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Effect of Bentazon and Different Lipid-Inhibitor Herbicides on Weed Control and Yield of Faba Bean (*Vicia faba* L.) in Upper Egypt

Ibrahim Abd El-Wahab Mohamed
Plant Protection Department, Faculty of Agriculture, Assiut University, 71526 Assiut, Egypt
*E-mail: ibrahim.mahmoud@agri.aun.edu.eg

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ABSTRACT

Weeds are amongst the major serious agricultural pests of faba bean (*Vicia faba* L.) production in Egypt and should be controlled. Clethodim is the only post-emergence herbicide registered for grass weed control in faba beans in Egypt. Two field separate experiments were conducted at Assiut University farm in two different locations in 2021-2022. The first field experiment aimed to evaluate the efficacy of some lipid–inhibitor herbicides (clethodim 24%, clethodim 12%, clethodim + haloxyfop 22.6%, diclofop-methyl 36%, fenoxaprop-p-ethyl 7.5%, quizalofop-p-ethyl 5%, and thiobencarb 50%) and hand hoeing treatments for controlling the grass weed, *Phalaris minor* Retz in faba bean. The second field experiment aimed to evaluate the effects of bentazon 48% herbicide on broad-leaf weeds in faba bean. *Phalaris minor* was the only grass weed presented in the first experimental field, while *Beta vulgaris* L., *Cichorium pumilum* Jacq. and *Ammi majus* L. were the dominant broadleaf weeds in the second experimental field. In the first experiment, all selected lipid–inhibitor herbicides except fenoxaprop provided 89.49–98.58% in controlling *P. minor* compared with the weedy control at 62 days after crop sowing. Among all lipid–inhibitors, clethodim 24%, thiobencarb 50%, diclofop-methyl 36%, and clethodim + haloxyfop 22.6% performed the highest increment (82.81–86.57%) in faba bean yield versus control. In the second experiment, bentazon 48% provided excellent efficiency against broadleaf weeds with weed reduction of up to 95% and increased faba bean yield by 69.54% compared with the control at 68 days after crop sowing. In the current scenario, the grass herbicides (clethodim 24%, thiobencarb 50%, diclofop-methyl 36%, and clethodim + haloxyfop 22.6%) and a broadleaf herbicide (bentazon 48%) can be used as a promising chemical herbicide option for the control of weeds in faba bean *cv.* Giza 843 in Upper Egypt.

INTRODUCTION

Faba bean, also known as fava bean or broad bean (*Vicia faba* L., Fam. Fabaceae), is an economically important legume crop worldwide (Elsebaie *et al.*, 2022). It is among the healthiest staple foods in the Egyptian diet that provide the majority of necessary macronutrients (such as proteins, fiber, and carbohydrates) and main vitamins and minerals (El-Metwally *et al.*, 2017). Faba bean is currently cultivated in more than 66 countries (Merga *et al.*, 2019), and Egypt is one of the world's largest faba bean producers in 2019 (FAO, 2021). However, the local production of faba bean is not sufficient for the Egyptians'

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needs, so Egypt resorts to importing seeds of faba bean from other countries mostly from Australia, France and the United Kingdom (Attia *et al.,* 2019). To date, Egypt remains the biggest importer of faba bean crop in the world as it imports more than 50% of the total import volume in the world (Attia *et al.,* 2019; Elsebaie *et al.,* 2022).

There are various biotic stresses (such as pests) and biotic stresses (such as drought, waterlogging and heat), affecting the global production of faba bean (Maalouf *et al.*, 2018). Farmers often consider pests, especially weeds and plant diseases to be the main biotic constraints to faba bean and other legume crop production (Aboali and Saeedipour, 2015; Maalouf *et al.*, 2018). There are several troublesome broad-leaved and grass-weeds-infested faba bean cultivation areas (Karkanis *et al.*, 2018). Weeds infestations reduced the seed yield of *V. faba* by 30% to over 80% (Hassan, 1987; Mohamed *et al.,* 2004; Frenda *et al.,* 2013; El-Gedwy *et al.,* 2020). Grass weeds such as *Phalaris* spp., *Lolium rigidum* Gaud., and *Avena* spp. in faba bean and other grain and forage legume crops can be controlled by different lipid-inhibitor post-emergence herbicides such as clethodim, sethoxydim, quizalofop-p-ethyl, and haloxyfop (Aboali and Saeedipour, 2015; APC, 2020).

Pendimethalin and clomazone are registered as pre-emergence herbicides to control grass and broadleaf weeds in faba bean fields in the European Union, while bentazon is registered as a post-emergence herbicide to control broadleaf weeds. Bentazon is a selective benzothiadiazole herbicide that inhibits the photosynthesis II pathway in weeds (Aboali and Saeedipour, 2015). It is widely used to control various broadleaf weeds in different cereal crops and faba beans cultivation (El-Shahawy, 2008; Aboali and Saeedipour, 2015). Application of imazthapyr 10% SL at 0.6 L ha^{-1} and a tank-mixed of bentazon 48% SL at 1.5 L ha^{-1} + haloxyfop-methyl 10.8% EC at 0.6 L ha^{-1} possessed high efficacy against weeds in broad bean and increased biological and seed yield of the crop (Aboali and Saeedipour, 2015).

To date, few herbicides are labeled for application in faba beans in Egypt. Clethodim (labeled as Bolfix ® 24% EC and twomix® 24% EC, 0.714 L ha^{-1} or Select Super 12.5% EC at 0. 595 L ha^{-1}) is the only registered post-emergent herbicide for grass weed control in faba bean fields in Egypt (APC, 2021). Glyphosate herbicide at 0.607 L ha^{-1} is also used by farmers as a post-emergence herbicide to control a parasitic weed, *Orobanche crenata* Forskal, in faba bean at its flowering stage. Unfortunately, no broadleaved herbicide product is currently labeled for application on faba beans in Egypt. Therefore, alternative post-emergence herbicides to control grass weeds or other problem broadleaf weeds in faba bean would be of significant benefit to farmers.

Therefore, the main investigation of the present study was to 1) evaluate the effectiveness of seven lipid-inhibitor herbicides and compared with hand hoeing on a troublesome grass weed *Phalaris minor* in faba bean field, 2) evaluate the efficacy of bentazon herbicide against broadleaf weeds in faba bean field.

MATERIALS AND METHODS

Two field separate experiments were conducted at Assiut University Farm in two different locations in 2021-2022 growing season. The first field experiment aimed to evaluate the efficiency of seven lipid–inhibitor herbicides (clethodim 24%, clethodim 12%, clethodim + haloxyfop 22.6%, diclofop-methyl 36%, fenoxaprop-p-ethyl 7.5%, quizalofop-p-ethyl 5%, and thiobencarb 50%) and hand hoeing treatments against the noxious grass weed, *Phalaris minor* Retz in faba bean. The second field experiment aimed to evaluate the potency of bentazon 48% herbicide on broadleaf weeds in faba bean field. The soil type of the experimental fields was clay. Details of the lipid–inhibitor and bentazon herbicides treatment are represented in Table (1).

Table 1. List of post-emergence herbicides, their active ingredient(s), trade name, application rate (L ha^{-1}), and manufacturing company used in this study.

Active ingredient	Trade name	Application rate (L ha^{-1})	Manufacturing company
I. Lipid-inhibitor graminicide herbicides			
Clethodim 12.5%	Select Super 12.5% EC	0.60	Arysta Life science Ltd., Egypt
Clethodim 24%	Bowflex ultra 24% EC	0.71	Camagrochemicals Company, Egypt
Clethodim 15% + Haloxyfop-p-methyl 7.5%	Fine 22.5% EC	1.36	Starchem Industrial Chemical, Egypt
Diclofop-methyl 36%	Fakto 36% EC	2.98	Starchem Industrial Chemicals, Egypt
Fenoxaprop-p-ethyl 7.5%	Alarm 7.5% EW	1.79	Elhelb Pesticides and Chemicals, Egypt
Quizalofop-p-ethyl	Fop Super 5% EC	1.19	Cairo Chemical Company, Egypt
Thiobencarb	Kafro Saturn 50% EC	4.76	Kafr El Zayat Company, Egypt
II. Broadleaf herbicide			
Bentazone	Dribble 48% SL	1.19	Starchem Industrial Chemical, Egypt

The first experiment was carried out at the Farm of Agronomy Department, Assiut University, Egypt in 2021–2022. Seeds of faba bean variety Giza 843 were sown on the 20th of October in 2021. The plot size was 16 m^{-2} and each one consisted of six ridges of faba bean. Broadleaved weed species were removed manually. The experiment consisted of nine treatments as follows:

1. Clethodim 24% (Bowflex ultra 24% EC) applied at 0.71 L ha^{-1} at 32 days after crop sowing (DAS).
2. Clethodim 12.5% (Select Super 12.5% EC) applied at 0.60 L ha^{-1} at 32 DAS.
3. Clethodim 15% + Haloxyfop-p-methyl 7.5% (Fine 22.5% EC) applied at 1.36 L ha^{-1} at 32 DAS.
4. Diclofop-methyl 36% (Fakto 36% EC) applied at 2.98 L ha^{-1} at 32 DAS.
5. Fenoxaprop-p-ethyl 7.5% (Alarm 7.5% EW) applied at 1.79 L ha^{-1} at 32 DAS.
6. Quizalofop-p-ethyl (Fop Super 5% EC) applied at 1.19 L ha^{-1} at 32 DAS.
7. Thiobencarb 50% (Kafro Saturn 50% EC) applied at 4.76 L ha^{-1} at 32 DAS.
8. Hand hoeing (twice) at 21 and 40 DAS.
9. Weedy control.

The second field experiment was conducted in the Farm of Plant Protection Department, Assiut University in 2021-2022. Seeds of faba bean variety Giza 843 were sown on the 15th of November in 2021. The plot size was 10.5 m^{-2} and each one consisted of five ridges of faba bean. Grass weed species were removed manually. Treatments in the second experiment were as follows:

1. Bentazon 48% (Dribble 48% SL) applied at 1.19 L ha^{-1} at 37 days after crop sowing (DAS).
2. Weedy control.

The tested herbicides in each experiment were applied by an electric knapsack sprayer with a single nozzle (Granada, model KF-20C-18) at a water spray volume of 476.19 L ha^{-1}. All agricultural practices for faba bean crop were conducted uniformly.

Statistical Analysis:

The treatments in each experiment were arranged as a randomized block design with three replications. The total number and fresh weight of target weeds included *P. minor* in the first experiment and broadleaf weeds in the second experiment and their rates in faba bean plots were measured at 62 and 68 days after crop sowing (DAS), respectively. The weed control efficacy of the tested weed control treatments in each experiment was calculated from the data of density and fresh weight of target weeds according to Mohamed and Abdalla (2023). After that, data on the density and fresh weight of target weeds in each experiment were transferred using ($\sqrt{X+1}$) square root transformation prior to the ANOVA using CoStat-software and the treatment means in each experiment were separated by L.S.D. test at $P < 0.05$ (Steel and Torrie, 1980). To assess the seed yield of faba bean; all faba bean plants in each plot in each experiment were harvested and the seed yield of each one was weighted, and then expressed as Kg ha^{-1} and the results of each one were also statistically analyzed.

RESULTS AND DISCUSSION

I-Grass Weed Control Experiment:

In the first experiment, faba bean field was infested with only grass weed, *Phalaris minor*. Maximum density and fresh weight of *P. minor* were 469.33 weed m^{-2} and 2117.73 g m^{-2}, respectively, which emerged in the weedy control plots at 62 days after crop sowing (DAS) (Table 2). *Phalaris minor* was recorded as one of the most broadly widespread and serious narrow-leaved weeds in winter legume crops such as faba bean (Karkanis *et al.*, 2018; Boutagayout *et al.*, 2020; El-Gedwy *et al.*, 2020).

Table 2. Density and fresh weight of *Phalaris minor* weed found in weedy control plots in faba bean field at 62 days after sowing during 2020/2021.

Grass weed specie	Family	Weed density (n m^{-2})	% of weed density	Fresh weight (g m^{-2})	% of weed fresh weight
Phalaris minor	Poaceae	469.33±76.82	100%	2117.73±279.74	100%

All lipid-inhibitor herbicides (clethodim 24%, clethodim 12%, clethodim + haloxyfop 22.6%, diclofop-methyl 36%, fenoxaprop-p-ethyl 7.5%, quizalofop-p-ethyl 5%, and thiobencarb 50%) and hand hoeing (twice) treatments exhibited efficiency to control *P. minor* in the faba bean field compared to the weedy control at 62 DAS (Table 3). Among all treatments, clethodim 24%, clethodim 12%, clethodim + haloxyfop 22.6%, diclofop-methyl 36%, and thiobencarb 50% herbicides were most effective against *P. minor*, significantly reducing the density of *P. minor* by 96.31 to 98.58% and its fresh weight by 99.10 to 99.93%, versus the weedy control (Table 3). Quizalofop-p-ethyl 5% reduced the density and fresh weight of *P. minor* by 89.49% and 97.68%, respectively (Table 3). Hand hoeing and fenoxaprop-p-ethyl 7.5% treatments showed intermediate efficacy against *P. minor* and reduced its density by 87.50 and 79.55%, respectively as compared to the weedy control (Table 3). Regarding the herbicide treatments, the highest efficacy of all tested herbicides except fenoxaprop-p-ethyl 7.5% on *P. minor* may be due to their inhibition effects on synthesis and production of fatty acids and lipids in the target weed that it is an essential component of plant growth (Kobek *et al.,* 1988; Mohamed, 2017).

In this study, the variable effectiveness of the lipid-inhibitor herbicides against *P. minor* in faba bean field may be caused by the variable of active ingredient(s) of these herbicides or the variable susceptibility of *P. minor* to these compounds. Similar to our results, post-emergence application of clethodim, diclofop-methyl, and haloxyfop herbicides provided high activity against *P. minor* and other aggressive narrow-leaved weeds in faba bean and other dicot crops (Aboali and Saeedipour, 2015; Saini *et al.,* 2015; El-Gedwy *et al.,* 2020). Application of bentazon 48% at 1.5 L ha^{-1} + fenoxaprop 12% at 0.7 L ha^{-1} resulted in the least weed control efficacy in faba bean (Aboali and Saeedipour, 2015). Hand hoeing treatment was usually not effective compared to chemical herbicide treatments in some crops (Bhullar *et al.,* 2013; Mohamed, 2017).

Table 3. Effect of selected lipid-inhibitor herbicides and hand hoeing treatments on density and fresh weight (g m^{-2}) of *Phalaris minor* in faba bean filed at 62 days after sowing during 2020/2021.

Weed control treatments	Weed density (n m^{-2})	% Control	Fresh weight (g m^{-2})	% Control
Clethodim 12.5%	9.00±0.58d	98.08±0.12a	2.54±0.52d	99.88±0.02a
Clethodim 24%	8.00±1.15d	98.30±0.25a	3.41±0.70d	99.84±0.03a
Clethodim + Haloxyfop 22.5%	6.67±1.67d	98.58±0.36a	1.54±0.47d	99.93±0.02a
Diclofop-methyl 36%	13.33±3.33d	97.16±0.71a	18.97±3.07d	99.10±0.15ab
Fenoxaprop-p-ethyl 7.5%	96.00±10.58b	79.55±2.25c	290.89±13.8b5	86.26±0.65c
Quizalofop-p-ethyl 5%	49.33±4.81c	89.49±1.02b	49.21±7.95c	97.68±0.38b
Thiobencarb 50%	17.33±2.91d	96.31±0.62a	8.22±4.32cd	99.61±0.20a
Hand hoeing	58.67±6.36c	87.50±1.36b	257.77±32.98b	87.83±1.56c
Weedy control	469.33±76.82a	-	2117.73±279.74a	-

Means within each column with the same letters are not significantly different (at $p < 0.05$) of L.S.D. test.
Data of *Phalaris minor* were subjected to square-root transformation equation $\sqrt{(X+1)}$ before analysis.

Concerning faba bean seed yield, all the lipid-inhibitor herbicides expect fenoxaprop-p-ethyl 7.5% and hand hoeing (twice) treatments achieved a significant increment in the seed yield of faba bean (kg ha^{-1}), compared to the weedy control (Table 4). The highest seed yields were recorded in faba bean plots treated with clethodim 24% (4023.36 Kg ha^{-1}), thiobencarb 50% (3575.18), diclofop-methyl 36% (3555.56), and clethodim + haloxyfop 22.6% (3138.89) with similar statistics. Clethodim 12% (2586.21) and hand hoeing (2440.87) also provided increment in the faba bean yields without significantly different with clethodim + haloxyfop 22.6% (Table 4). Among all lipid-inhibitor herbicides, quizalofop-p-ethyl 5% (1633.77 Kg ha^{-1}) followed by fenoxaprop-p-ethyl 7.5% (1380.95 Kg ha^{-1}) have the lower seed yield (Table 4). In contrast, the lowest faba bean seed yield was recorded in the weedy control plots with 539.57 Kg ha^{-1} (Table 4). The former treatments caused increments in the faba bean seed yield by 86.57, 84.91, 84.82, 82.81, 79.14, 77.89, 66.97, and 60.93%, respectively compared with the weedy control (Table 4).

Table 4. Faba bean seed yield (Kg ha^{-1}) and percentage of yield increased as affected by different lipid-inhibitor herbicides and hand hoeing treatments in faba bean filed during 2020/2021.

Weed control treatments	Seed yield (kg ha^{-1})	% Increase seed yield
Clethodim 12.5%	2586.21±139.36b	79.14±1.08ab
Clethodim 24%	4023.36±311.79a	86.57±0.98a
Clethodim + Haloxyfop 22.5%	3138.89±227.38ab	82.81±1.19a
Diclofop-methyl 36%	3555.56±420.37a	84.82±2.03a
Fenoxaprop-p-ethyl 7.5%	1380.95±524.55de	60.93±13.79c
Quizalofop-p-ethyl 5%	1633.77±129.28cd	66.97±2.83b
Thiobencarb 50%	3575.18±263.87a	84.91±1.05a
Hand hoeing	2440.87±95.27bc	77.89±0.88ab
Weedy control	539.57±59.95e	-

Means within each column with the same letter(s) are not significantly different (at $p < 0.05$) of L.S.D. test.

The highest increment of faba bean seed yield was caused by clethodim 24%, thiobencarb 50%, diclofop-methyl 36%, clethodim + haloxyfop 22.6%, and clethodim 12%, which may be contributed to the high effectiveness of these herbicides on the elimination of *P. minor*, which helped in decreasing competition between faba bean crop plants and *P. minor* weed on essential resources, improving and increasing faba bean vegetative growth, pods formation and seed yield. In the same manner, the effectiveness of some herbicides such as clethodim + bentazon, haloxyfop, and imazethapyr, and hand weeding on weeds in faba bean fields have been confirmed and resulted in an increase in faba bean seed yield and its components (El Mahi, 1991; Aldhahi *et al.*, 2018; Alemu and Sharma, 2018; Fakkar and Khlifa, 2018).

In the present study, severe competition between *P. minor* and faba bean plants in the weedy control plots led to unacceptable faba bean yield losses. The seed yield loss in *V. faba* crop due to weeds was 60% versus a weed-free control (Frenda *et al.*, 2013). Less effectiveness of quizalofop-p-ethyl 5% and fenoxaprop-p-ethyl 7.5% on *P. minor* may be due to the lower yield than other herbicides. Poor control of *P. minor* by fenoxaprop was reported due to resistance evolution (Chhokar and Shar, 2008; Abbas *et al.*, 2018). Quizalofop induced genotoxic effects on the root cells of different plants such as faba bean and sunflowers (Karaismailoğlu *et al.*, 2013; Çelik *et al.*, 2022). Mahakavi *et al.* (2014) also indicated the negative effects of quizalafop on enzymes, photosynthetic pigments, growth, and yield of *Vigna mungo* L. crop.

II-Broadleaf Weeds Control Experiment:

In the second experiment, major broadleaf weeds infesting the faba bean field in Plant Protection Department Farm were: *Ammi majus* L. (bishop's flower), *Beta vulgaris* L. (weed beet), *Cichorium pumilum* Jacq. (Small chicory), *Rumex dentatus* L. (toothed dock), *Snochus oleraceus* L. (annual sowthistle), and *Chenopodium murale* L. (nettle-leaved goosefoot) at 68 days after crop sowing (DAS) in 2021-2022 (Table 5). Among these broadleaf species, *B. vulgaris*, *C. pumilum*, and *A. majus* were the most dominant in the weedy control plots (Table 5). Bentazon 48% herbicide achieved excellent efficiency against individual and total broadleaf weeds in the experimental faba bean field at 68 DAS (Table 6). The efficacy of bentazon 48% against individual broadleaf in the treated field at 68 DAS was presented in Table (6). The herbicide bentazon 48% completely controlled *A. majus* weed plants (100%) while, it reduced the density of *B. vulgaris*, *C. pumilum*, *R. dentatus*, *S. oleraceus*, and *C. murale* by 98.12 to 99.77% and their fresh weight by 99.73 to 99.99%, versus the weedy control (Table 6). Bentazon 48% also performed a significant reduction of total broadleaf species density by 95.07% and its fresh weight by 99.44% compared to the weedy check (Table 6). El-Gedwy *et al.* (2020) found that the application of bentazon 48% at 571.4 g a.i./ha in faba bean field significantly reduced dry biomass of total broad-leaved by 91.50 - 92.30%, versus the control. Bentazon as a photosynthesis (II)-inhibitor herbicide can selectively control many broad-leaved weeds in various vegetables and agronomic crops such as faba bean and increased their yields (Vencill, 2002; Aboali and Saeedipour 2015; El-Gedwy *et al.*, 2020).

In the present study, a high faba bean seed yield (5049.21 Kg ha^{-1}) was recorded in plots treated with bentazon 48%, while a low seed yield (1538.10 Kg ha^{-1}) was from the weedy control plots, with a similar statistical difference (Table 7). In despite, bentazon 48% treatment increased the crop yield by 69.54% over the control (Table 7). In the same manner, bentazon 48% at 0.576 Kg a.i. ha^{-1} reduced the fresh and dry biomass of broad weeds (such as *B. vulgaris*, *Chenopodium album*, and *Melilotus indica* L.) by 89.51% and 90.23%, respectively in faba bean and then increased plant yield by 76.5% over control (El-Shahawy, 2008). A tank mixture of bentazon 48% at 1.5 L ha^{-1} with haloxyfop 10.8% at 0.6 L ha^{-1} or fenoxaprop 12% at 0.7 L ha^{-1} exhibited controlled weeds populations by 55.83% and 31.23%, and reduced the weed dry biomass by 98.60 and 95.70%, respectively versus to untreated control in broad bean and they increased the crop yield by 60.70 and 65.03%, respectively (Aboali and Saeedipour, 2015). The higher seed yield of faba bean in the bentazon treatment in comparison to the non-treated control may result from the efficiency of this herbicide in the control of broad weeds there. Similar results were also confirmed in other previous research (El-Shahawy, 2008; Aboali and Saeedipour, 2015; Mohamed, 2017; El-Gedwy *et al.*, 2020).

Table 5. Density and fresh weight of broadleaf weeds found in weedy control plots in faba bean field at 68 days after sowing during 2021/2022.

Broadleaf weed species	Family	Weed density (n m^{-2})	% Weed density	Weed fresh weight (g m^{-2})	% Weed fresh weight
Ammi majus L.	Apiaceae	28.00±1.15b	19.72±0.81b	36.49±16.2b	2.46±1.08c
Beta vulgaris L.	Amaranthaceae	53.33±5.70a	37.56±4.01a	1070±202.33a	72.16±13.65a
Chenopodium murale L.	Amaranthaceae	3.33±1.76c	2.35±1.24c	29.79±17.89b	2.01±1.21c
Cichorium pumilum Jacq.	Asteraceae	45.33±9.62a	31.92±6.77a	40.60±272.21b	18.36±2.74b
Snochus oleraceus L.	Asteraceae	3.33±1.33c	2.35±0.94c	37.30±11.06b	2.52±0.75c
Rumex dentatus L.	Polygonaceae	8.67±1.33c	6.10±0.94c	36.94±8.78b	2.49±0.59c
Total broadleaf weeds		142.00±15.01	100.00	1482.73±182.30	100.00

Means within each column with the same letters are not significantly different (at $p < 0.05$) of L.S.D. test.

Table 6. Effect of bentazon herbicide on density and fresh weight (g m^{-2}) of broadleaf weeds in faba bean filed at 62 days after sowing during 2020/2021.

Treatments	Control	Bentazon		Control	Bentazon	
Broadleaf weed species	Weed density (n m^{-2}) †	Weed density (n m^{-2}) †	% Control[(a)]	Fresh weight (g m^{-2}) ‡	Fresh weight (g m^{-2}) ‡	% Control[(b)]
Ammi majus L.	28.00±1.15a	0.00±0.00b	100.0±0.00***a***	36.49±16.20a	0.00±0.00b	100.0±0.00***a***
Beta vulgaris L.	53.33±5.70a	1.33±0.67b	99.06±0.47***ab***	1070.0±202.33a	1.32±0.99b	99.91±0.07***ab***
Chenopodium murale	3.33±1.76a	0.33±0.33a	99.77±0.23***a***	29.79±17.89a	0.18±0.18a	99.99±0.01***a***
Cichorium pumilum Jacq.	45.33±9.62a	2.67±0.33b	98.12±0.23***b***	40.60±272.21a	4.06±1.89b	99.73±0.13***b***
Snochus oleraceus L.	3.33±1.33a	1.00±0.58a	99.30±0.41***ab***	37.30±11.06a	1.26±0.97b	99.92±0.07***ab***
Rumex dentatus L.	8.67±1.33a	1.67±0.88b	98.83±0.62***ab***	36.94±8.78a	1.50±0.80b	99.90±0.05***ab***
Total broadleaf weeds	142.00±15.01a	7.00±1.15b	95.07±0.81	1482.73±182.30a	8.32±3.24b	99.44±0.22

Means within each row († for weed density and ‡ for weed fresh weight; separated for each weed species in bentazon and control treatments) and a column (percent reduction in weed density (a) and weed fresh weight (b)) with the same light or bold letters are not significantly different based on L.S.D. at $p < 0.05$. Broadleaf weeds data were subjected to square-root transformation equation $\sqrt{(X+1)}$ before analysis.

Table 7. Faba bean seed yield (Kg ha^{-1}) and percentage of seed yield increased as affected bentazon herbicide in faba bean filed during 2020/2021.

Treatments	Seed yield (kg ha^{-1}) *	% Increase seed yield
Bentazon	5049.21±530.81a	69.54±3.60
Control	1538.10±547.62a	-

*Means within each column with the same letters are not significantly different (at $p < 0.05$) of L.S.D. test.

Conclusion

In conclusion, among all the lipid-inhibitor herbicides and hand hoeing treatments, clethodim 24%, thiobencarb 50%, diclofop-methyl 36%, clethodim + haloxyfop 22.6%, and clethodim 12% were the most effective treatments against *P. minor* in faba bean field in Assiut area and they also achieved the highest crop yield than other treatments and the weedy control. Bentazon 48% was very effective against common noxious broadleaf weeds in faba bean and it produced a higher seed yield than the weedy control. Therefore, these former lipid inhibitors (particularly clethodim 24%, thiobencarb 50%, diclofop-methyl 36%, clethodim + haloxyfop 22.6%) and bentazon 48% may be considered as new powerful and safe post-emergence herbicides for controlling weeds in a field of faba bean *cv.* Giza 843 in Upper Egypt. More field research is still needed to evaluate the effects of these and other pre- and post-emergences herbicides on the growth and yield of faba bean cultivars and their associated weeds in Egypt.

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