	3.38	3.17	52.97	50.60	66.50	64.13	6.17	5.90
	4- Salicylic acid thrice	3.74	3.44	56.03	55.60	68.77	46.47	6.40	6.03
	5-Hand pulling twice	3.18	3.01	51.73	48.17	65.70	60.00	6.13	5.83
	6- Untreated (chick)	1.73	2.13	50.73	46.00	56.70	51.33	3.50	3.27
Nitrogen fertilization+ Organic manure fertilizers	1- Glyphosate twice 75	3.85	3.75	56.91	59.66	72.43	69.03	6.46	6.80
	2- Glyphosate 75+ Salicylic acid	3.13	3.44	56.42	58.27	68.81	65.87	6.27	6.33
	3- Glyphosate 50+ Salicylic acid	3.08	3.43	49.63	55.37	68.27	65.70	6.07	6.17
	4- Salicylic acid thrice	3.21	3.47	56.71	59..03	69.01	67.67	6.30	6.40
	5-Hand pulling twice	2.78	3.08	45.95	53.47	56.81	65.63	5.70	6.13
	6- Untreated (chick)	1.73	2.03	43.30	50.60	50.13	55.83	3.27	3.80
Untreated (check)	1- Glyphosate twice 75	3.86	3.64	53.53	53.90	66.47	63.27	5.83	5.63
	2- Glyphosate 75+ Salicylic acid	3.04	3.05	50.00	53.20	61.47	61.13	5.53	5.33
	3- Glyphosate 50+ Salicylic acid	2.77	2.92	49.28	51.23	60.17	61.07	5.37	5.17
	4- Salicylic acid thrice	3.47	3.33	52.57	53.27	64.43	62.37	5.77	5.57
	5-Hand pulling twice	2.75	2.84	41.13	44.40	58.20	60.63	5.27	5.07
	6- Untreated (chick)	1.78	1.96	37.63	41.13	47.90	52.77	2.77	2.57
$L.S.D_{0.05}$		0.36	0.47	5.42	4.77	5.56	5.02	0.49	0.57

This may be owing to effect of interaction between the role of fertilizer with mechanical and chemical methods in controlling broomrape in faba bean. This may be due to the few amount of N in the organic manure than in synthetic nitrogenous fertilizers. These results are in good harmony with those reported by Mekky *et al*. (2003), Kawochar *et al*. (2011) and El-Metwally *et al*. (2013).

CONCLUSION

It can be concluded from this study that the feasibility of using cultural methods as mineral nitrogen and organic manure fertilizations beside foliar application of herbicide namely Glyphosate and/or Salicylic acid is considered a save method to broomrape control and increasing faba bean productivity in Upper Egypt.

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تاثير الجليفوسيت وحامض السلسليك و التسميد الازوتي والعضوي علي مكافحة الهالوك وانتاجية الفول البلدي

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الملخص العربى

يصاب الفول البلدي بشدة بالهالوك بالوجه القبلى نظرا للارتفاع الشديد فى درجات الحرارة مما أدى إلى انخفاض المساحة المنزرعة بالفول البلدي. لذا تم إقامة تجربتين حقليتين في حقول مصابة بالهالوك بمحطة البحوث الزراعية بشندويل– محافظة سوهاج – مركز البحوث الزراعية خلال الموسم الشتوي 2016/ 2017 و2017/ 2018م لدراسة تاثير التسميد ومعاملات مكافحة الهالوك علي تقليل الاصابة بالهالوك وزيادة محصول الفول البلدى. استخدم تصميم القطع المنشقة مرة واحدة مع ثلاثة مكررات. تكونت التجربة من 24 معاملة وهى عبارة عن اربعة مستويات من التسميد (20 كجم/ف نيتروجين – 20 م3/ف سماد عضوي – 10 كجم سماد نتروجيني + 10 م3 سمادعضوي – بدون تسميد) وضعت في القطع الرئيسية وستة معاملات لمكافحة الهالوك (الجليفوسيت مرتين بمعدل 75 سم3/ف – الجليفوسيت مرة واحدة بمعدل 75 سم3/ف + حمض السلسليك مرة واحده بمعدل200 مجم/لتر ماء – الجليفوسيت مرة واحدة بمعدل 50 سم3/ف + حمض السلسليك مرة واحده بمعدل بمعدل 200 مجم/لتر ماء – حمض السلسليك ثلاث مرات بمعدل 200 مجم/لتر ماء – نقاوة يدوية الهالوك مرتين – بدون معاملة) وضعت في القطع الشقية وكان الصنف المستخدم جيزة 843 ومساحة القطعة التجريبية 10.5م^2 وكانت اهم النتائج المتحصل عليها كالتالي:

أدت اضافة السماد النتروجيني بمعدل 20 كجم/ف وكذلك التسميد النتروجيني بمعدل 10 كجم/ف+ تسميد عضوي بمعدل 10 م3/ف الي زيادة عدد نباتات الفول البلدي/قطعه بنسبة (10,28 & 6,84٪) و(2,84 & 1,18٪) وانخفاض كل من نباتات الفول البلدي المصابة بالهالوك/قطعه بنسبة (33,41& 17,40٪) و(13,86 & 10,58٪) وعدد شماريخ الهالوك/ قطعه بنسبة (31,49 & 22,16٪) و(15,44 & 12,83٪) ووزن شماريخ الهالوك (جم/قطعه) بنسبة (31,38 & 22,00٪) و(15,45 & 12,84٪) في الموسمين علي التوالي مقارنة بمعاملة عدم التسميد. كما ادت إلي زيادة طول النبات ، وزن قرون النبات ووزن بذور النبات ووزن الـ100 بذرة ومحصول البذور/ف في الموسمين مقارنة بعدم إضافة السماد الأزوتى.

ادي رش مبيد الجليفوسيت مرتين بمفردة او الجليفوسيت مرة واحدة + حمض السلسليك مرة واحده إلي زيادة عدد نباتات الفول الكلية/ قطعه بنسبة (12,44& 12,35٪) و(4,61 & 4,12٪) وانخفاض كل من نباتات الفول البلدي المصابة بالهالوك/قطعه بنسبة (59,43 & 46,69٪) و(52,52 & 51,54٪) وعدد شماريخ الهالوك/قطعه بنسبة (55,06 & 50,64٪) و(49,630& 49,48٪) ووزن شماريخ الهالوك (جم/ قطعه) بنسبة (55,10 & 50,69٪) و(49,62 & 49,47٪) في الموسمين علي التوالي مقارنة بمعاملة عدم التسميد. كذلك ادت هذه المعاملة ايضا إلي زيادة فى زيادة طول النبات ، وزن قرون النبات ووزن بذور النبات ووزن الـ100 بذرة ومحصول البذور/ف في الموسمين مقارنة بدون معاملة.

من خلال هذه الدراسة يمكن استخدام حمض السلسليك كبديل امن علي النبات والبيئه كاتجاه جديد في مكافحة الهالوك وزيادة انتاجية الفول البلدي

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