EFFECT OF SOWING DATE, BROOMRAPE (*OROBANCHE CRENATA* Forsk) CONTROL AND RELEASING *PHYTOMYZA OROBANCHIA*, Kalt, ON FABA BEAN (*VICIA FABA* L.) GROWTH AND PRODUCTIVITY

BY

Zein, A.A.* , M. M. Abd EL-Hamid**, M. F. Shady* and M. E. Kenapar**

* Dept. of Pesticide, Fac. of Agric. Kafr El- Sheikh, Tanta University, Egypt

** Weed Control Central Lab.; Agric. Res. Center, Giza, Egypt

ABSTRACT

Experiments were carried out during 2000 / 2001 and 2001 / 2002 seasons at Sakha Agricultural Research station, Kafr El-Shiekh, Egypt, to investigate the effect of sowing date, broomrape control and releasing *Phytomyza orobanchia* on broomrape control and faba bean growth and productivity .

Results revealed that delay sowing date to November 15th significantly decreased number, fresh and dry weights of broomrape spikes. It also decreased spike length, spikes per bean plant and capsules per spike. Sowing faba bean on November 15th produced the highest dry weight of pods, plant height, fresh and dry weights of plant and bean seed yield.

The application of glyphosate (36 g *a.i.*/fed., two or three times) at bean flowering stage, or imazethapyer (30 g *a.i.*/fed., pre planting soil incorporated) were the greatest effective treatments on broomrape and produced the highest bean yield. Hand pulling of broomrape (twice) was an effective mean of its control, but did not increase the bean yield, as it was carried out after its real establishment .

Releasing Phytomyza at a rate of 3 flies per spike, increased its population in broomrape capsules to 71 and 91%, in the succeeding March and April, respectively, and reduced broomrape seed weight by 74 and 77%, respectively. Combined releasing of phytomyza and glyphosate application, or broomrape hand pulling (once) increased such reduction. Releasing Phytomyza with glyphosate application achieved the highest increase in the bean seed yield, which attributed to the effect of glyphosate only. Obviously, late sowing (November 15th)of the bean, combined with

hand weeding of broomrape and (or) releasing Phytomyza, is an effective mean in reducing broomrape seed bank in the soil .

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the main winter leguminous crops for the majority of Egyptian People. Productivity of this crop decreased dramatically due to broomrape (*Orobanche crenata*, Forsk.) parasitism, it decreased seed yield by decreasing pods per plant mainly. Yield reduction due to broomrape infestation varied from 32 to 55%, depending on the infestation levels (Geipert, 1997).

Different methods were suggested for broomrape control to minimize its damage to the crop productivity, such methods include cultural practices (as sowing dates, hand pulling, flooding and crop rotation); biological control (by releasing *Phytomyza orobanchia* Kalt); and chemical control (using glyphosate and other herbicides, Al-Eryan, 1996).

Attachment of broomrape growth to the bean roots occurred at its different growth stages, and depends mainly upon the ambient temperature during crop growth. Therefore, the effect of sowing date is attributed to the difference in the environmental conditions experienced by the crop at various stages of phenological development, under different sowing dates. Delaying sowing of faba beans decreased *Orobanche spp.* parasitism and increased crop seed yields, as reported by Hezewijk *et al.* (1991); Sillero *et al.* (1999) and Ghalwash (2003).

Hand weeding is always considered the first approach for broomrape control at the level of small farms, with low levels of infestation. It could also complement other methods, which have given insufficient control. The purpose of broomrape hand weeding may be mainly short term, to reduce the actual damage; or long term, to prevent seeding, and hence reduce future problems (Parker and Riches, 1993); and (Linke, 1995).

Glyphosate is the most common herbicide used to control broomrape. Hence, broomrape was found to be efficiently controlled in broad bean by glyphosate at 0.08 kg/ha applied 2 or 3 times at 15 day intervals (Kukula and Masri, 1984) or at 60 g/ha at the stages of visible flowering buds (Mesa-Garcia and Vazquez, 1985). Single application of glyphosate at a rate of 36 g/fed. at 20

% faba bean flowering stage did not prevent broomrape infestation. However, two successive applications (with three weeks intervals) were efficient to prevent infestation as reported by Garcia-Torres *et al.* (1989). Various control treatments of glyphosate enhanced growth of faba bean and increased the yield of both infected and healthy plants, without apparent crop injury. Glyphosate at 75 ml/fed. gave the best results (Ghalwash, 2003).

Imazethapyr (Pursiut) herbicide can be applied pre-emergence or post-emergence for broomrape control. It was found, among other herbicides, to be effective for broomrape control in faba bean fields, as reported by Geipert (1997); Jurado-Exposito *et al.* (1997) and Ghalwash (2003).

Biological control of this destructive parasitic weed (*O. crenata*) by releasing the monophagous fly, *Phytomyza orobanchia* Kalt. (Diptera, Agromyzidae) has been successfully applied on large scale. Tawfik *et al.* (1976) reported that the larvae of *P. orobanchia* attach the ovules of *O. crenata*. The larval populations reached a peak numbers in the third week of March and the larval infestation was 100 % in the second and fourth weeks of April. The beneficial bio-controlling role of broomrape fly, *P. orobanchia* by feeding at larval stage on the immature seeds of the fully parasitic weeds, has been reviewed in many parts of the world. Linke *et al.* (1991) found that, the first appearance of *P. orobanchia* flies coincided with the first emergence of the broomrape shoots, and suggested that, its appearance is most probably related to temperature. Hassanein *et al.* (1998) reported that microscopic analysis of *O. crenata* capsules revealed that infestation rates by *P. orobanchia* ranged between 24 to 100%. Mean infestation levels on *O. crenata* were 66.3% in faba beans. Abu-Shal (2001) indicated that releasing *P. orobanchia* at a rate of 3 flies per broomrape spike caused 72.8 % reduction in broomrape seeds. Also, Al-Eryan and Zaitoun (2001) reported that the release of three pupae per spike was enough to get about 30% reduction in broomrape seed. Shalaby *et al.* (2002) revealed that releasing *P. orobanchia* in faba bean caused detectable increases in the percentage of broomrape capsules infected by *Phytomyza*, and reach 71.4% by releasing flies and to 100% by releasing spikes after 4 weeks of release, in a semi-field experiment, and to 61.3% in the filed experiment, after two

weeks of releasing, opposed to 33.3% in a field that did not receive any release in the same site.

This study was conducted to investigate the effect of sowing date, some broomrape control treatments and releasing *P. orobanchia* on broomrape control and faba bean growth and productivity.

MATERIALS AND METHODS

During 2000/2001 and 2001/2002 winter seasons, four experiments were carried out at the wire house at Sakha Agricultural Research station, Kafr El-Sheikh. Two of them were intended to investigate the effect of sowing date of faba bean and broomrape control, on broomrape (*Orobanche crenata)* infestation and faba bean (*Vicia faba* L.) growth and production. The other two aimed to investigate the effect of releasing *Phytomyza orobanchia* on broomrape infestation and productivity of faba bean, sown at two different dates. The experimental site was naturally heavily infested by broomrape. Faba bean variety was Giza 3 as a susceptible cultivar.

1. Faba bean sowing date and broomrape control:

Two experiments were conducted in split plot design with four replications, with plot size of 12 m^2. The main plots were assigned to sowing dates (October 15^{th} and November 15^{th}), whereas broomrape control treatments were arranged at the sub plots. The broomrape control treatments included glyphosate and imazethapyr herbicides. The treatments of glyphosate (36 g *ai*/fd.) were applied at the beginning of bean flowering, and included its application once, twice and three times, with a time interval of three weeks for each succeeding applications. The imazethapyr treatments included two rates (25 and 30 g *ai* / fd) with two methods of application for each (pre planting surface application, pps, and pre planting soil incorporation, ppi). Hand pulling treatment of broomrape started from the time of its emergence, and was carried out twice, with three weeks interval. A weedy check treatment was also included.

Broomrape spikes were randomly collected manually from each plot, using $1m^2$ quadrate, 130 days after sowing, to estimate broomrape spikes per square meter and per bean plant, capsules per spikes, broomrape spike length (cm) and their fresh and dry

weights (g/m^2). The dry weight was determined by drying the collected samples to a constant weight in a forced air oven at 70 °C.

Samples of ten bean plants were taken from each plot, 160 days after sowing, to estimate plant height (cm), number of branches, number and fresh weight of pods (g) per plant. Faba bean samples were also taken at harvest (180 days from sowing) to estimate the fresh and dry weights of branches (g), weight of 100 seeds (g) and seed yield (Ardab / fed.).

All the agronomic practices (such as land preparation, fertilization and irrigation) were carried out as recommended.

2. Treatments of *Phytomyza orobanchia* kalt :

Two experiments were conducted in an area heavily infested with broomrape, to study the efficacy of releasing flies of *Phytomyza orobanchia* in faba bean, sown in two different dates, on broomrape control and faba bean growth and productivity. Split plot design was used with four replications, with plot size of 12 m^2. The main plots were assigned to the sowing dates (October 15th and November 15th), whereas *P. orobanchia* treatments were arranged at the sub plots.

The treatments of phytomyza were three, in addition to an untreated check, these treatments were :

1- Glyphosate at 36 g *a.i.*/fed. applied once at the beginning of bean flowering, followed by releasing *Phytomyza orobanchia* at a rate of 3 flies per spike, just after the broomrape emergence.
2- Hand pulling (twice) of broomrape shoots, followed by releasing *P. orobanchia* at a rate of 3 flies / spike, just after the broomrape emergence.
3- Releasing *P. orobanchia* alone at a rate of 3 flies per spike, after the broomrape emergence.
4- Weedy check, without *P. orobanchia*. treatment.

P. orobanchia flies were released to *O. crenata*. spikes grown inside muslin cages. Random samples of ten spikes from each plot were taken at March 20th and April 10th, in both seasons, to evaluate percentages of *P. orobanchia* parasitism, and percentage of damaged seeds per spike. Reduction in seed output, due to *P. orobanchia* parasitism, was also estimated, relatively to the mean mature seed weight of capsules per spike. The ripened infested capsules were collected and opened for counting the *P. orobanchia*

pupae, and the remaining mature seeds were also collected. Samples of broomrape spikes were also randomly collected from each plot, using 1 m^2 quadrate, to evaluate the efficacy of the studied treatments on broomrape growth and bean yield. The collected data were subjected to proper statistical analysis of split plot design, according to procedure outlined by Snedecor and Cochran (1967). Means were compared at 5% level of significance, by the least significant different (L.S.D.) test.

RESULTS AND DISCUSSION :

1. Effect of bean-sowing date on broomrape growth characters:

Data shown in Table (1) clearly indicated that, sowing date significantly affected broomrape growth characters.

Table (1): Broomrape characters as affected by faba bean sowing dates during 2000/2001 and 2001/2002 seasons

Broomrape characters	2000/2001 season				2001/2002 season			
	Sowing dates				Sowing dates			
	Oct. 15	Nov. 15	Mean	LSD	Oct. 15	Nov. 15	Mean	LSD
No. of spike per m^2	53.2	42.8	48.0	4.6	58.3	26.6	42.5	6.6
No. of spike per plant	6.3	4.9	5.6	1.0	6.2	4.7	5.4	0.5
No. of capsules per spike	53.7	47.3	50.5	3.1	24.1	20.4	22.3	1.8
Spike length (cm)	27.6	22.6	25.1	2.2	27.4	22.3	24.9	3.9
Fresh wt of spike, g/m^2	499.0	288.0	393.5	57.0	718.0	607.0	662.5	255.0
Dry wt of spike, g/m^2	255.8	186.6	221.2	39.3	219.6	189.1	204.4	66.4

Delaying sowing date to November 15th reduced number of broomrape spikes by 19.5 and 54.4%; number of broomrape spikes per plant by 22.2 and 24.2%; number of capsules per spike by 11.9 and 15.4 %; spike length by 18.1 and 18.6 %; and fresh weight of spikes per m^2 by 42.3 and 15.5 % and their dry weights by 27.1 and 13.9%, in the 2000/2001 and 2001/2002 seasons respectively, compared with those of the early sowing date on October 15th.

Linke *et.al* (1991) mentioned that, late sowing of faba bean gave excellent results for broomrape control under its heavy infestation. Such results indicated that, faba bean early sowing was responsible for the acceleration of broomrape emergence, and the long duration of broomrape parasitism.

2. Effect of sowing date on bean yield and yield components:

Data in Table (2) indicate that, sowing date significantly affected both faba bean yield and yield components, during both seasons. Delaying faba bean sowing to November 15th , significantly improved all measured bean yield and yield components, except those of plant height and number of branches. Late sowing caused an increase in number of pods per plant by 16.1 and 17.9%; in plant fresh weight by 7.8 and 8.4%, and dry weight by 5.8 and 18.6 %. It also increased pods dry weight per plant by 8.3, 12.8 %; 100-seed weight by 2.4 and 0.6%; and seed yield by 15.6 and 19.1 %, in the two succeeding seasons 2000/2001 and 2001/2002 respectively, compared to that sown on October 15th. Such delaying of sowing date caused an opposite effect on plant height and on number of branches per plant, as it caused significant decrease in those two characters, as shown in table (2).

Table (2): Faba bean yield and yield components as affected by sowing date during 2000/2001 and 2001/2002 seasons.

Faba bean yield and yield components	2000/2001 season				2001/2002 season			
	Sowing dates				Sowing dates			
	Oct. 15	Nov. 15	Mean	LSD	Oct. 15	Nov. 15	Mean	LSD
Number of branches per plant	3.1	2.8	2.9	0.6	3.5	3.1	3.3	0.7
Number of pods per plant	13.0	15.5	14.2	1.8	12.4	15.1	13.7	0.6
Faba bean plant height (cm)	132.1	124.5	128.3	4.8	131.1	126.6	128.9	11.3
Fresh weight of faba bean plant (g)	64.1	69.5	66.8	10.3	94.3	103.0	98.7	16.1
Dry weight of faba bean plant (g)	21.0	22.3	21.6	3.8	44.7	54.9	49.8	3.1
Dry weight of pods/plant (g)	159.2	173.6	166.4	27.7	166.6	191.1	178.9	14.0
Weight of 100-seed (g)	67.8	69.5	68.6	1.3	68.4	68.8	68.6	NS
Faba bean seed yield (Ardab/fed.)	5.4	6.4	5.9	0.6	5.5	6.8	6.2	1.1

Promotions in most of the bean yield and yield components may be attributed to the successful control of broomrape, and (or) to the developmental growth of the bean late sowing, that consequently produced healthy bean growth and increased seed production. The increase in the seed yield could be attributed to the increase in seed weight per plant and to the 100-seeds weight. Zahran *et al.* (1982) reported that, late sowing of faba bean to the month December has been found to be more favorable, than the

early sowing on November, particularly in the heavily infested fields with broomrape.

3. Chemical control of broomrape :

Data in Table (3) indicated that, application of glyphosate (36 g *ai*/fed., thrice or twice) or imazethapyr (30 g *a.i.*/fed, pre-planting soil incorporation, PPI) reduced broomrape spikes number by 98, 89 and 88%, respectively in 2000/2001 and by 97, 84 and 90%, respectively in 2001/2002. Meanwhile, the application of glyphosate at 36 g *a.i.*/fed. (once), imazethapyr at 30 g *a.i.*/fed. applied pre-planting as surface application (PPS), or imazethapyr at /25 g *a.i.*/fed. (PPI) or (PPS) were less effective in reducing broomrape spike numbers per m^2. Hand pulling (twice) reduced recorded broomrape spikes number per m^2 by 77 and 88% during both seasons. The best results of the measured broomrape characters in the two seasons, were obtained from the application of glyphsate thrice, twice and imazethapyr (PPI) respectively.

Glyphosate at 36 g *a.i.*/fed. thrice, twice or once; imazethapyr (PPI) at 30 or 25 cc/fed. were superior in decreasing number of capsules per broomrape spike as compared with weedy check in both seasons, hence it reduced number of capsules per broomrape spike by 97, 82, 65, 71 and 62%, respectively at 2000/2001 season and 91, 81, 66, 74 and 64 % in season 2001/2002 respectively. The reduction in number of capsules / spike under hand pulling (twice) treatment was 68 and 73 % in the two seasons, respectively.

Results indicated also that glyphosate at 36 g *a.i.*/fed. either applied (thrice) or (twice), imazethapyr at 30 g *a.i.*/fed. (PPI) and hand pulling (twice) exhibited the highest reduction in fresh weight of broomrape spikes / m^2 during both seasons, hence it reduced fresh weight of broomrape spikes / m^2 by 99, 95, 81 and 82%, respectively in 2000/2001 season and 97, 92, 84 and 80%, respectively in 2001/2002 season (table 3).

All broomrape control treatments significantly reduced dry weight of broomrape spikes / m^2 compared with the untreated plants. Within weed control treatments, results indicated that glyphosate at 36 g *a.i.*/fed. (thrice or twice); imazethapyr at 30 g *a.i.*/fed. (PPI) and hand pulling (twice) showed the highest reduction in the dry weight of broomrape spikes per m^2, which was amounted by 99, 96, 84 and 81%, respectively at 2000/2001 season

and by 96, 92, 83 and 80 %, respectively during 2001/2002 season. Americanos (1983) found that dry weight of broomrape spikes was reduced by glyphosate application.

Table (3): Broomrape characters as affected by some broomrape control treatments in faba bean, during 2000/2001 and 2001/2002 seasons

Treatments	Rate g a.i. Per fed.	No. of spikes per m^2	No. of spikes per plant	No. of capsules per spike	Spike length (cm)	Fr. wt. of spike (g/m^2)	Dry wt. of spike (g/m^2)
2000/2001 season							
Glyphosate (once)	36	38.4	3.8	45.9	25.1	279	141
Glyphosate (twice)	36	15.1	2.0	24.3	16.3	74	33
Glyphosate (thrice)	36	3.5	0.5	4.4	1.9	15	7
Imazethapyr (PPS)*	25	73.0	7.4	61.9	32.4	711	318
Imazethapyr (PPI)**	25	49.1	5.4	50.4	25.4	407	217
Imazethapyr (PPS)*	30	62.5	6.1	56.5	27.0	489	247
Imazethapyr (PPI)**	30	17.1	2.4	38.3	21.3	283	120
Hand pulling (twice)	-	32.3	2.8	41.8	15.8	261	148
Weedy check	-	140.8	20.0	131.3	60.9	1474	761
LSD at 5% level		6.9	1.7	15.7	5.5	124.0	61.8
2001/2002 season							
Glyphosate (once)	36	37.6	3.9	19.6	23.7	516	161
Glyphosate (twice)	36	21.1	2.3	11.9	13.6	153	46
Glyphosate (thrice)	36	3.9	0.8	4.8	5.1	66	22
Imazethapyr (PPS)*	25	61.4	8.3	26.9	33.0	1003	313
Imazethapyr (PPI)**	25	41.1	5.6	21.9	28.8	713	218
Imazethapyr (PPS)*	30	52.3	7.4	24.9	28.3	929	284
Imazethapyr (PPI)**	30	13.9	2.4	12.5	23.6	307	97
Hand pulling (twice)	-	16.6	2.1	11.4	20.4	374	119
Weedy check	-	134.0	16.1	66.4	47.3	1900	582
LSD at 5% level		13.0	1.7	4.3	4.8	328.0	89.8

PPS* = Pre-planting surface application

PPI = Pre-planting soil incorporation**

García-Torres *et al.* (1995) reported that imazethapyr when applied pre-emergence for broomrape control in faba bean in field, gave high broomrape control. Hassanein *et al.* (2000) indicated that glyphosate applied two or three times was effective against broomrape, where it reduced number and dry weight of broomrape

spikes. Hand pulling (twice) was also effective in reducing number of broomrape spikes per plant where it recorded 86 and 87 % reduction in the two seasons respectively as shown at Table (3).

4. Effect of broomrape control on bean yield and yield components:

Data in Table (4) indicated that broomrape control treatments significantly affected number of branches per bean plant in both seasons, compared to the untreated plants. Glyphosate at 36 g a.i./fed. thrice, twice or once increased number of branches per bean plant by 70, 64, 59 and 48%, respectively in 2000/2001 season and by 50, 49 and 45%, respectively in 2001/2002 season. All applications of glyphosate at 36 g a.i./fed were more effective than imazethapyr to increase number of faba bean branches per plant in both seasons. Hand puling (twice) increased number of faba bean branches per plant by 29 and 10%, respectively in the two seasons.

With the exception of hand pulling (twice), all other studied broomrape control treatments significantly increased number of pods per faba bean plant as compared to the untreated one. In 2000/2001 season, the highest values of number of pods per plant (28.2, 26.1 and 16.6) were obtained by the application of imazethapyr at 30 g *a.i.*/fed (PPI) and glyphosate at 36 g *a.i.*/fed. (thrice) or (twice) respectively.

Meanwhile, during the second season, glyphosate at 36 g *a.i.*/fed. (thrice), imazethapyr at 30 g *a.i.*/fed (PPI) and glyphosate at 36 g *a.i.*/fed. (twice) recorded the highest number (24.5, 23.9 and 16.2). This increase could be attributed to broomrape control, that reduced the chance of broomrape attachment to the host plants, hence decreased the injury to bean plants. All broomrape control treatments significantly increased bean plant height, compared to the untreated check, hence the herbicidal applications increased plant height in the two seasons, by (23 - 39%) and (11 - 27%), respectively. Hand pulling (twice) increased bean plant height by 9% in the first season. With the exception of hand pulling, other broomrape control treatments significantly increased the fresh weight of faba bean plant by (45 - 71%) and (30 - 54%), respectively in the two seasons as compared to the untreated plants.

Table (4): Faba bean yield components as affected by some broomrape control treatments, during 2000/2001 and 2001/2002 seasons

Treatments	Rate g a.i. per fed.	No. of branches per Plant	No. of Pods per Plant	Plant Height (cm)	Fr. wt. of faba plant	Dry wt. of faba plant	Dry wt. of Pods (g) plant	Weight of 100-seed (g)	Seed yield Ard./ fed.
2000/2001 season									
Glyphosate (once)	36	3.6	11.0	128.5	53.9	16.2	166.1	68.5	5.92
Glyphosate twice)	36	4.1	16.6	125.3	77.9	21.7	232.6	69.0	7.90
Glyphosate (thrice)	36	5.0	26.1	120.4	94.8	25.1	289.9	69.6	11.21
Imazethapyr (PPS)*	25	2.3	10.4	141.1	63.3	22.9	127.0	68.1	3.90
Imazethapyr (PPI)**	25	2.6	15.1	146.1	78.5	27.7	161.3	69.0	6.25
Imazethapyr (PPS)*	30	2.4	13.8	144.4	67.8	22.8	151.3	68.5	5.05
Imazethapyr (PPI)**	30	2.9	28.2	153.2	101.5	30.0	307.5	69.3	10.94
Hand pulling (twice)		2.1	4.6	102.5	34.0	15.8	40.3	68.1	1.02
Weedy check		1.5	2.3	93.3	29.9	12.6	21.8	67.8	0.77
LSD at 5% level		0.7	4.0	7.0	15.8	5.4	38.2	NS	0.82
2001/2002 season									
Glyphosate (once)	36	4.1	12.5	131.3	85.7	39.3	167.3	68.8	6.42
Glyphosate (twice)	36	4.4	16.2	123.3	95.6	44.2	241.5	69.1	8.44
Glyphosate (thrice)	36	4.5	24.5	120.6	118.0	52.0	316.3	69.3	11.22
Imazethapyr (PPS)*	25	2.9	12.3	138.3	108.3	54.2	152.3	68.9	4.22
Imazethapyr (PPI)**	25	3.0	15.0	144.6	114.6	60.5	185.1	69.4	6.70
Imazethapyr (PPS)*	30	2.9	13.5	139.6	111.8	61.2	163.1	69.0	5.72
Imazethapyr (PPI)**	30	3.1	23.9	147.1	130.5	69.3	308.9	69.6	11.07
Hand pulling (twice)		2.5	3.2	107.6	63.2	36.3	39.3	66.8	1.03
Weedy check		2.3	2.6	107.1	60.4	31.5	36.0	66.5	0.81
LSD at 5% level		0.6	1.5	13.6	29.4	9.8	27.4	1.7	1.14

PPS* = Pre-planting surface application

PPI** = Pre-planting soil incorporation

The application of imazethapyr at 30 g *a.i.*/fed. (PPI), glyphosate at 36 g *a.i.*/fed. (thrice), imazethapyr at 25 g *a.i.*/fed.

(PPI), glyphosate at 36 g *a.i.*/fed. (twice) exhibited the highest increase in fresh weight of faba bean plant amounted by (71, 68, 62 and 62%) and by (49, 47 and 37%), respectively in the two seasons. Hand pulling (twice) increased fresh weight of faba bean plant by 12 and 4%, respectively in the two seasons.

Also, with the exception of hand pulling (twice) and glyphosate applied once, all other studied broomrape control treatments significantly increased dry weight of faba bean plant by (42–58%) and by (29–54%), respectively for the two seasons as compared with the untreated plants.

Data revealed that, with the exception of hand pulling (twice), all studied herbicides significantly increased the dry weight of pods per faba bean plant. Imazethapyr at 30 g *a.i.*/fed. (PPI), glyphosate at 36 g *a.i.*/fed. (thrice, twice and once), imazethapyr at 25 g *a.i* /fed. (PPI) increased dry weight of pods per plant by 93, 92, 91, 87 and 87%, respectively in the first season. Meanwhile, glyphosate at 36 g *a.i.*/fed. (thrice), imazethapyr at 30 g *a.i.*/fed. (PPI), glyphosate at 36 g *a.i.*/fed. (twice), imazethapyr at 25 g *a.i.*/fed. (PPI) increased dry weight of pods per faba bean plant by 89, 88, 85 and 81%, respectively as compared to the untreated check.

Broomrape control treatments did not affect 100-seed weight as compared to the untreated check in the first season, while in the second season, it significantly increased 100-seed weight. Glyphosate at 36 g *a.i.*/fed (thrice) or (twice) and imazethapyr at 30 or 25 g *a.i.*/fed. (PPI) slightly increased 100-seed weight significantly. Assaad *et al.* (1982) found that the use of glyphosate at three sequential rates at 100, 120 and 140 ml/feddan at three weeks intervals at the beginning of flowering did not affect weight of 100-seeds of faba bean.

With the exception of hand pulling (twice), all other studied treatments significantly increased faba bean seed yield if compared with the untreated check, these results hold fairly true in both seasons. The highest increases in seed yield were obtained by the application of glyphosate at 36 g a.i./fed. (thrice), imazethapyr at 30 g *a.i.*/fed. (PPI), glyphosate at 36 g a.i./fed. (twice), imazethapyr at 25 g *a.i.*/fed. (PPI). These treatments increased faba bean seed yield per fed. by (93, 93, 90 and 88%) and (93, 93, 90 and 88%) in

the first and second season, respectively. Assaad *et al.* (1982) indicated that glyphosate application decreased broomrape growth, which in turn increased faba bean productivity.

5. Combined effect of sowing date and broomrape bio-control by *Phytomyza* on faba bean yield:

a. Results of the 2000/2001 season:

Results indicated that delaying sowing date to November 15th significantly decreased number of capsules per spike by 21.0 and 12.9%, respectively at March and April and decreased seed weight of capsules per spike by 16.5 and 14.0%, respectively at the same dates as compared with early sowing date on October 15th. Meanwhile, sowing dates had no significant effect on number of infested capsules per spike at the two samples (Table 5).

Releasing *P. orobanchia* at 3 flies/spike (alone) did not affect number of capsules per spike at March and April. When releasing *P. orobanchia* was combined with application of glyphosate at 36 g *a.i.*/fed. (once) or with hand pulling (twice), it significantly reduced number of capsules per spike by (66.9 and 74.2%) and (63.8 and 70.7%), respectively at first and second survey.

Releasing of *Phytomyza* at 3 flies/spike (alone) or combined with glyphosate or hand pulling (twice) increased infestation percentage by *P. orobanchia*, hence these treatments recorded 67.0, 63.5 and 64.5% infestation compared to 4.5 % infestation estimated at the weedy check at the first sample. Same trend was observed at the second sample, where these treatments recorded 84, 75 and 77%, respectively compared to 5% infestation estimated at the weedy check. It should be noted that percent of infestation calculated by comparing mean value of infested capsules per spike to its original number of capsules per spike (table 5).

Results indicated that releasing *P. orobanchia* at rate of 3 flies per spike (alone) significantly reduced broomrape seed weight by 77 and 75%, respectively at the two samples. Abu- Shal (2001) found that releasing of *P. orobanchia* at 3 flies per spike caused 72.8% reduction in broomrape seeds. When releasing of *P. orobanchia* was combined with glyphosate at 36 g a.i./fed. or with hand pulling (twice), the reduction in broomrape seed weight reached (97 and 98%) and (96 and 97%), respectively at March and April as shown at Table (5).

Table (5) Effect of sowing dates and *Phytomyza* treatments on number of capsules, number of infested capsules and broomrape seed weight per spike, during 2000/2001 season

	First survey (Marsh 2001)								
	No. of capsules per spike			No. of infested capsules / spike			Seed wt.of capsules per spike (g)		
Treatments	Sowing dates			Sowing dates			Sowing dates		
	Oct. 15	Nov. 15	Mean	Oct. 15	Nov. 15	Mean	Oct. 15	Nov. 15	Mean
Glyphosate then *Phytomyza*	18.25	15.25	16.75	12.00	9.25	10.63	0.024	0.018	0.021
Hand pulling then *Phytomyza*	14.00	12.00	13.00	9.25	7.50	8.38	0.015	0.012	0.014
Phytomyza (alone)	56.50	44.25	50.38	38.25	29.25	33.75	0.154	0.178	0.166
Weedy check	57.25	43.50	50.38	3.00	1.75	2.38	0.825	0.643	0.734
Mean	36.50	28.75		15.63	11.94		0.255	0.213	
LSD for Treatments (T) :		7.46			6.51			0.085	
Sowing dates (D) :		4.08			NS			0.079	
Interaction (T X D) :		NS			9.21			0.12	

	Second survey (April 2001)								
Glyphosate then *Phytomyza*	26.25	23.50	24.88	20.75	16.75	18.75	0.042	0.029	0.036
Hand pulling then *Phytomyza*	20.75	19.50	20.13	17.00	14.00	15.50	0.029	0.024	0.027
Phytomyza (alone)	71.75	60.50	66.13	61.50	49.50	55.50	0.27	0.21	0.240
Weedy check	73.25	63.75	68.50	4.00	3.00	3.50	1.06	0.943	1.002
Mean	48.00	41.81		25.81	20.81		0.35	0.301	
LSD for Treatments (T) :		7.29			6.67			0.061	
Sowing dates (D)		6.34			NS			0.082	
Interaction (T X D) :		NS			9.43			0.086	

The interaction of sowing dates and broomrape control treatments significantly affected both number of capsules/spike and infestation percent by *P. orobanchia* at both samples. Shalaby *et al.* (2002) found that releasing the fly caused detectable increases in the percentage of infested *O. crenata* capsules. Also, data showed a significant difference in broomrape seed weight. Hence, all *P. orobanchia* treatments recorded the highest reduction in broomrape

seed weight at both sowing dates as shown at Table (5). In this respect, Al-Eryan (1996) and Abo-Shal (2001) reported that the application of glyphosate and releasing *P. orobanchia* reduced seed weight of broomrape spike up to 90.6% reduction.

b. Results of the 2001/2002 season:

Results shown in Table (6) revealed that, delaying sowing up to November 15th significantly decreased number of capsules per spike by 20.9 (at March), decreased number of infested capsules per spike by 27% (at March) and decreased seed weight of capsules per spike by 11.4 and 8.5%, at March and April, respectively, compared with early sowing date on October 15th (Table 6).

Releasing *P. orobanchia* at 3 flies/spike with the application of glyphosate at 36 g a.i./fed. or with hand pulling, significantly surpassed other treatments in reducing number of capsules per spike. It recorded 13.1 and 7.1 capsules / spike compared with 43.1 and 42.9 capsules / spike estimated by releasing *P. orobanchia* (alone) or by weedy check at the first sample. Also, it recorded 21.1 and 13.1 capsules / spike compared with 66.0 and 67.3 capsules / spike recorded by releasing *P. orobanchia* (alone) or by weedy check at the second sample.

Releasing of *P. orobanchia* at 3 flies/spike (alone) or combined with glyphosate application or hand pulling (twice), significantly increased infestation percentage by *P. orobanchia* and recorded 71.0, 66.5 and 68.5% infestation, respectively compared to 9.5% infestation estimated at the weedy check at the first sample. At the second sample, these treatments recorded 91.0, 88.5 and 82.0% infestation, respectively compared to 12.5 % infestation estimated at the weedy check.

Results indicated that releasing *P. orobanchia* at 3 flies/spike (alone) significantly reduced broomrape seeds weight by 76 and 74%, respectively at the two samples. When releasing of *Phytomyza* was combined with glyphosate at 36 g *a.i.*/fed. or with hand pulling (twice), the reduction in broomrape seed yield reached to 96 and 98%, respectively at March and to 95 and 97%, respectively at April.

Concerning the interaction, data showed a significant difference in broomrape seeds weight. All *P. orobanchia* treatments recorded the highest reduction in broomrape seeds

weight at both sowing dates. Al-Eryan (1996) and Abo-Shal (2001) found that the application of glyphosate and releasing *P. orobanchia* gave the highest *O. crenata* seeds reduction.

Table (6): **Effect of sowing dates and Phytomyza treatments on number of capsules, number of infested capsules and broomrape seed weight per spike during 2001/2002 season**

First survey (Marsh 2002)									
Treatments	No. of capsules / spike			No. of infested capsules per spike			Seed wt.of capsules per spike (g)		
	Sowing dates			Sowing dates			Sowing dates		
	Oct. 15	Nov. 15	Mean	Oct. 15	Nov. 15	Mean	Oct. 15	Nov. 15	Mean
Glyphosate then *Phytomyza*	14.5	11.75	13.13	10	7.5	8.75	0.023	0.016	0.020
Hand pulling then *Phytomyza*	8.25	6.00	7.13	5.75	4.00	4.88	0.013	0.008	0.011
Phytomyza (alone)	48.25	38.00	43.13	35.25	26.25	30.75	0.138	0.105	0.122
Weedy check	47.50	38.25	42.88	5.00	3.25	4.13	0.53	0.496	0.513
Mean	29.63	23.50		14.00	10.25		0.176	0.156	
LSD for									
Treatments (T) :		6.29			5.54			0.06	
Sowing dates (D) :		6.56			5.09			0.073	
Interaction (T X D) :		8.90			7.83			0.084	
Second survey (April 2002)									
Glyphosate then *Phytomyza*	22.50	19.75	21.13	18.25	15.75	17.00	0.046	0.041	0.044
Hand pulling then *Phytomyza*	14.25	12.00	13.13	11.75	9.75	10.75	0.025	0.02	0.023
Phytomyza (alone)	68.00	64.00	66.00	62.00	58.25	60.13	0.24	0.224	0.232
Weedy check	69.50	65.00	67.25	9.50	7.25	8.38	0.913	0.84	0.878
Mean	43.56	40.19		25.38	22.75		0.306	0.28	
LSD for									
Treatments (T) :		6.45			5.82			0.06	
Sowing dates (D) :		NS			NS			0.04	
Interaction (T X D) :		9.13			8.23			0.08	

6. Combined effect of the glyphosate/*phytomyza* application on the bean seed yield :

Data in Table (7) revealed that delaying sowing date to 15th November reduced number of broomrape spike per m^2 by 17 and 48% in the two seasons, respectively as compared to sowing date of 15th October. Also, delaying sowing date to 15th Nov. significantly reduced fresh weight of broomrape spike by 14 and 10% at both seasons, respectively as compared to sowing date of 15th October.

Also. data revealed that delaying sowing date to November 15th significantly increased faba bean seeds yield (Ardab/fed) by 31 and 27% at both seasons, respectively as compared to sowing date at October 15th.

Table (7): Effecte of sowing dates and *Phytomyza* treatments on broomrape and faba bean seed yield during 2000/2001 and 2001/2002 season

Treatments	2000/2001 season								
	No. of spike per m2			Fr. wt. of spike, g / m2			Seed yield, Ardab per fed		
	Oct. 15	Nov. 15	Mean	Oct. 15	Nov. 15	Mean	Oct. 15	Nov. 15	Mean
Glyphosate then *Phytomyza*	35.8	28.3	32.1	318	159	238	4.68	7.22	5.95
Hand pulling then *Phytomyza*	33.3	21.5	27.4	255	176	215	0.92	1.09	1.01
Releasing Phytomyza (alone)	139.3	106.5	122.9	1096	948	1022	0.82	1.06	0.94
Weedy check	158.5	148.0	153.3	1500	1448	1474	0.60	0.94	0.77
Mean	91.7	76.1		792	683	737	1.76	2.57	2.17
LSD for									
Treatments (T)		24.99			121.4			0.59	
Sowing dates (D)		12.35			132.9			0.73	
Interaction (T X D)		35.35			171.6			0.83	
	2001/2002 season								
Glyphosate then *Phytomyza*	46.5	23.0	34.8	490	413	451	5.03	7.28	6.16
Hand pulling then *Phytomyza*	22.0	11.0	16.5	370	355	363	0.97	1.09	1.03
Releasing Phytomyza (alone)	163.0	87.8	125.4	1545	1370	1458	0.88	1.09	0.98
Weedy check	177.8	90.3	134.0	1975	1825	1900	0.61	1.00	0.81
Mean	102.3	53.0	77.7	1095	991	1043	1.87	2.61	2.24
LSD for									
Treatments (T)		27.37			456			0.66	
Sowing dates (D)		26.02			165.5			0.91	
Interaction (T X D)		38.71			646.3			0.94	

Releasing *P. orobanchia* by 3 flies/spike (alone) did not affect number of broomrape spikes per m^2. When the release was combined with the application of glyphosate at 36 g a.i./fed (once) or with hand pulling (twice), it reduced number of broomrape spike/m^2 by 79 and 82%, respectively at first season and by 74 and 88%, respectively at second season compared to the weedy check.

Releasing *P. orobanchia* at 3 flies/spike combined with either glyphosate or hand pulling increased its efficacy against broomrape, hence it reduced the fresh weight of broomrape spike by 84 and 85% compared to 31% resulted by releasing *P. orobanchia* (alone) at the first season . Also, it recorded 76 and 81% reduction compared to 23% recorded by releasing *P. orobanchia* alone at the second season.

Data revealed that releasing *P. orobanchia* at 3 flies/spike combined with glyphosate achieved the highest increase in faba bean seeds yield (87%) in both seasons. This increase might be attributed to the effect of glyphosate only. Meanwhile, releasing *P. orobanchia* (alone) or combined with hand pulling (twice) recorded an increase in seeds yield estimated by 23 and 18%, respectively at first season and 22 and 18%, respectively at second season.

The interaction showed significant effect on faba bean seeds yield, i.e. releasing *P. orobanchia* combined with glyphosate recorded the highest increase in faba bean seeds yield when sown at Nov. 15th at both seasons.

REFERENCES

Abu-Shal, Amany, M.H.(2001). Applied study on utilization of *Orobanche* fly and other biotic agents in biological and integrated managements of broomrape and other noxious weeds. M. Sc. Thesis, fac. of Agric., Alexandria University, 12-5 pp.

Al-Eryan, M.A.S. (1996). Role of certain bioassociates in the biological control and integrated best management *Phytomyza orobanchia* Kalt. and glyphosate as biochemical control agents of *Orobanche crenata* Forsk. Ph. D. Thesis, Faculty of Agriculture, Alexandria University, Egypt.

Al-Eryan, M.A.S. and F.M.F. Zaitoun (2001) Loss assessment and forecasting work on plant diseases. 3. Statistical models of *Orobanche crenata* seed yield and its reduction due to *Phytomyza orobanchia*. J. Agric. Sci. Mansoura Univ., 26(6): 3643-3654.

Americanos, P.G.(1983) Control of *Orobanche* in broad-beans. Technical-Bulletin, Agricultural Research Institute, Nicosia, Cyprus. (1983 No.50, 4pp).

Assaad, M.; F.H. Farag and E.E. Hassanein (1982). Effect of pronamide and glyphosate on growth and mineral content of *Vicia faba* and *Orobanche crenata*. Proc. Egypt. Bot. So. 3. Mansoura Conference pp: 626- 643.

Garcia-Torres, L. ; F. Lopez-Granados; M. Saavedra; and J. Mesa-Garcia (1989). Selection of herbicides for control of broomrape (*Orobanche* spp.) in faba bean (*Vicia faba* L.) FABIS Newsletter, 24: 32-36.

Garcia-Torres, L.; M. Castejon-Munoz; F. Lopez. Granados and M. Jurado-Exposite (1995). HTCS (herbicide treated crop seed) treatments for the control of broomrape (*Orobanche SPP.*). Proceedings of the 1995 Congress of the Spanish Weed Sci. Society, Huesca, Spain, 14-16 November 369-372.

Geipert, S. (1997). Potentials and constraints for the control of *Orobanche crenata* Forsk. on Faba beans (*Vicia faba* L.) in Morocco.1997, 144 pp., plits 15 (5).

Ghalwash, A. M. (2003). Studies on broomrape weed in Egypt. Ph. D. Thesis, fac. of Agric. Minufiya University, 140 pp.

Hassanein E. E.; Y. H. Fayed; F.F. Shalaby and A.S. Kholosy (1998). Natural role of *Phytomyza orobanchia* Kalt., a beneficial fly against the parasitic weeds orobanche spp. infesting legumes and carrots in Egypt. Annals. Of Agricultural. Sciences. Ain Shams, Cairo, 43:1, 201-206.

Hassanein, E.E.; Z.R. Yehia; and M.S. Mekky (2000). Effect of sowing date and glyphosate on *Orobanche* control and seed yield of faba bean at Sids. NVRP for wild oats control in wheat and other winter crops. 8th Annual Meeting, Cairo, 3-7 Sept.: 309 – 313.

Hezewijk, M.J.V.; K.H. Linke; J.A.C. Verklleij and A.H. Pieters (1991). The effect of ammonium fertilizer in combination with nitrification inhibitors on *Orobanche crenata* infestation in faba bean. Proceeding of the 5th International Symposium of Parasitic Weed, Nairobi, Kenya: 470-483.

Jurado-Exposito, M.; L. Garcia-Torres and M. Castejon-Munoz (1997). Broad bean and lentil seed treatments with imidazolinones for the control of broomrape (*Orobanche crenata*). Journal. of Agricultural. Sciences. 129:3; 307-314.

Kukula. S.T. and H. Masri (1984). Integrated cultural practices and chemical control of *Orobanche crenata* in Faba bean. ICARDA, Aleppo, Syria. Proceedings of the Third International Symposium on Parasitic Weeds. 256-261.

Linke, K.H; S. Weigand and M.C. Saxena (1991). Biological control of *Orobanche*. ICARDA, Legume Program: Annual Report pp. 231- 233.

Linke, K.H. (1995). Status Quo of *Orobanche* control: preventive, cultural and physical control. European J. of plant pathology XIII International Plant Protection Congress, Netherlands.

Mesa-Garcia, J. and C. A. Vazquez (1985). Problems in the use of glyphosate in faba bean (*Vicia faba* L.) for the control of *Orobanche crenata* Forsk. Information-Tecnica. Economica-Agraria, 16 (61): 52-56.

Parker, C. and C.R. Riches (1993). Parasitic weeds of the world (Biology and control). CAB International, UK, 340 pp.

Shalaby F.F.; H.M. Ibrahim and E.E. Hassanein (2002). *Phytomyza Orobanchia* Kalt (Diptera:Agromyzidae). A vailable biocontrol agent against broomrape in Egypt. 2nd International Conf. Plant Protection Research Institute, Giza, Egypt, 21-24.

Sillero, J. C.; A. Perez-de-luque; D. Rubiales and M. T. Moreno (1999). Effects of the sowing date on *Orobanche crenata* infection on susceptible and resistant Faba bean and vetch varieties. SEMH Congreso:Sociedad Espanola de Malherbologia, Actas, Logrono, Spain, 23-25 November 401-405.

Snedecor, G.W. and W.G. Cochran (1967). Statistical Methods. 6th Ed., Iowa State Univ. Press, Ames. USA: 325-330.

Tawfik, M.F.S.; K.T. Awadallah and F.F. Shalaby (1976). Biology of *Phytomyza orobanchia* Kalt. (Diptera:Agromyzidae). Bull. Soc. Ent. Egypt, 60:53-64.

Zahran, M.K; F. H. Farag and T. S. Ibrahim (1982). Control of parasitic plants (broomrape and dodder) in different crops in Egypt. Final Tech. Report. Agric. Res. Program, Public Law 480, Grant No. FG-EG-130. Project No. F9- ARS-15.

الملخص العربى

تأثير مواعيد الزراعة ومكافحة الهالوك بالمبيدات وباطلاق حشرة الفيتومايزا على نمو الفول وإنتاجيّته

أمين عبد الباقى زين* – مسعد محمود عبد الحميد** – محمد فاضل شادى* ومحمد عماد قنيبر**

* قسم المبيدات – كلية الزراعة بكفر الشيخ – جامعة طنطا

** المعمل المركزى لبحوث الحشائش – مركز البحوث الزراعية – جمهورية مصرالعربية

ملخص البحث:

أقيمت أربعة تجارب بالصوبة السلكية بمحطة البحوث الزراعية بسخا – كفر الشيخ فى موسمى ٢٠٠٠/٢٠٠١ و ٢٠٠١/٢٠٠٢ فى نوعين من الدراسات. شملت الدراسة الأولى تجربتين لدراسة تأثير مواعيد الزراعة وكفاءة بعض المعاملات على مكافحة الهالوك ومحصول الفول ، كما شملت الدراسة الثانية تجربتين لدراسة كفاءة اطلاق حشرة الفيتومايزا منفردة أو مع بعض مبيدات الحشائش على الهالوك وانتاج بذورالفول. صممت تجارب الدراسة الأولى فى نظام قطع منشقة مرة واحدة حيث وزعت مواعيد الزراعة (١٥ أكتوبر و ١٥ نوفمبر) فى القطع الرئيسية بينما تم توزيع معاملات مكافحة الهالوك عشوائيا فى القطاعات الشقية وكانت معاملات مكافحة الهالوك : مبيد الجليفوسيت بمعدل ٣٦ جم مادة فعالة / فدان (مرة ، مرتين أو ثلاث مرات) بينها ثلاث اسابيع، المعاملة الأولى مع بداية تزهير الفول. ومبيد ايمازيثابير بمعدل ٢٥ أو ٣٠ جم مادة فعالة / فدان (رشا سطحى قبل الزراعة أو خلطا بالتربة) ومعاملة النقاوة اليدوية (مرتين) بالإضافة إلى القطع الغير معاملة. كما صممت تجارب الدراسة الثانية فى نظام قطع منشقة مرة واحدة ايضا، حيث وزعت مواعيد الزراعة (١٥ أكتوبر و ١٥ نوفمبر) فى القطع الرئيسية بينما تم توزيع معاملات اطلاق حشرة الفيتومايزا عشوائيا فى القطاعات الشقية.

أوضحت النتائج أن تأخير زراعة الفول الى ١٥ نوفمبر أدى الى خفض معنوى للعدد والوزن الغض والجاف لشماريخ الهالوك، كما أنها أدت الى تقليل معنوى فى أطوال الشماريخ و عدد الشماريخ / نبات فول وأيضا فى عدد الكبسولات لكل شمراخ هالوك. بالاضافة الى أن زراعة

الفـول فـي ١٥ نوفمـبر نتج عنه أعلى وزن جاف لقرون الفول/ نبات وأعلى ارتفاع لنباتات الفول واعلى وزن جاف لنبات الفول وبالتالى أعلى محصـول لـبذور الفـول. كما أوضحت النتائج الكفاءة العالية لمعاملات الجليفوسـيت بمعـدل ٣٦ جم مادة فعالة / فدان (ثلاث مرات أو مرتين) ومبيد الايمازيثابير بمعدل ٣٠ جم مادة فعالة / فدان (خلطا بالتربة) والتى حققـت أعلى نسبة مكافحة للهالوك وأعلى محصول الفول. كما أوضحت النتائج أيضا فاعلية معاملة النقاوة اليدوية فى تقليل أعداد وأوزان الهالوك ، الا أنـه لـم ينـتج عنها زيادة معنوية فى محصول الفول لأنها تنفذ بعد حدوث التطفل بالهالوك فعلا.

كمـا أوضـحت النـتائج أن اطـلاق حشرة الفيتومايزا بمعدل ٣ حشـرات / شمراخ هالوك أدى الى زيادة نسبة الاصابة بالحشرة الى ٦٧ – ٧١% فـي مارس و٨٤ – ٩١% فى ابريل فى موسمى الدراسة على الـتوالى. مما أدى الى خفض وزن بذور الهالوك / شمراخ بنسبة ٧٤ – ٧٧ % . وان لـم تـؤدى الى زيادة معنوية فى محصول الفول . وعندما تلـى اطـلاق الحشرة بمعاملة الجليفوسيت زادت نسبة الخفض فى بذور الهـالوك الـى ٩١ – ٩٨%، وزاد محصول الفول معنويا وان كانت هذه الزيادة ترجع الى فاعلية الجليفوسيت فقط.

ويمكـن القول بأن دور النقاوة اليدوية واطلاق حشرة الفيتومايزا يكمن فى تقلـيل اعـداد بذور الهالوك التى سوف تضاف للتربة. ويمكن اضافتهما لعناصـر المكافحـة المتكاملة للهالوك فى الفول الى جانب تأخير زراعة الفـول الـى ١٥ نوفمـبر وتطبـيق أى مـن معـاملات الجليفوسيت أو الايمازيثابير.