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EFFECT OF GLYPHOSATE ON GROWTH OF FABA BEAN (*Vicia faba* L.) AND BROOMRAPE (*Orobanche crenata* Frosk)

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ABSTRACT

The present investigation was carried out at the Agricultural Experiment and Research Station, Faculty of Agriculture, Cairo University, Giza, Egypt, during the two growing seasons of 1990/91 and 1991/92 to study the effect of the herbicide glyphosate on the growth and yield of faba bean. The effectiveness of glyphosate in controlling *Orobanche* was also studied. In each season two experiments were curried out, the first in *Orobanche* free field and the second in field naturally infested with *Orobanche*. Glyphosate was applied as a post emergence foliar spray at doses of 0.0, 13.5, 27.0 and 40.5 g.a.i./fed. Each dose was sprayed thrice at three weeks intervals started at the beginning of host flowering.

Application of glyphosate specially at the rate of 40.5 g.a.i./fed., to faba bean grown in *Orobanche* free field negatively affected plant growth and yield. Using the herbicide in field naturally infested with *Orobanche* decreased number and dry weight of broomrapes per faba bean plant. The rate of 40.5 g.a.i./fed of glyphosate decreased infection by about 97%. Consequently, the growth and yield of the host treated plants increased, comparing with the untreated (infested) plants.

INTRODUCTION

Orobanche represents a major threat to faba bean (*Vicia faba* L.) in Egypt and other Mediterranean countries. The loss in the yield of faba bean attributed to *Orobanche* may be reaches up to 100% according to the level of infestation and some other factores (Edwards, 1972; Schmitt *et al.*, 1979; Mesa – Garcia and Garcia – Torres, 1985 and Darwish, 1991).

It has been found by many workers that application of glyphosate to faba bean for *Orobanche* control produced complete parasite destruction and increases in the yield (kasasian, 1973; Basler, 1979; Schmitt *et al.*, 1979; Jacobsohn and Kelman, 1980; Shlutter and Aber, 1980; Zahran *et al.* 1980; Ahmed 1981; Darwish 1982; Kukula and Masri 1984; Nassib *et al.* 1984; Garcia -Torres *et al.* 1989 and Ramirez *et al.* 1992).

The present investigation aims to study the effects of different doses of glyphosate on growth and yield of two cultivars of faba bean under *Orobanche* infested and free conditions. The effectiveness of glyphosate in controlling *Orobanche* was also studied.

MATERIALS AND METHODS

The present investigation was carried out at the Agricultural Experiment and Research Station, Faculty of Agriculture, Cairo University, Giza, during the two growing seasons 1990/1991 and 1991/1992. In each season two experiments were conducted, the first in *Orobanche* free field and the second in naturally *Orobanche* infested one.

Two commercial cultivars Giza 402 and Giza 3 of faba bean were used in this study. Seeds were obtained from the Legume Department, Field Crop Research Institute, Agricultural Research Center, Giza, Egypt.

The herbicide glyphosate, N. (phosphonomethyl) glycine, (36%active ingredient) was applied as a post emergence foliar application at three doses named, 13.5, 27.0 and 40.5 g.a.i./fed. The control plants were sprayed only with water. Each dose of the herbicide was sprayed thrice at three weeks intervals starting at the beginning of host flowering.

The layout of experiment was randomized complete block design in split plot arrangement with four replications. The herbicide treatments were assigned to main plots and host cultivars in the sub-plots. Each sub-plot consists of four ridges each was four miters long and 60cm. apart, hand planted in one side with two seeds/hill in 20cm. distances. Irrigation and fertilization were applied according to normal recommendation of faba bean production in vicinity.

In both *Orobanche* free or infested experiments, a sample of 16 plants for each treatment, 4 plants from each replicate, were taken at harvest to study the different growth and yield characters, except the dry weight of leaves per plant, which was taken three weeks after the second spray at the ages of 92 and 102 days, in the first and second seasons, respectively. The following characters were studied:

1. Length of the tallest branch (plant height).
2. Number of the tallest branch internodes.
3. Number of branches per plant.
4. Dry weight of shoots and root system per plant.
5. Dry weight of leaves per plant.
6. Number of pods per plant.
7. Number of seeds per plant.
8. Seed yield per plant.
9. Seed index (weight of 100 seeds).
10. Number of broomrapes per plant.
11. Dry weight of broomrapes per plant.

RESULTS AND DISCUSSION

The first experiment :

Effect of different concentrations of glyphosate on the growth and yield of faba bean grown in *Orobanche* free field.

Effect of glyphosate on some growth traits and yield of faba bean was studied at harvest, when plants were already sprayed thrice with 0.13.5,27.0 or 40.5 g. a. i./ fed. of glyphosate.

1. Growth characters

The average length of the tallest branch (plant height) exhibite significant decrease in plants treated with 27.0 or 40.5 g.a.i./fed. glyphosate as compared with control. Insignificant decrease in this respe was recorded when the lowest rate (13.5g.a.i./fed.) was applied (Table 1).

Table (1): Length of the tallest branch cm. (plant height) of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* free field.

Season	1990 - 1991			1991 - 1992		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	102.7	93.9	98.3	90.0	88.8	89.4
13.5	94.9	81.4	88.2	85.0	81.3	83.2
27	84.1	88.1	86.1	77.5	80.0	78.8
40.5	85.3	77.7	81.5	75.0	77.5	76.3
Average	91.8	85.3		81.9	81.9	
L.S.D. (0.05)			12.2			9.2

There was a gradual decrease in the average number of internodes of the tallest branch in plants treated with different concentrations of glyphosate as compared with untreated ones. However the differences were statistically insignificant. The highest reduction in this respect was obtained at 40.5 g.a.i./fed. (Table 2)

Table (2): Number of tallest branch internodes of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* free field.

Season	1990 - 1991			1991 - 1992		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	29.6	27.3	28.5	26.3	25.8	26.1
13.5	29.1	25.8	27.5	25.8	25.5	25.7
27	26.7	26.7	26.7	24.0	24.5	24.3
40.5	27.2	23.2	25.2	23.3	23.5	23.4
Average	28.2	25.8		24.9	24.8	
L.S.D. (0.05)			ns.			ns.
Ns.: not significant						

It could be concluded therefore that in *Orobanche* free field, application of glyphosate thrice to faba bean decreased plant height specially when 27.0 or 40.5 g.a.i./fed were used. This result is in agreement with the findings of Abou-el-Suoud (1986).

A slight increase in the average number of branches of treated plants was recorded in both seasons, with significant difference only at the rate of 40.5 g.a.i./fed in comparison with control in the second season (Table 3). In this connection Abou-el-Suoud (1980) found that number of branches was ot affected by application of glyphosate at rates of 130 and 195 g.a.i./fed.

Table (3): Number of branches per plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* free field.

Season	1990 - 1991			1990 – 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	3.0	2.8	2.9	2.3	2.4	2.4
13.5	2.7	3.1	2.9	2.4	2.4	2.4
27	3.3	3.1	3.2	2.0	2.4	2.2
40.5	3.9	3.4	3.7	2.9	3.2	3.1
Average	3.2	3.1		2.4	2.6	
L.S.D. (0.05)			ns.			0.6
ns.: not significant						

2. yield and yield components

All treatments of glyphosate induced insignificant decrease in the average number of pods and seeds per plant as compared with control (Table 4 and 5). This indicating that the decrease in the number of seeds per plant obtained due to glyphosate treatments might be due mainly to its effect on the number of pods per plant.

Table (4): Number of podes per plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* free field.

Season	1990 - 1991			1990 - 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	22.7	22.5	22.6	17.9	19.2	18.6
13.5	22.7	20.7	21.7	16.7	16.1	16.4
27	19.7	23.1	21.4	15.0	17.7	16.4
40.5	18.5	21.0	19.8	14.0	11.2	12.6
Average	20.9	21.8		15.9	16.1	
L.S.D. (0.05)			ns.			3.4
ns.: not significant						

Table (5): Number of seeds per plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* free field.

Season	1990 - 1991			1990 - 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	56.3	53.8	55.1	34.7	36.0	35.4
13.5	50.0	52.5	51.3	28.3	28.8	28.6
27	47.3	55.1	51.2	28.9	32.3	30.6
40.5	43.2	49.7	46.5	27.5	24.4	26.0
Average	49.2	52.8		29.9	30.4	
L.S.D. (0.05)			ns.			5.8
ns.: not significant						

The average seed index of faba bean plants treated with any concentration of glyphosate were lesser than that of the control ones. Treatment was more effective in the second season specially at the two higher rates (27.0 and 40.5 g.a.i./fed), where the differences between these two doses and control were statistically significant (Table 6).

Table (6): Seed index (weight of 100 seed) of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* free field.

Season	1990 - 1991			1990 - 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	64.7	64.7	64.7	58.4	56.3	57.4
13.5	66.2	61.1	63.7	55.1	57.7	56.4
27	58.7	63.2	61.0	50.7	54.5	52.6
40.5	65.2	62.6	63.9	55.0	52.3	53.7
Average	63.7	62.9		54.8	55.2	
L.S.D. (0.05)			ns.			2.8

ns.: not significant

In both seasons all used concentrations of glyphosate significantly decreased the average seed yield per plant as compared with the corresponding controls. The effect of glyphosate on seed yield of faba bean increased gradually by increasing its dose (Table 7).

Table (7): Seed yield (gm) per plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* free field.

Season	1990 - 1991			1990 - 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	38.0	36.3	37.2	21.8	22.2	22.0
13.5	34.2	32.3	33.3	16.5	17.3	16.9
27	29.7	34.8	32.3	15.2	17.6	16.4
40.5	28.1	31.2	29.7	13.4	12.6	13.0
Average	32.5	33.7		16.7	17.4	
L.S.D. (0.05)			ns.			1.6

ns.: not significant

From the above results, it could be concluded that spraying faba bean plants thrice with 13.5, 27.0 or 40.5 g.a.i./fed of glyphosate in *Orobanche* free field negatively affected seed yield.
These results are in accordance with the findings of Mesa-Garcia *et al.* (1984).

The Second Experiment:
Effect of different concentrations of glyphosate on growth of *robanche* and faba bean grown in *Orobanche* infested field.

In this experiment each of the three concentrations used of glyphosate, was sprayed thrice on faba bean plants grown in *Orobanche* infested field to study its effect in controlling the *Orobanche* and probable subsequent improvement in the growth and yield of faba bean.

Effect on Orobanche

Application of glyphosate thrice to faba bean infested with *Orobanche* significantly decreased the number and dry weight of broomrapes per plant or ridge, when used at any of the adopted rates as compared with control. The effect of glyphosate increased by raising its dose (Tables 8 and 9 and Fig. 1).

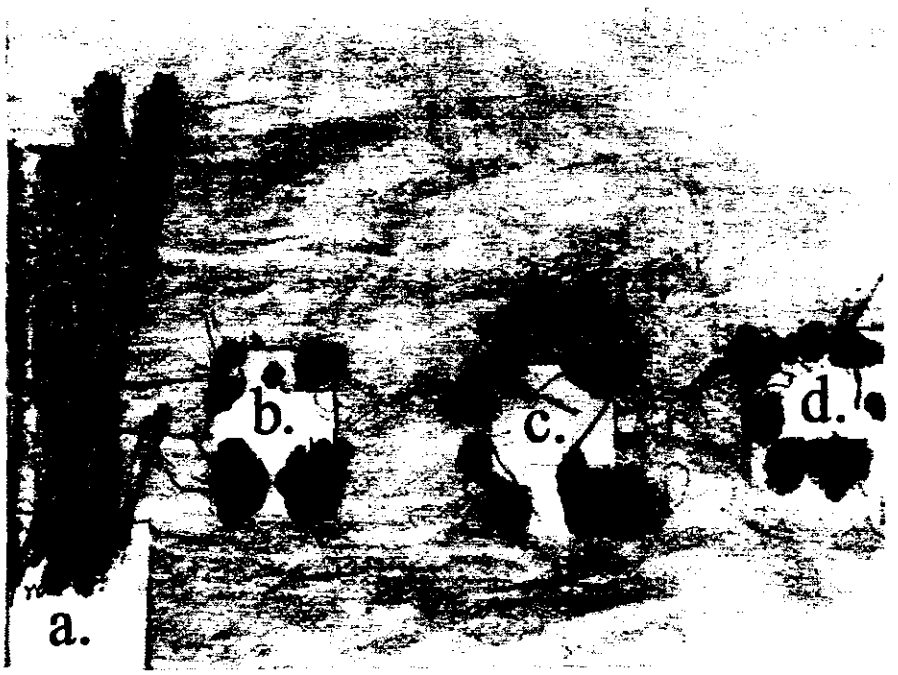

Fig. (1): Effect of glyphosate doses on broomrape, [a (0.0), b (13.5),c (27.0) and d (40.5) g.a.i./fed. each sprayed thrice]

Irrespective of treatment the average number and dry weight of broomrape per plant or ridge at harvest was higher in Giza 3 than in Giza 402 cultivar. However, the deference was statistically significant only in the first season.

It could be realized, therefore that application of glyphosate at any used rate to faba bean, heavily infested with *Orobanche*, induced conspicuous reduction in both number and dry weight of *Orobanche* per plant.

Table (8): Number of broomrapes per host plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* infested field.

Season	1990 - 1991			1990 - 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	4.6	3.4	4.0	5.2	2.9	4.1
13.5	4.2	2.5	3.4	2.8	2.7	2.8
27	3.7	1.9	2.8	1.7	2.5	2.1
40.5	2.2	1.8	2.0	1.7	1.9	1.8
Average	3.7	2.4		2.9	2.5	
L.S.D. (0.05)			ns.			ns.
ns.: not significant						

Table (9): Dry weight (gm) of broomrapes per host plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* infested field.

Season	1990 - 1991			1990 - 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	5.0	6.2	5.6	5.1	3.2	4.2
13.5	1.6	2.1	1.9	1.8	2.5	2.2
27	0.8	1.0	0.9	0.8	1.7	1.3
40.5	0.3	0.2	0.3	0.3	1.3	0.8
Average	1.9	2.4		2.0	2.2	
L.S.D. (0.05)			2.2			2.7

These result are more or less in accordance with the findings of Kasasian, 1979; Schmitt *et al.*, 1979; Shlutter and Aber, 1980; Zahran *et al.*, 1980; Ahmed, 1981; Darwish, 1982; Kukula and Masri, 1984; Nassib *et al.*, 1984; Mesa-Garcia and Garcia Torres, 1985 and Garcia Torres *et al.*, 1989.

Effect on faba been:

Growth traits:

Insignificant increase in the average height (length of the tallest branch) of glyphosate treated plants was obtained as compared with the control. The rate of 27.0 g.a.i./fed produced the tallest plants in the two seasons (Table 10).

The tallest branches of plants treated with glyphosate specially with the higher two rates recorded insignificant increase in the average number of internodes when compared with the control (Table 11).

It could be concluded that the rate 27.0 g.a.i./fed of glyphosate was the most effective treatment, which produced the tallest shoots at harvest by increasing the number of their internodes. It could be said also that infection with *Orobanche* affected stem elongation mainly by decreasing the number of its internodes and treatment with glyphosate could overcome the inhibitive effect of infection on the formation of internodes. In this connection Darwish (1982) found that plant height was not affected with glyphosate treatment.

Table (10): Length of the tallest branch (cm) of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* infested field.

Season	1990 - 1991			1990 - 1991		
Cultivars / Dose (g.a.i./fed)	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
0	49.3	64.9	57.1	60.5	54.3	57.4
13.5	58.7	79.7	69.2	57.5	59.8	58.7
27	63.2	76.8	70.0	55.3	66.8	61.1
40.5	64.1	69.6	66.9	62.3	55.1	58.7
Average	58.8	72.8		58.9	59.0	
L.S.D. (0.05)			2.1			ns.

ns.: not significant

Table (11): Number of internodes of the tallest branch of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* infested field.

Season	1990 - 1991			1990 - 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	15.4	16.2	15.8	16.5	17.0	16.8
13.5	14.7	17.7	16.2	18.2	20.0	19.1
27	16.1	18.5	17.3	19.1	19.5	19.3
40.5	16.7	19.8	18.3	20.4	18.6	19.5
Average	15.7	18.1		18.6	18.8	
L.S.D. (0.05)			ns.			ns.

ns.: noi significant

The average number of branches per plant was not affected with application of glyphosate (Table 12). This might be due to that first application was performed at flowering stage after the development of most basal branches. In this respect Ahmed, 1981 and Darwish, 1982 recorded an increase in the number of branches per faba bean plant due to treatment with glyphosate.

Table (12): Number of branches per plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* infested field.

Season	1990 - 1991			1990 – 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	2.3	2.6	2.5	3.0	3.1	3.1
13.5	2.3	2.6	2.5	3.5	3.0	3.3
27	2.5	2.5	2.5	3.3	2.8	3.1
40.5	2.3	2.7	2.5	2.6	3.2	2.9
Average	2.4	2.6		3.1	3.0	
L.S.D. (0.05)			ns.			ns.
ns.: not significant						

The average dry weight of shoots and roots per treated plants were higher than those of untreated ones with significant difference in the second season. But in the first season the increment in this character due to treatment was significant only at the rate of 40.5 g.a.i./fed (Table 13). The dry weight of leaves per plant was promoted with any concentration used of glyphosate. This promotive effect increased by raising the dose of herbicide (Table 14). However, the differences between treatments and control were statistically insignificant.

Table (13): Dry weight (gm) of shoots and roots per plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* infested field.

Season	1990 - 1991			1990 - 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	5.4	11.5	8.5	11.5	17.5	14.5
13.5	8.6	17.4	13.0	20.6	23.6	22.1
27	10.7	20.0	15.4	23.4	27.9	25.7
40.5	12.9	26.3	19.6	23.1	27.9	25.5
Average	9.4	18.8		19.7	24.2	
L.S.D. (0.05)			10.5			7.6

Table (14): Dry weight (gm) of leaves per plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* infested field.

Season	1991 - 1992			1991 - 1992		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	2.8	5.0	3.9	5.9	7.1	6.5
13.5	3.6	6.0	4.8	6.0	8.6	7.3
27	4.4	6.7	5.6	6.9	8.2	7.6
40.5	5.4	8.2	6.8	8.5	10.2	9.4
Average	4.1	6.5		6.8	8.5	
L.S.D. (0.05)			ns.			ns.
ns.: not significant						

It could be said that in general application of glyphosate to faba bean infested with *Orobanche*, decreased the harmful effect of the parasite on growth traits of the host. The two higher rates 27.0 and 40.5 g.a.i./fed were more effective in this respect. This result is in accordance with the findings of Jacobsohn and Kelman, (1980).

Number of pods and seed yield per plant

Triple application of glyphosate at 27.0 or 40.5 g.a.i./fed to faba bean plants, heavily infested with *Orobanche*, significantly increased the average number of pods per plant in comparison with control. An increment in this yield component was recorded also by the rate of 13.5 g.a.i./fed but the difference between this rate and control did not reach the level of significance (Table 15).

Table (15): Number of pods per plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* infested field.

Season	1990 - 1991			1990 - 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	0.1	1.4	0.8	0.4	2.1	1.3
13.5	0.5	2.5	1.5	2.4	3.8	3.1
27	1.1	4.7	2.9	4.1	6.1	5.1
40.5	2.4	4.9	3.7	7.0	7.1	7.1
Average	1.0	3.4		3.5	4.8	
L.S.D. (0.05)			1.3			3.7

The average seed yield per plant was significantly increased with glyphosate treatment at any of the three adopted concentrations except at the rate of 13.5 g.a.i./fed in the first season where, the increment was statistically insignificant as compared to control (Table 16).

Table (16): Seed yield (gm) per plant of two faba bean cultivars as affected by different doses of glyphosate in *Orobanche* infested field.

Season	1990 - 1991			1990 - 1991		
Cultivars	Giza 3	Giza 402	Average	Giza 3	Giza 402	Average
Dose (g.a.i./fed)						
0	0.1	1.9	1.0	0.5	2.4	1.5
13.5	0.6	2.8	1.7	2.9	3.8	3.4
27	1.6	4.8	3.2	3.4	4.4	3.9
40.5	3.1	4.3	3.7	5.5	6.0	5.8
Average	1.4	3.5		3.1	4.2	
L.S.D. (0.05)			1.7			1.8

From the aforementioned results it could be deducted that applications of any dose used of glyphosate three times to faba bean plants grown in naturally *Orobanche* infested field were effective in controlling *Orobanche* and consequently increased seed yield of the crop. The highest

yield was obtained when the rate of 40.5 g.a.i./fed was sprayed thrice. It is worthy to mention that the increase in seed yield was mainly due to the increase in number of pods per plant after treatment with glyphosate. In accordance with this results many workers recorded increase in seed yield of faba bean due to the control of *Orobanche* with glyphosate (Schmitt *et al.*, 1979; Jacobsohn and Kelman, 1980; Shlutter and Aber, 1980; Zahran *et al.*, 1980; Ahmed, 1981; Darwish, 1982; and Nassib *et al.*, 1984).

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تأثير المعاملة بالجليفوسات على نمو نبات الفول البلدى والهالوك

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أجري هذا البحث بمحطة التجارب والبحوث الزراعية بكلية الزراعة – جامعة القاهرة – الجيزة ــ مصر ــ خلال موسمي النمو ١٩٩٠/٩١ ، ١٩٩١/٩٢ لدراسة تأثير مبيد الحشائش جليفوسات علي نمو ومحصول الفول البلدي وأيضا تأثير هذا المبيد علي مقاومة طفيل الهالوك وأجريت تجربتين في كل موسم، الأولي في حقل خال من الهالوك والثانية في حقل مصاب طبيعيا بهذا الطفيل. وقد استخدم الجليفوسات رشا علي المجموع الخضري لنباتات الفول بتركيزات صفر، ١٣,٥، ٢٧,٠، ٤٠,٥ جرام مادة فعالة للفدان، وتم رش كل تركيز ثلاث مرات، مرة كل ثلاث أسابيع ابتداءا من وقت تزهير الفول.

وقد أظهرت نتائج البحث أن استخدام الجليفوسات خاصة بمعدل ٤٠,٥ جرام للفدان في الحقل الخالي من الهالوك قد أدي إلى نقص في نمو ومحصول نباتات الفول. أما استخدام المبيد في الحقل المصاب بالهالوك فقد أدي إلى نقص في عدد ووزن نباتات الهالوك علي نبات الفول العائل وخاصة بعد الرشة الثالثة بالجرعة ٤٠,٥ جم مادة فعالة / فدان التي أدت إلى نقص الإصابة بالهالوك بحوالي ٩٧%. ونتيجة لذلك كانت نباتات الفول التي عوملت بالمبيد أقوي نموا وأعلي محصولا من تلك التي لم يتم رشها والتي تأثرت كثيرا بالإصابة بالهالوك.